"A model for achieving the allocative efficiency of credit resources in Ukraine's banking system"

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A model for achieving the allocative efficiency of credit resources in Ukraine's banking system

Abstract

The article presents a model for achieving the allocative efficiency of credit resources in Ukraine's banking system. The research involves establishing a set of criteria for assessing a borrower's creditworthiness and analyzing them by means of the discriminant analysis, Helwig's methods, cluster analysis, the dendrite method, and principal component analysis; the methods are, then, contrasted. This is followed by designing an optimal credit portfolio of the banking system and comparing it with actual credit portfolios with the help of similarity metrics.

Keywords: banking system, borrower's creditworthiness, credit portfolio, statistical methods, similarity metrics.
JEL Classification: G22, E51, C14, C18, C61.

Introduction

Nowadays the capacity of the banking system to support the growth of other economy sectors requires a scientific approach to allocating its credit resources. Allocation refers to the distribution of financial resources among various sectors and institutions with a view to analyzing their movement and efficiency. In this respect, it seems appropriate to use the term "allocative efficiency", i.e., efficient distribution of funds within the banking system aimed at reducing transactional expenses.

In Ukraine, achieving allocative efficiency is fraught with the following challenges: insufficient funding of the real economy sector which results from diverting funds to other transactions, often for speculative purposes; concentration of financial resources in the most profitable branches – trade and finance; insufficient funding of innovative activities; round-trip transactions which involve sending capital abroad and, then, disguising it as foreign investments; disproportional distribution of funds within the state budget jeopardizes the interests of municipal budgets; insufficient funding of small businesses; credibility issues with investment and banking services.

The abovementioned issues are related to the so-called "allocative failures", i.e., lack of balance in the distribution of finance within the banking system as a whole and in individual economic sectors.

In Ukraine, the stability of the banking system is determined largely by the ratio of loans provided to an economy sector to total gross loans issued to banks. Therefore, it is crucial for national economy as a whole and for its banking system in particular to explore "the allocative efficiency of credit resources within the banking sector", because the latter actually serves as "the circulatory system" of economy.

Therefore, achieving the allocative efficiency of credit resources within the banking system means promoting the development of its financial relations and processes and spending its consolidated financial resources in line with the strategies developed by the national economy and the banking sector. This involves the following processes:

1) consolidating the goals of individual units within the banking system in the interests of national economy, which boosts the country's financial security;
2) allocating credit resources into statutory assets;
3) combating corrupt practices in the banking sector.

Being the regulator of financial relations in the banking sector, the state must order the National Bank of Ukraine to assist banking institutions with resolving the following urgent issues: securing consumer rights; reforming economic structure; promoting the development of banking services; building an efficient institutional environment of the banking system; participating in integration processes, for instance, with the EU.

However, customers applying to commercial banks for loans must provide truthful information for the analysis of their financial state and subsequent assessment of their creditworthiness. Such analysis is essential for the efficiency of both lending services and banking activity as a whole. As regards the borrowing enterprise, the possibility of obtaining a loan depends on the accuracy in assessing its creditworthiness.

1. Literature review

The overview of the literature on the research area is presented in the following subsections:

1.1. A methodology of identifying a borrower's creditworthiness. Nowadays Ukraine's banking system employs a wide range of creditworthiness assessment methods. Individual banks develop their own assessment systems on the basis of their lending policy, technological potential, specialization, loan terms and conditions, work priorities, market positioning strategies, credibility with customers, the

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country's political and economic stability, etc. A borrower's creditworthiness assessment is regulated by the resolution of the National Bank "On the Procedure for Forming and Using Provisions for Compensation of Possible Losses under Active Banking Transactions" (On approving the Regulation ..., 2012), which identifies the norms of forming reserves which may arise from potential losses in credit transactions by commercial banks.

Creditworthiness assessment issues have been addressed in many studies (Hidulian, 2012; Grytsenko at al., 2010; Derevyahin, 2011), which explore systems of selecting and evaluating indicators used for analyzing creditworthiness of a business largely by means of traditional approaches such as horizontal and vertical analysis, trend analysis, comparative analysis, ratio analysis, point rating, etc. The common feature of the traditional financial analysis methods is that they explore simple mathematical connections between individual sections of financial reports on the basis of calculating a certain selection of indicators (financial coefficients) and comparing them against normative values – industry averages and dynamic indicators. The typical shortcomings of using such a set of indicators for assessing credit risks are as follows: subjectivity in selecting a set of indicators to be analyzed (disregarding multicollinearity, etc.); disregard for (or subjective focus on) the differences in the impact of individual indicators on final results; some of the parameters of financial state are determined with the help of a different number of indicators, which distorts analysis results; internal methods do not consider all financial parameters which affect credit risks; insufficient objectivity of report indicators (manipulating indicators at some levels of management); disregarding the indicators which characterize net cash flow and the ones which neutralize the influence of local taxation specifics, depreciation charges, etc.

