UDC 336.276.2:336.717

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IMPROVING THE BANK CREDIT RISK MANAGEMENT BY MEANS OF REGULATION OF ITS BRANCH CONCENTRATION

Overcoming consequences of the financial and economic crisis of 2008-2010 put on the agenda the question of forms and methods of bank risk management. As the Nobel laureate in economics Joseph Stiglitz said "Чрезмерные риски, на которые пошли банки, множество конфликтов интересов и широкие масштабы мошеннических действий – все эти уродливые явления неоднократно выходили на первое место, когда бум в конце концов оканчивался крахом, и в этом отношении нынешний кризис не является исключением"[1] [1, p. 189]. While lending retains the most profitable component of bank assets, credit risk remains the principal risks inherent to banking activities.

A large number of works by national and international experts is devoted to problems of bank credit risk management. Among foreign studies are noteworthy papers on methodology and practice of bank credit portfolio management (E. Morsman jr. [2]), credit risk analysis (R. Merton [3] – a structural approach; P. Artsner, F. Delbaen [4] - reduced form approach, D. Duffy [5], R. Jarrow [6] – incomplete information approach), study on the influence of sectoral loan portfolio concentration on economic capital (K. Düllmann [7]). In fact these approaches and models of credit risk assessment are of market type. Their use is fully justified in the case of acceptance of the hypothesis about the effectiveness of the stock market as an indicator of sustainability of enterprises. In modern conditions, when the stock market has lost its economic function of determining the value of companies to raise their funds, in terms of institutional and technological backwardness of the stock market the possibility of using these models is very limited.

The possibility of adapting the developed approaches to modern institutional framework are presented in the works of many Russian experts, among which should be noted A. Mishchenko and A. Chizhova [8] - single-criterion optimization of the loan portfolio on the basis of the H. Markovitz problem, M. Pomazanov [9] - methodology for the verification and optimization of the internal rating system of the bank (IRB-approach), T. Pustovalova, R. Kutuev [10] – the practical implementation of CreditMetrics model for credit risk assessment, E. Solozhentsev [11] - transparency analysis of credit risk assessment methodologies and ratings, etc. Among Ukrainian specialists we should mention I. Annenkov [12] – consideration of institutional factors in evaluating creditworthiness of borrowers, V. Galasyuk [13] – methodological problems of evaluating the creditworthiness of borrowers, L. Primostka [14] – the study of the banking risks management process, Yu. Bugel [15] – the organization of the bank loan portfolio management, etc. However, consideration of branch characteristics of credited enterprises in credit risk assessment was not adequately reflected. This is especially true for large banks that lend to businesses in various industries. In this regard, in order to reduce the overall risk of the bank's portfolio it is particularly important to regulate branch concentration of credit risk. Methodological and applied aspects of the implementation of credit risk management practices, in particular of the diversification draw much attention in the scientific literature, but the problem of branch diversification of bank credit investments is usually considered at the conceptual, formulating level. Questions of methodical adaptation of known theoretical

[1] "Excessive risks that banks have taken, many conflicts of interest and widespread fraud - all these ugly phenomena repeatedly came out on top when the boom eventually ended in a crash, and in this respect the current crisis is no exception".

ISSN 1562-109X
2014, № 1 (65)

approaches to the real practice of regulating branch concentration of credit risk in the bank and the relevant practical aspects of their implementation remain underdeveloped.

The objective of this article is to ground the scientific and methodical approach to credit risk management of the bank on the basis of regulating their branch concentration and developing on this basis practical recommendations to diversify its loan portfolio, taking into account branch factors.

Approaches used to optimize the bank's loan portfolio are methodically based on the analogy of securities portfolio and use for these purposes H. Markovitz problem [16]. On one hand it is justified, because either buying securities or giving money as a loan are different institutional ways of fixing the debt. The first method is used in the case of well developed stock market, the second way - in banking driven economies. Furthermore, both cases of portfolio diversification by H. Markovitz involve determining the optimal structure of investments, minimizing risk and maximizing revenue. However, in the case of securities portfolio, this model operates two main parameters - return of a security and its risk, as measured by standard deviation of return.

Return of a security is determined for representative historical period by grouping the data for previous uniform periods and calculating on this base simple average (variation) of the return.

Expected risk of a security is calculated as the standard deviation of return from its expectated value. In this case it is assumed that statistics (standard deviation, variance, variation) is the measure of the relative risk of the asset in the portfolio, as a measure of the variability of the object, they reflect the level of uncertainty of the future course of events, which in fact is an expression of risk.

In the case of loans its return is determined by the interest rate, which in turn is closely related to the value of the discount rate of the Central Bank. In most cases, loans to enterprises of different branches have the same interest rate, and currently the variation of interest rate is not used as a tool of the branch risk regulation.

And as the return on loans is not a statistic, therefore, the calculation of its standard deviation in order to use it to assess the risk is unreasonable. Therefore it is necessary to use a fundamentally different measure to assess branch risk to optimize the loan portfolio.

Assessment of the risk of lending to different branches of economy uses a variety of quantitative and qualitative indicators: the growth rate of sales revenue, level of profitability, solvency, liquidity, turnover of the bank's loans, the share of term debt in total debt on bank loans, the dynamics of overdue bank loans, loans to the estimated amount of bank reserves ratio, reserve ratio by category of credit transactions etc. All these and other indicators are used at different stages of credit risk management and are used for the analysis and evaluation of the borrowing companies, reflecting different aspects of their interaction with the bank. So the level of solvency, liquidity and dynamics of overdue bank loans are mainly used in the management of credit risk at the individual loan and characterize financial condition of the borrowing companies. Loans to estimated amount of reserves ratio, the bank reserve ratio by category of credit operations are mainly used for grounding of reserves for credit operations of the bank.

In order to use in the optimization model of the bank loans to assess the risk of economy branch lending should take measures that characterize the branch as a separate lending entity. These indicators can be output (sales revenues) and profitability of the branch. Output is an absolute indicator that characterizes the branch quantitatively. In this regard, certain parallels can be made between the amount of production in the sector and the monetary expression of offer of securities in the stock market. Profitability, as a relative measure, comprehensively characterizes the degree of efficiency of the use of material, labor, money and natural resources in the sector. And drawing a parallel with the stock market, we can say that the profitability index is similar to the return of the security.

If the output, describing the supply of the branch, depends largely on the number of external factors (resource prices, production technology, taxes and subsidies, prices of other goods , the number of sellers in the market, promising expectations of producers, seasonal changes , changes in demand for other products), the profitability reflects the efficiency of resource use and depend on a number of internal factors (prices for materials and semi-finished products,

wages, seles prices, the range and quality of products).

And to build risk indicator for branch lending it is interesting not indicators of output and profitability, but their limiting values (derivatives), which characterize the rate of change of the relevant indicators. So lending to growing industries is more preferably due to the rapid growth of financial indicators of borrowing enterprises. Investors on the stock market also prefer fast-growing companies. Consequently, the lending risk should be inversely proportional to the rate of output growth. Similarly, more attractive for lending branches with growing profitability, it means that the risk of lending is also inversely proportional to the rate of change in profitability.

However, if the derivatives are negative, that indicates that the functions of output and profitability are declining, the corresponding value of the derivative should not decrease but increase the risk of lending, therefore, in this case it is directly proportional to the absolute value of these derivatives.

In general, the risk of lending is inversely proportional to the positive value of the risk factor rate of change and is directly proportional to the absolute value of its negative rate of change.

For values of the derivative in the interval [0, 1], despite their positive sign, the same formula for calculating the risk is used that as for negative values of derivatives as an asymptotic approximation of the risk function in this interval to zero distorts the calculated risk, bringing it closer to infinity that obviously does not make economic sense. This explains the value of 1 instead of 0 in the formula 2 for risk calculation.