Nowadays the discriminant method is the most widely used approach to assessing the creditworthiness of a business. It has been the focus of extensive research by O. Tereschenko (2012); this methodology served as the basis of the current resolution of the National Bank "On the Procedure for Forming and Using Provisions for Compensation of Possible Losses under Active Banking Transactions" (On approving the Regulation ..., 2012). Despite the obvious advantages of this methodology, it is not devoid of shortcomings. A number of issues still remain unresolved; for example, overestimating the role of quantitative indicators with qualitative ones being underestimated; lack of control over selecting a system of basic quantitative indicators; high sensitivity to distortion (invalidity) of the initial data (for instance, of financial reports, which is most typical of domestic borrowing businesses); cumbersome

selections of indicators; numerous indicators which cannot be recorded influence the fact of declaring a borrowing business bankrupt.

1.2. Criteria for optimizing the credit portfolio of the banking system. Achieving the allocative efficiency of credit resources is concerned not only with the methodology for assessing a company's creditworthiness, but also with subsequent optimization of the credit portfolio of the banking system. The majority of banking system optimization models are viewed in terms of risk - profitability correlation; in addition, they are marked by a number of limitations and complexities for practical application.

For example, the abovementioned issue is the focus of international researchers such as Berger at al. (2015), Di Clemento (2014), Salari at al. (2012) and Phillips (2013), who explore the issues of optimizing a bank's credit portfolio by involving the experience of developed countries.

Thus, research by Hrushko and Ivanenko (2014) presents a mathematical model of developing a bank loan portfolio optimized in terms of risk-profit correlation. The research by Zhukova and Zrazhevska (2013) focuses on the management of credit portfolios in terms of risk-profit assessment. Further improvements of the banking system, for instance, bank loan portfolio management, are discussed in the study by Semencha and Tkachova (2014).

A comprehensive system of assessing bank loans at two levels (that of the banking system and an individual bank) is developed in Moldavska and Demidenko (2013). Assessing the quality of the credit portfolio with the view to its effective management under conditions of economic and political instability in Ukraine is presented in Stetsenko (2015). The common feature of these studies is that they all regard optimization in terms of achieving optimal balance between the expected level of profitability, risk and liquidity in the credit portfolio structure. The diversification of the credit portfolio is achieved by means of distributing credits in the following directions: by geographical characteristics, the amount of loan, loan duration, type of currency, loan security.

The studies by Drobnitska (2013), Onyschak (2009), Taranukha (2013) are representative of this approach: they focus on the process of assessing and managing non-performing loans. The researchers suggest a procedure of calculating the cost of credit, methods of assessing a borrower's creditworthiness, methods of identifying reserves on credit operations; in addition, they address the practical aspects of dealing with problematic borrowers, etc.

However, despite extensive literature on the issue, it is necessary to continue research on the optimization of

the credit portfolio of the banking system in terms of identifying the optimal correlation of loans in individual economy sectors to total bank loans. Thus, the research goal is to design a model for achieving the allocative efficiency of credit resources in Ukraine's banking system.

2. Methodology

In accordance with the research goal, designing and implementing the model involves the following stages:

2.1. Selecting a set of units of analysis and the initial set of variables. The set of units of analysis (branches of economy) was selected from Classifi-

cation... (1996) and presented in Table 2. The initial set of variables was compiled from the indicators (financial coefficients) contained in the Resolution (On approving the Regulation ..., 2012) and financial reports (Table 1). This allows for the possibility of comparing the proposed methodology with the approaches previously used (Tereschenko, 2012).

Table 1 presents the indicators selected from various economic activities. As regards the complexity and efficiency of analysis, the financial and economic state of businesses is assessed primarily on the basis of the following four major groups of indicators: liquidity ratio, debt ratio, turnover ratio, profitability ratio, as well as additional ratios.