For equivalent consideration for all risk factors it is necessary to valuate output and profitability before constructing approximating curves and calculation of derivatives. Then, the corresponding graphs are positioned in the range [0, 1].

For indicators valuation is used the following formula:

$$P_i^n = \frac{P_i - P_{\min}}{P_{\max} - P_{\min}}, \qquad (1)$$

where P_i^n, P_i, P_{min}, P_{max} – respectively normalized, current, minimum, maximum value of the index.

Thus, the general expression for the risk can be written using the following formula:

$$\sigma = \begin{cases} \dfrac{1}{R'^n \cdot V'^n}, & \mathrm{R'^n} \geq 1,\ \mathrm{V'^n} \geq 1 \\ \dfrac{\left|\mathrm{R'^n}\right|}{V'^n}, & \mathrm{R'^n} < 1,\ \mathrm{V'^n} \geq 1 \\ \dfrac{\left|\mathrm{V'^n}\right|}{R'^n}, & \mathrm{R'^n} \geq 1,\ \mathrm{V'^n} < 1 \\ \left|R'^n\right| \cdot \left|V'^n\right|, & \mathrm{R'^n} < 1,\ \mathrm{V'^n} < 1, \end{cases} \qquad (2)$$

where R'^n, V'^n – respectively derivatives of normalized functions of branches profitability and output.

Accordingly the problem of optimization of the bank loan portfolio based on branches diversification of credit investments can be formulated as follows.

Let x_i – share of loans to the i-th branch ($i = \overline{1,N}$), d_i – profitability of loans to the i-th branch, D – expective return of the loan portfolio, L – free bank reserve (pool of money that is currently available in the bank and can be used for active operations), L_i – loan limit of i-th branch. Loan portfolio optimization problem reduces to choosing a portfolio structure (x_i), which return is not less than the value of return D (constraint (4)), and the risk is minimal (the objective function (3)). Economic and mathematical model of the problem in this case takes the following form:

$$\sqrt{\sum_{i=1}^{N} x_i^2 \sigma_i^2} \to \min; \qquad (3)$$

$$\sum_{i=1}^{N} d_i x_i \geq D; \qquad (4)$$

$$x_i L \leq L_i,\ \mathrm{i} = \overline{1,\mathrm{N}}; \qquad (5)$$

$$\sum_{i=1}^{N} x_i = 1; \qquad (6)$$

$$x_i \geq 0,\ \mathrm{i} = \overline{1,\mathrm{N}}. \qquad (7)$$

Expression (5) describes the condition of non-excess of the loan limit for each industry. Equation (6) means that the sum of the shares of credit investments across all branches is equal to 1, the expression (7) constrain the non-negativity of the x_i variables.

Implementation of the described tasks was carried out on the example of "General Directorate of Prominvestbank in Donetsk region".

The loan portfolio is represented by the following seven branches: mining and quarrying of energy minerals, mining and quarrying except energy, food processing, beverages and tobacco; metallurgical production and fabricated metal products; machinery and equipment manufacturing, distribution, repair of motor vehicles, household goods and personal items; transport and communications. Initial data for the loan portfolio optimization are shown in Table 1 (the designation of economic activity at the appropriate classifier is given in parentheses in Latin). Financial indicators are in constant prices of 2010.