Table 1. The formation of the initial set of indicators

Indicator	Notation
Coverage ratio (3rd stage of liquidity)	K1
Interim coverage ratio	K2
Financial independence ratio	K3
Asset coverage ratio	K4
Return-on-equity ratio	K5
EBIT profitability ratio	K6
EBITDA profitability ratio	K7
Net profit ratio	K8
Current assets turnover ratio	K9
EBITDA turnover ratio	K10
Investment-to-capital ratio	K11
Profit-to-sales ratio (corrected indicator)	K12
The ratio of net profit enterprises to the total number of enterprises	K13

Source: compiled by the authors on the basis of on approving... (2012).

The last group of indicators illustrates investment and trading, as well the ratio of net profit enterprises to the total number of enterprises. The reason for analyzing investment indicators was that they reflect manufacturing and services and characterize the prospects for the development of the branch. The trading indices indicate the stages in the development of economy sectors. Therefore, we calculated the profit-to-sales ratios, which were corrected in accordance with the consumer price index with a view to elimination the influence of this phenomenon on our findings. The ratio of net profit enterprises was analyzed as an additional profitability indicator.

2.2. Identifying variable stimulators, destimulators and dominants; statistic analysis of the variables. The classification of indicators must be preceded by a comprehensive analysis of their impact on the development of the branch. In this respect, it is important to define variables – stimulators, destimulators and dominants. From the comparison of the indicators, their calculation formulas and their impact, it can be concluded that all the indicators are stimulators.

The next stages include the compilation of the initial set of data and statistical analysis of the variables in order to be able to judge their validity for analyzing the state of the branches. The following characterization parameters were selected: the arithmetic mean, standard deviation, the coefficient of variation, minimum and maximum values, the median, the first decile, the tenth decile, asymmetry coefficient and kurtosis.

2.3. Assessing the borrowers' creditworthiness on the basis of statistical methods and their contrastive analysis. This stage involves forming the final set of indicators on the basis of Dubrov et al. (1998), Kim and Mueller (1989), Kukula (1996):

♦ the nonparametric method developed by Helwig;
♦ the dendrite method of systematizing indicators;
♦ the hierarchical procedure of agglomeration;
♦ the principle of component analysis on the basis of factoring analysis;
♦ the discriminant analysis.

A contrastive analysis of the last two methods will prevent from duplicating information from a certain aspect of financial state, which, in turn, will provide a

comprehensive evaluation of the customer's financial state in terms of various parameters which characterize its activity (liquidity, financial stability, business activity, profitability, other additional characteristics).

The next stage involved normalizing the indicators in order to be able to aggregate them. We calculated aggregated indicators for each group of variables; they were used for classifying the sectors. In order to compute aggregation, the following formula was used:

$$z_i = \sum_{k=1}^{K} \alpha_k z_{ik}, \quad (i = 1, 2, ..., N), \tag{1}$$

where z_{ik} – normalized values of the indicators,

$$\alpha_k = \frac{\sum_{i=1}^{K} |r_{ki}|}{\sum_{k=1}^{K} \sum_{i=1}^{K} |r_{ki}|}, \quad (k, i = 1, 2, ..., K) \quad \text{– their weight,}$$

r_{ki} – elements of the correlation matrix.

2.4. Developing an optimal credit portfolio of the banking system. The next stage involves analyzing results of assessing the creditworthiness of the borrowers (i.e., Ukraine's economic sectors) with a view to developing a credit portfolio of the banking system, which must be optimally structured in line with its significance for the country's economy. The calculation of the credit portfolio was based on a formula which allows for corrections depending on the assets available in an economic sector:

$$w_i = \frac{(z_i - z_M) A_i}{\sum_{i=1}^{N} (z_i - z_M) A_i}, \quad (i = 1, 2, ..., N), \tag{2}$$

where z_M – indicates the minimum values for each economic sector; A_i – represents the assets available in economic sector i. Such changes were made in order to consider the borrowers' financial needs, which is crucial for calculating the amount of loan.

2.5. Comparing the actual credit portfolios against the optimal one with the help of similarity metrics. Analyzing structural similarity of the actual credit portfolios against the optimal one will identify the economy sectors with the most significant differences between the actual and optimal values.

With this end in view, the actual portfolios were compared against the optimal ones by means of similarity metrics (Dubrov et al., 1998; Kim and Mueller, 1989; Kukula, 1996):

$$\mu = \sum_{i=1}^{N} min(w_{1i}, w_{2i}), \tag{3}$$

$$\mu = 1 - \frac{1}{2} \sum_{i=1}^{N} |w_{1i} - w_{2i}|, \tag{4}$$

$$\mu = 1 - \left[\frac{1}{2} \sum_{i=1}^{N} \left(\sqrt{w_{1i}} - \sqrt{w_{2i}} \right)^2 \right]^{\frac{1}{2}}, \tag{5}$$

$$\mu = 1 - \left[\sum_{i=1}^{N} \left| w_{1i}^2 - w_{2i}^2 \right| \right]^{\frac{1}{2}}, \tag{6}$$

$$\mu = \sum_{i=1}^{N} min(w_{1i}, w_{2i}) \Big/ \sum_{i=1}^{N} max(w_{1i}, w_{2i}), \tag{7}$$

$$\mu = 1 - \frac{1}{N} \sum_{i=1}^{N} \frac{|w_{1i} - w_{2i}|}{|w_{1i} + w_{2i}|}, \tag{8}$$

$$\mu = 1 - \left[\frac{1}{N} \sum_{i=1}^{N} \left(\frac{w_{1i} - w_{2i}}{w_{1i} + w_{2i}} \right)^2 \right]^{\frac{1}{2}}. \tag{9}$$

3. Results

The next stage focuses on testing the model for achieving the allocative efficiency of credit resources in Ukraine's banking system. Therefore, as mentioned above, the set of units of analysis (branches of economy) was selected from "The Classification of Economic Activities" presented in Table 4. Further statistical analysis involved only big and medium-sized businesses (The Activity of business...). The financial state of the businesses is presented as a set of 13 indicators whose statistical values are shown in Table 2. As can be seen from Table 2, all the variables are characterized by a high level of differentiation. Most coefficients show right asymmetry, and only the liquidity ratios K1, K2, K4 and additional ratios K12, K13 have left asymmetry. The distribution of ratios K3, K6-K11 and K13 can be considered symmetrical, whereas that of K2 and K5 are clearly asymmetrical.

Table 2. Statistical analysis of indicators of the financial state of Ukraine's economy branches

Indicator	Arithmetic mean	Standard deviation	Minimum value	Maximum value	Coefficient of variation	Median	First decile	Tenth decile	Asymmetry coefficient	Kurtosis
K1	1.159	0.458	0.746	2.485	1.500	1.079	3.199	2.485	-0.663	4.846
K2	0.486	0.184	0.279	1.050	1.587	0.474	1.285	1.050	-0.711	6.387

Table 2 (cont.). Statistical analysis of indicators of the financial state of Ukraine's economy branches

Indicator	Arithmet-ic mean	Standard deviation	Minimum value	Maximum value	Coefficient of variation	Median	First decile	Tenth decile	Asymmetry coefficient	Kurtosis
K3	0.412	0.185	0.096	0.756	1.600	0.387	0.209	1.466	6.039	0.095
K4	0.792	0.499	0.309	2.275	2.481	0.627	1.150	2.275	-3.152	5.366
K5	0.033	0.139	-0.124	0.475	17.963	0.018	-0.226	0.475	1.870	7.670
K6	3.613	8.538	-1.600	21.700	10.876	2.800	-17.600	21.700	0.926	2.853
K7	0.053	7.660	-19.600	15.600	660.000	0.000	-19.600	15.600	0.796	3.097
K8	0.004	0.039	-0.077	0.101	48.763	0.009	-0.077	0.101	1.075	2.662
K9	1.454	0.845	0.325	3.253	2.014	1.429	0.889	3.253	3.381	-0.198
K10	0.026	0.083	-0.136	0.205	12.946	0.022	-0.136	0.205	1.162	0.995
K11	1.042	0.303	0.303	1.454	1.104	1.005	0.303	4.294	4.682	1.285
K12	1.142	0.213	0.892	1.777	0.775	1.124	2.749	1.777	-0.402	5.340
K13	0.610	0.059	0.525	0.782	0.421	0.606	1.068	0.782	-0.381	4.735

Source: calculated on the basis of The Activity of business....