Table 1

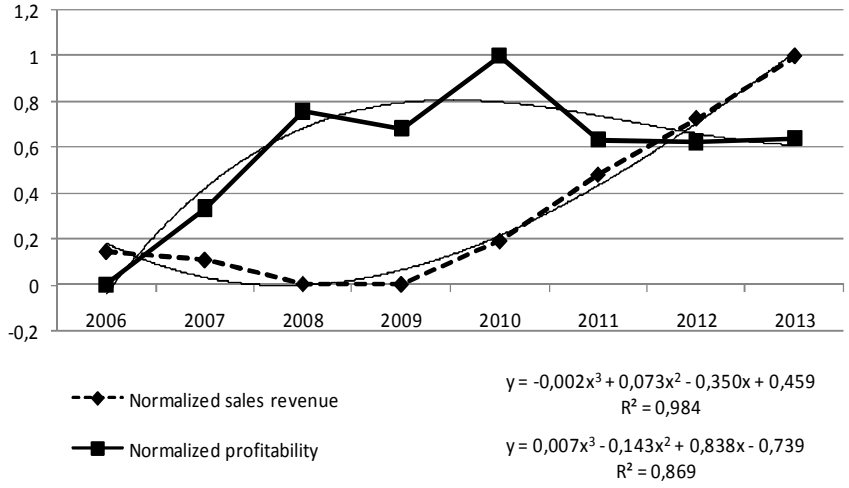
Initial data for the loan portfolio optimization

Indexes	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1	2	3	4	5	6	7	8	9
Mining and quarrying of energy minerals (CA)								
(Financial result/ operational costs)*100, %	-2,10	-4,30	-4,50	-8,10	-6,90	-5,50	-3,23	-3,04
Normalized	1,00	0,63	0,60	0,00	0,20	0,43	0,81	0,84
Sales revenue, mln UAH	38149,43	25730,93	24459,93	22100,17	22419	31321,84	33878,88	37494,67
Normalized	1,00	0,23	0,15	0,00	0,02	0,57	0,73	0,96
Deflator	112,15	140,73	164,90	86,73	108,90	-	-	-
Mining and quarrying except energy (CB)								
(Financial result/ operational costs)*100, %	4,60	10,50	18,00	16,70	22,30	15,80	15,62	15,95
Normalized	0,00	0,33	0,76	0,68	1,00	0,63	0,62	0,64
Sales revenue, mln UAH	4131,19	3951,06	3433,02	3424,91	4360,00	5790,00	7006,00	8352,00
Normalized	0,14	0,11	0,00	0,00	0,19	0,48	0,73	1,00
Deflator	112,15	140,73	164,90	86,73	108,90	-	-	-
Production of food products, beverages and tobacco (DA)								
(Financial result/ operational costs)*100, %	1,90	1,90	0,60	1,30	1,30	2,00	2,10	2,40
Normalized	0,72	0,72	0,00	0,39	0,39	0,78	0,83	1,00
Sales revenue, mln UAH	15768,84	16630,85	11567,11	14358,23	16348	21438	21721	25208,67
Normalized	0,31	0,37	0,00	0,20	0,35	0,72	0,74	1,00
Deflator	115,03	118,55	164,90	86,73	113,90	-	-	-
Metallurgical production and production of metal goods (DJ)								
(Financial result/ operational costs)*100, %	6,30	7,30	6,40	3,20	0,00	0,20	1,50	1,81
Normalized	0,86	1,00	0,88	0,44	0,00	0,03	0,21	0,25
Sales revenue, mln UAH	120896,9	135530,3	108756,5	88068,2	121185,8	172070,0	201665,0	233060,0
Normalized	0,23	0,33	0,14	0,00	0,23	0,58	0,78	1,00
Deflator	115,03	118,55	164,90	86,73	113,90-	-	-	-
Production of machines and equipment (DK)								
(Financial result/ operational costs)*100, %	2,70	3,60	1,70	1,70	4,50	6,10	5,80	5,60
Normalized	0,23	0,43	0,00	0,00	0,64	1,00	0,93	0,89
Sales revenue, mln UAH	26217,86	28310,56	20442,08	17622,04	19622,52	21623,00	23570,00	27761,00
Normalized	0,80	1,00	0,26	0,00	0,19	0,37	0,56	0,95
Deflator	115,03	118,55	164,90	86,73	113,90	-	-	-
Distribution, repair of motor vehicles, household goods and personal items (G)								
(Financial result/ operational costs)*100, %	13,10	15,00	10,80	7,40	9,40	9,20	8,90	9,00
Normalized	0,75	1,00	0,45	0,00	0,26	0,24	0,20	0,21
Sales revenue, mln UAH	248132,0	264343,0	238041,2	149472,5	25873,9	215031,0	260792,0	316077,0

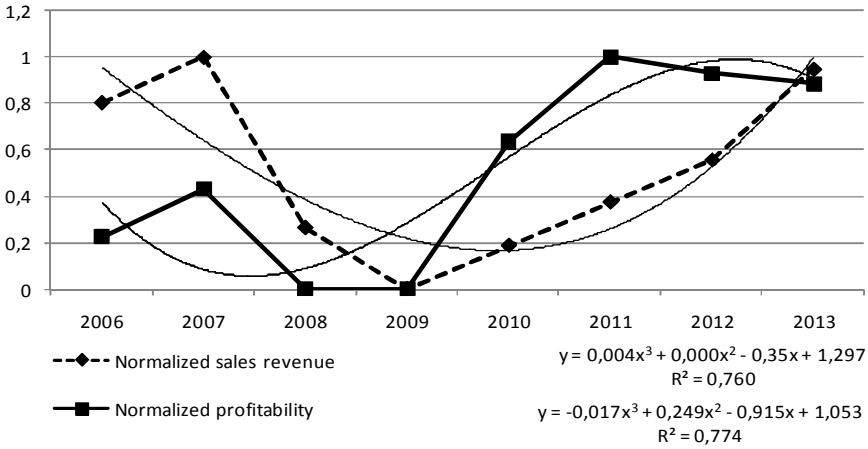
Ending of Table 1

1	2	3	4	5	6	7	8	9
Normalized	0,77	0,82	0,73	0,43	0,00	0,65	0,81	1,00
Deflator	103,65	120,38	135,75	119,98	115,00	-	-	-
Transport and communications (I)								
(Financial result/ operational costs)*100, %	3,90	3,60	3,80	6,80	7,90	8,30	8,70	9,20
Normalized	0,05	0,00	0,04	0,57	0,77	0,84	0,91	1,00
Sales revenue, mln UAH	20932,65	21815,53	25643,68	22095,13	24502,4	27842	34405	42458
Normalized	0,00	0,04	0,22	0,05	0,17	0,32	0,63	1,00
Deflator	109,80	114,60	113,55	120,43	115,00	-	-	-

Using the data we plot normalized graphs of branches profitability and sales revenues. Presented graphs are well approximated by a polynomial of the third degree. Fig. 1 shows the dynamics of normalized sales revenue and profitability of branch operations using the third degree polynomial trend line on the example mining and quarrying except energy (same directional change of indicators) and production of machines and equipment (different vector-change of indicators).



a) mining and quarrying except energy



b) production of machines and equipment

Fig. 1. Dynamics of normalized sales revenue and profitability of operation activity of Donetsk region branches

According to the obtained equations, using the known rules of differentiation, we calculate the values of the derivatives at the last point using the following formula:

$$f'(x) = n * f(x)^{n-1}, \text{ for } f(x) = x^n, \quad (8)$$

where $f(x)$, $f'(x)$ – respectively polynomial function and its derivative.

Results of calculations are shown in Table 2.

Table 2

Branches lending risks calculations

Branches	Derivative of normalized profitability (R'^n)	Derivative of normalized sales revenue (V'^n)	Risk (σ)
Mining and quarrying of energy minerals (CA)	0,320	0,159	0,051
Mining and quarrying except energy (CB)	-0,019	0,322	0,006
Production of food products, beverages and tobacco (DA)	0,091	0,150	0,014
Metallurgical production and production of metal goods (DJ)	0,517	0,340	0,176
Production of machines and equipment (DK)	-0,227	0,584	0,133
Distribution, repair of motor vehicles, household goods and personal items (G)	0,152	0,574	0,087
Transport and communications (I)	-0,174	0,532	0,092

It should be noted about setting a loan limit for branches. Limitation, along with the diversification, reservation, securitization, is a separate method of credit risk management. It is about setting maximum allowable size of loans to one or a group of related borrowers, which allows limit the risk to a certain extent.