The next stage of the statistical analysis of the initial data involved identifying a connection between the variables. This entailed building a correlation matrix (Table 3), where r^2_{ij} are its elements. The correlation ratios among the indicators are generally significant. It means that the variables selected for analysis correlate with each other. Naturally, the variables inside the groups show the highest degree of correlation, since they describe the same characteristic of the financial and economic state and are computed with the help of similar formulas. The liquidity ratios are closely connected with profitability ratios, which leads to the conclusion that the economy branches with high liquidity ratios are also marked by high profitability and, in the same way, the branches with low liquidity have a low level of profitability. Including net profit indicators in the formulas results in the fact that debt service coverage ratio is marked by a strong correlation with profitability indicators. The lowest level of correlation with the rest of the variables can be observed in financial independence ratios, current assets turnover ratios, as well as investment-to-capital ratios.

Table 3. Correlation matrix

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13
K1	1.000	0.864	0.260	0.928	0.552	0.458	0.537	0.609	-0.377	0.523	0.028	-0.407	0.403
K2	0.864	1.000	0.411	0.907	0.346	0.431	0.557	0.515	-0.091	0.505	0.094	-0.545	0.281
K3	0.260	0.411	1.000	0.538	0.245	0.146	0.489	0.327	0.133	0.376	0.385	-0.142	0.256
K4	0.928	0.907	0.538	1.000	0.504	0.430	0.567	0.569	-0.233	0.513	0.204	-0.419	0.352
K5	0.552	0.346	0.245	0.504	1.000	0.809	0.756	0.914	-0.022	0.827	0.091	-0.325	0.917
K6	0.458	0.431	0.146	0.430	0.809	1.000	0.835	0.886	0.198	0.862	0.076	-0.643	0.824
K7	0.537	0.557	0.489	0.567	0.756	0.835	1.000	0.902	0.126	0.855	0.242	-0.625	0.813
K8	0.609	0.515	0.327	0.569	0.914	0.886	0.902	1.000	0.081	0.960	0.095	-0.602	0.898
K9	-0.377	-0.091	0.133	-0.233	-0.022	0.198	0.126	0.081	1.000	0.228	-0.027	-0.277	0.227
K10	0.523	0.505	0.376	0.513	0.827	0.862	0.855	0.960	0.228	1.000	0.050	-0.587	0.874
K11	0.028	0.094	0.385	0.204	0.091	0.076	0.242	0.095	-0.027	0.050	1.000	-0.139	-0.044
K12	-0.407	-0.545	-0.142	-0.419	-0.325	-0.643	-0.625	-0.602	-0.277	-0.587	-0.139	1.000	-0.334
K13	0.403	0.281	0.256	0.352	0.917	0.824	0.813	0.898	0.227	0.874	-0.044	-0.334	1.000

Source: calculated on the basis of The Activity of business....

The next stage includes the compilation of the final set of data and calculation of aggregated indicators of creditworthiness with the help of the abovementioned statistical methods. This resulted in a comprehensive analysis of economic sectors classified by activity on the basis of five methods (Table 4). Table 4 shows aggregated values, with the place of the branch given in brackets; debtor ranks were determined for discriminant analysis as per on approving... (2012) from 1 to 9.

Table 4. Comprehensive analysis of economic sectors (by activity)

Type of economic activity	Code as per CEA	Discriminant function	Helwig's method	Dendrite method	Clustering	Factoring
Agriculture, forestry and fishery	A	0.094 (1)	0.037 (9)	0.028 (1)	0.100 (3)	0.021 (8)
Industry	B+C+ +D+E	0.019 (1)	0.011 (4)	0.043 (7)	0.120 (9)	0.014 (6)

Table 4 (cont.). Comprehensive analysis of economic sectors (by activity)

Type of economic activity	Code as per CEA	Discriminant function	Helwig's method	Dendrite method	Clustering	Factoring
Construction	F	0.002 (4)	0.088 (15)	0.041 (4)	0.074 (2)	0.062 (14)
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	0.021 (1)	0.014 (5)	0.046 (10)	0.060 (1)	0.004 (3)
Transport, storage, postal and courier services	H	0.023 (1)	0.007 (2)	0.044 (9)	0.138 (12)	0.000 (1)
Temporary food service activities	I	0.027 (8)	0.061 (13)	0.044 (8)	0.116 (8)	0.040 (13)
Information and telecommunications	J	0.041 (1)	0.026 (6)	0.053 (15)	0.123 (10)	0.013 (5)
Finance and insurance activities	K	0.012 (2)	0.009 (3)	0.035 (2)	0.151 (13)	0.007 (4)
Real estate activities	L	0.034 (9)	0.038 (10)	0.043 (6)	0.113 (7)	0.27 (10)
Professional, scientific and technical activities	M	0.002 (4)	0.084 (14)	0.036 (3)	0.108 (5)	0.063 (15)
Administrative and support service activities	N	0.031 (1)	0.003 (1)	0.047 (12)	0.158 (15)	0.003 (2)
Education	P	0.050 (1)	0.029 (7)	0.048 (14)	0.153 (14)	0.015 (7)
Health care and social work activities	Q	0.004 (4)	0.031 (8)	0.048 (13)	0.123 (11)	0.022 (9)
Arts, sports, entertainment and recreation	R	0.124 (9)	0.050 (12)	0.046 (11)	0.112 (6)	0.030 (12)
Other activities	S	0.003 (6)	0.040 (11)	0.043 (5)	0.107 (4)	0.029 (11)

Source: calculated on the basis of The Activity of business....

This was followed by selection of the best classification on the basis of the maximum value of the variation coefficient and the highest level of consistency with the results of the other classifications. The first criterion allows for the highest level of differentiation between aggregated indicators and, as a result, for lower probability of rating errors. The second criterion helps to identify which rating is closest to the other ratings. This requires the use of the Pearson correlation coefficient and Spearma's rank correlation coefficient (Table 5). The correlation coefficients show that the greatest compatibility can be observed between the classifications based on factorization, which is why this model is regarded as an alternative approach to such kind of research.

Table 5. The Pearson correlation and Spearman's rank correlation coefficients

Model/method	The Pearson correlation coefficient					Spearman's rank correlation coefficient				
	Discriminant function	Helwig's method	Dendrite method	Clustering	Factoring	Discriminant function	Helwig's method	Dendrite method	Clustering	Factoring
Discriminant function	1.000	0.641	0.246	0.127	0.596	1.000	0.682	0.129	0.295	0.703
Helwig's method	0.641	1.000	0.074	0.351	0.987	0.682	1.000	0.329	0.636	0.971
Dendrite method	0.246	0.074	1.000	0.169	0.145	0.129	0.329	1.000	0.479	0.346
Clustering	0.127	0.351	0.169	1.000	0.363	0.295	0.636	0.479	1.000	0.518
Factoring	0.596	0.987	0.145	0.363	1.000	0.703	0.971	0.346	0.518	1.000

Source: calculated on the basis of The Activity of business....

Table 6 shows an optimal structured credit portfolio developed on the basis of assessing the creditworthiness of Ukraine's economic sectors. The values for the credit portfolio were computed with the help of two methods – discriminant function analysis (recommended by the National Bank of Ukraine) and factoring analysis. According to Table 6, there are significant differences among the actual and optimal values for the credit portfolios obtained by the two methods. The lowest deviations can be observed in the values for transport, storage, postal and courier services (factoring analysis) and construction (discriminant function analysis). Both methods identify the highest deviations in industry values. Such considerable differences (obtained by different methods) are a warning sign for the banking system, since it offers loans for industry, Ukraine's major economic sector.

Table 6. Optimal structured credit portfolio developed on the basis of assessing the creditworthiness of Ukraine's economic sectors

Type of economic activity	Code as per CEA	Discriminant function			Factorization		
		actual data	optimal data	deviation	actual data	optimal data	deviation
Agriculture, forestry and fishery	A	0.094	0.217	-0.123	0.021	0.061	-0.040
Industry	B+C+ +D+E	0.019	0.257	-0.238	0.014	0.255	-0.241

Table 6 (cont.). Optimal structured credit portfolio developed on the basis of assessing the creditworthiness of Ukraine's economic sectors