Limits are defined as the maximum amount of the loan or loan direction and are expressed as absolute limit values (loan amount in monetary terms), and in relative terms (coefficients, indexes, norms). The base for calculating limits is determined primarily by the bank's credit policy and can be determined from the value of the bank's capital, the value of its loan portfolio, the balance-sheet and other indicators. Loan limit for borrowers of particular branch can be defined as the maximum aggregate amount of branch funds or as the average value of branch loans for a number of previous time periods.

In the presented computational experiments as a branch credit limit aggregate amount of branch funds was taken, which can be explained by the presence of this indicator in branch statistics. Loan debt may be used for this purpose. However, given that in recent years due to the effects of the financial and economic crisis of 2008-2009, when lending to businesses has been virtually suspended, changes in loan debt does not always mean the issuance of new loans, and to a greater extent due to the repayment by enterprises of already existing debt, the use of this indicator is not always justified. In addition, the establishment of reasonable loan limit is relatively independent scientific and practical problem (see [17]) and is not included in the present study areas.

Thus, the central element of the proposed methodological approach to branch diversification of risks in the bank loan portfolio is the use of not only actual but also forecast data of the branches development. This approach is methodologically different from calculations based on actual data on the following points of view.

So in the classic H. Markovitz problem of investment portfolio diversification the data about securities return and its variations are determined for representative historical period with an implicit prerequisite that the same trends will remain in the future. These indicators are defined retrospectively and assessed statically at the time of calculation. In the proposed ap-

proach, the lending risk is associated with the branches future. Long-term lending of a stagnant branch is not justified, even if it's financial indicators are high.

Another fundamental aspect is the use is not absolute, but limit values for the calculation of risk. By this mean cyclical trends in branches development is taken in account. So for growing branch risk, determined by the derivative at the time of calculation, is positive and is proportional to the absolute value of the growth rate, for stagnant – it is negative and its absolute value is proportional to the decrease rate.

Equally important in the proposed approach is the use of the calculation of the risk of not only financial indicator of branch profitability, but also the sales revenues (output). This is justified by economic factors, as sales revenues and financial indicators are determined by factors of a different nature and institutional factors. In circumstances where there is a propensity to conceal the actual financial results and distort financial statements, statistical data on the branches profitability can be questioned. However, the "safe" industry sales revenues will grow, and the "dysfunctional" will decline.

The essential difference of the proposed approach to the bank loan portfolio diversification is the consideration of the branch loan limitations. So in the classical H. Markovitz problem it is assumed that in order to maximize their profitability or minimize the risk an investor can buy any number of securities of different companies. When lending of branhes should consider their specific "bandwidth". So different branches have different loan requirements. As a rule, in the current economic conditions loans to enterprises are given for working capital, and therefore a statistically significant relationship between the branch working capital and the value of its loans can be traced.

Finally, the proposed approach implements R. Foster's principle of considering technology life cycle in branch lending (see concept of the S-shaped curve reflecting the emergence, abrupt growth and gradually achieving full maturity stage of a process or a product [18]). It is necessary for lending companies not only analyze current financial performance but technology life-cycle phase of the branch.

The calculation of the optimal loan portfolio is made on forecast data of The informational and analytical system of budgetary process support on regional level (IASBP) [19]. One of the IASBP objects is analysis of real sector of the economy enterprises, grouped by type of economic activity. The complex of mathematical models of the region's economy formed in the system is designed to predict trends in the development of real and financial sectors of the economy in the medium term. The choice of sectors for modeling economic development in the region in IASBP is performed using a methodical approach, grounded in the work [20] on the basis of the following criteria:

share of tax revenues of particular branches in the total sum of region's tax revenues (all possible types of economic activity are considered from the point of the budgeting, tax revenue of selected branches to the budget of region should be more than 90% of total tax revenue);

output (aggregate amount of sales revenue of selected industries should be almost 100% of the total sales revenue);

branch typicality (typical region's branches should be chosen for modeling).