Type of economic activity	Code as per CEA	Discriminant function			Factorization		
		actual data	optimal data	deviation	actual data	optimal data	deviation
Construction	F	0.002	0.001	0.001	0.062	0.171	-0.109
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	0.021	0.183	-0.162	0.004	0.041	-0.038
Transport, storage, postal and courier services	H	0.023	0.063	-0.040	0.000	0.000	0.000
Temporary food service activities	I	0.027	0.007	0.020	0.040	0.014	0.025
Information and telecommunications	J	0.041	0.034	0.006	0.013	0.014	-0.001
Finance and insurance activities	K	0.012	0.035	-0.024	0.007	0.032	-0.024
Real estate activities	L	0.034	0.113	-0.079	0.027	0.118	-0.091
Professional, scientific and technical activities	M	0.002	0.000	0.002	0.063	0.274	-0.211
Administrative and support service activities	N	0.031	0.060	-0.029	0.003	0.007	-0.004
Education	P	0.050	0.001	0.049	0.015	0.000	0.015
Health care and social work activities	Q	0.004	0.000	0.003	0.022	0.003	0.019
Arts, sports, entertainment and recreation	R	0.124	0.028	0.096	0.030	0.008	0.022
Other activities	S	0.003	0.000	0.003	0.029	0.001	0.027

Source: calculated on the basis of The Activity of business....

The optimal credit portfolio of the banking system can serve as a basis for developing portfolios of individual banks, which determine the allocative efficiency of credit resources in Ukraine's banking system as a whole. With this end in view, the actual portfolios need to be compared with the optimal ones by means of similarity metrics (3)-(9). The findings are presented in Table 7.

Table 7. Actual credit portfolios compared against optimal portfolios by means of similarity

Formula No.	Factoring	Discriminant function	Deviation
3	0.241	0.305	0.063
4	0.566	0.562	0.004
5	0.432	0.430	0.002
6	0.571	0.583	0.012
7	0.218	0.258	0.040
8	0.354	0.373	0.019
9	0.692	0.682	0.010

Source: calculated by the authors on the basis of The Activity of business....

The calculations show that the credit portfolios have a high level of structural similarity. Due to a great number of small values for the structural indicators, the similarity metrics (3) were the primary focus of analysis, because they show the smallest differences among the results obtained by the various methods. Similarity metrics are marked by the highest level of consistency with the values for the indicators under consideration.

Overall, it should be stressed that over the period analyzed there were medium values for the selected similarity metrics (0.439 for factoring analysis and 0.456 for discriminant function analysis). It can be concluded that the actual and the optimal credit portfolios show little structural similarity. Therefore, Ukraine's banks need to work on optimizing the structure of their credit portfolios in order to improve the allocative efficiency of their credit resources and the banking system as a whole.

Conclusion

The article presents a model for achieving the allocative efficiency of credit resources which the banking system can apply to an individual sector of national economy with a view to assessing the effectiveness of allocating its credit resources.

The topical issue of achieving the allocative efficiency of credit resources is concerned not only with the methodology for assessing a company's creditworthiness, but also with subsequent optimization of the credit portfolio of the banking system in terms of identifying the optimal correlation of loans in individual economy sectors to total bank loans.

The overview of research approaches shows that nowadays Ukraine's banking system employs a wide range of creditworthiness assessment methods. They differ in the number of indicators which constitute the

borrower's overall rating, as well as in the approaches to indicative characteristics and their priority. If the set of indicators remained the same for all banks and countries, it would be possible to exchange statistics and systematize information on a global scale. However, in reality, countries, banks and researchers use different systems of indicators. Thus, this research involves a contrastive analysis of five statistical methods of creditworthiness assessment followed by optimizing the indicators of the borrower's financial state. The contrastive analysis of various statistical methods of creditworthiness assessment shows that factoring analysis is the most effective approach to such kind of research.

Developing a credit portfolio of the banking system, which must be optimally structured in line with its significance for the country's economy, involves two methods – discriminant function analysis (recommended by the National Bank of Ukraine) and factoring analysis. This is followed by comparing the actual portfolios against the optimal ones by means of similarity metrics. It allows for the possibility of identifying the economy sectors with the most significant differences among the actual and optimal values for credit allocation. This results in determining the allocative efficiency of credit resources of the banking system in terms of identifying the correlation of loans in individual economy sectors to total bank loans.

Such kind of approach can be applied to analyzing the credit portfolio of an individual bank with regard to a certain economic sector. It allows for the possibility of observing changes in environment (i.e., in economic sectors as potential creditors) and monitoring allocative efficiency levels determined by the credit investments available for Ukraine's economic sectors. As a result, allocative efficiency assessment constitutes the basis for adopting relevant credit policies and effective corrective management strategies. Therefore, the model for achieving the allocative efficiency of credit resources in Ukraine's banking system can serve as the basis for developing a system of preliminary observation and monitoring, which will facilitate credit decision-making and optimize credit portfolios.

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