The following economic activities are selected for Donetsk region in IASBP: production of energy minerals, mining and quarrying except energy, metallurgy and production of fabricated metal products, distribution, repair of motor vehicles, household goods and personal items, production of food, beverages and tobacco products, production of machinery and equipment, transport vehicles and equipment. The validity of the branches set is confirmed by the real data on a loan - these branches is given loans. The following are the basic data for the loan portfolio optimization. Data of 2006-2010 is actual, of 2011-2013 is forecasted. Financial indicators are used in comparable prices.

Let's accept the portfolio return of 14%. Bank's free resources for lending amounted to the beginning of the calculation period 500 mln UAH. Calculation of the optimal portfolio is made by using "Solver" spreadsheet application of MS Excel, the results are shown in Table 3.

Table 3

The results of calculating the optimal loan portfolio

Branches	Return (d_i), %	Risk (σ)	Shares (x_i)	x_i^2	σ_i^2	Amount of branch loan, mln UAH	Loan limit (L_i), mln UAH
Mining and quarrying of energy minerals (CA)	14	0,051	0,012	0,000	0,003	6,10	1552,41
Mining and quarrying except energy (CB)	14	0,006	0,806	0,650	0,000	403,20	1258,06
Production of food products, beverages and tobacco (DA)	14	0,014	0,171	0,029	0,000	85,39	961,69
Metallurgical production and production of metal goods (DJ)	14	0,176	0,001	0,000	0,031	0,51	9099,43
Production of machines and equipment (DK)	14	0,133	0,002	0,000	0,018	0,89	1586,06
Distribution, repair of motor vehicles, household goods and personal items (G)	14	0,087	0,004	0,000	0,008	2,07	7022,93
Transport and communications (I)	14	0,092	0,004	0,000	0,009	1,84	1161,78

The results of this numerical experiment show that mining and quarrying except energy is the most preferred for lending. Its share in the optimal loan portfolio will be 0,81.

On second position is the production of food, beverages and tobacco (its share is 0,17). Mining and quarrying of energy minerals in the prospective portfolio takes third place according results of computer simulation (its share is 0,012). The least preferred is the lending of metallurgical production and production of metal goods, the corresponding share in the optimal portfolio decreased to 0,001. The achieved lowest value of risk is 0,00561.

Thus, the developed procedure of the loan portfolio formation is the basis for the implementation of the proposed approach to the regulation of the branch concentration of bank credit risk. It includes analyzing of the existing loan portfolio and choosing of branches to form a new portfolio, building and analyzing time series of branch revenues and profitability, calculating of risk indicators for each branch based on the limits of sales revenues and profitability in the forecast period, loan portfolio optimization by minimizing the risk, taking into account branches loan limits with achieving the expected return.

Approbation of the proposed approach on the example of the branch "General Directorate of Prominvestbank in Donetsk region" based on actual data for years 2006-2011 and forecast data for 2012-2013 was performed. The optimization of the loan portfolio shows the practicability of changing the loan portfolio structure, namely:

reduction of lending to mining and quarrying of energy minerals, metallurgical production, production of machines and equipment distribution, repair of motor vehicles, household goods and personal items to 447; 268; 371 and 2.377 mln UAH respectively;

increasing of lending to mining and quarrying except energy, production of food products, beverages and tobacco, transport and communication activities to 2964, 499 and 1 mln UAH respectively.

According to the analysis of the quality of the newly formed portfolio the expected reduction in the size of reserves for compensation of possible losses on loan operations of the bank in the amount of 127 to 196 mln UAH was revealed, that demonstrates the effectiveness of the proposed approach and allows recommending its perspective implementation in large Ukrainian banks. It should be noted that consideration of branches life cycles relationship in the developed model should be perspective of research in this direction.

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Received on 21.01.2014