

# Assessing Bank Financial Security Level Using the Comprehensive Index Technology

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**Abstract** — The paper is devoted to issues of assessment of the bank financial security level. The analysis of existing approaches to the solution of this problem has been carried out. The scientific-methodological approach based on the use of comprehensive index technology is proposed. The calculating algorithm is presented in the form of a four-step procedure, which contains the definition of the initial set of data, their normalization, the calculation of the comprehensive index of financial security and results interpretation. The identification of financial security levels and the boundaries of the corresponding comprehensive index is carried out on the basis of analysis of the objects' configuration in the two-scale space of partial composite indexes. It constructed by the division of the set of initial indicators using the its content characteristics. The grouping results are matched with similar results are obtained by cluster analysis and the method of the principal components. The article presents the practical implementation of the proposed calculation procedure. For this purpose, a training sample of banks and a set of initial indicators was formed. The obtained results allowed to determine the number of levels of financial security and their boundaries. The financial security levels established for the analyzed banks as a result of the calculations are conditional and determined by the sample.

**Keywords** — *Bank financial security, financial security level, principal component method, cluster analysis, partial composite index, comprehensive index of financial security.*

## I. INTRODUCTION

The banking industry has a key role in a country's economy, ensuring penetration of the main cash flow of and payments of various economic entities, as well as their lending, investment and financing. The global economic crisis, which accompanied by the emergence of the crisis conditions in the banking system in many countries of the world, challenged the reliability of the entire financial system, caused a real banks bankruptcy. The current trends in the development of bank activity in the countries of the world testify to the intensification of processes that provoke general global instability. The profound, structural nature of

these changes shows that the transformation of the world banking system, and with it and the national one, is inevitable. According to official data, the number of banking institutions of domestic owners in Ukraine has halved for the period from 2014 to 2018 [1], which testifies to the ineffectiveness of management work and the inability to withstand financial threats. Under such conditions, the urgent task of the future banking system is to ensure its stability, which is the dominant condition for its steady development.

Financial security, as a functional part of the bank's economic security, provides an appropriate level of stability of its financial state, which ensures the safety of priority financial interests associated with the implementation of the adopted development strategy and the meet the target competitive positions in the conditions of external and internal threats. Therefore, the banking system faces the challenge of achieving financial stability of each individual bank and guaranteeing the financial security of the entire system. The high dynamism of social development in the conditions of the growing openness of the national economy and its integration into the world economy increase the threats and influence of destabilizing factors of internal and external environment, deepening the financial markets competition prevent the process of realization of strategic directions of banks development in terms of profitability and minimization of risks. This determines the urgency of solving the problem of ensuring the financial security of banks, which will enable them to carry out preventive actions and minimize the negative effects of crisis in the national banking system.

At present, there are no common approaches among scholars to the definition of the nature and characteristics of financial security of banks, as well as to the procedures and mechanisms for its quantitative assessment and identification of security level. We agree with the views of scholars [2], according to which the financial security of the bank is considered as it state is characterized by the protection of its financial interests, sufficient volume of resources, the presence of stable growth dynamics of main indicators in the

current and prospective periods, which is achieved by using a sound financial strategy, flexibility in the adoption of financial decisions, timely response to the external and internal dangers and threats. Ensuring financial security of banks should be aimed at neutralizing the structural imbalances in their development and the negative impact of destabilizing internal and external disturbances. The state and level of bank security may have some variability in time, but if the fluctuation of such fluctuations is insignificant, its development is not subject to significant changes. Effective managing the bank's activities necessitates the use of modern tools for identification of bank financial security level and analyzing its dynamics. This allows as objective as possible to describe the current state of security and promptly signal about threats to the bank financial security depending on the purpose, objectives and interests of all stakeholders.

## II. LITERATURE REVIEW

The analysis and assessment of the financial security system has long been the subject of research by researchers. Traditionally, these issues were considered within the framework of diagnosing crisis phenomena and assessing the bankruptcy probability. However, recently they have been distinguished in a separate field and it can be stated that the number of scholar's publications and practical developments in this area is increasing. The key issue that arises in the assessing financial security is to establish its criterion like a benchmark that can be quantitatively measured by a certain set of initial indicators of the bank's activity. It allows us to conclude about the state or level of bank financial security. As these criteria we may use performance indicators, indicators of the financial condition, including financial viability, minimizing risks, maximizing the cost of equity capital, etc. Additionally, issues of identifying a set of defining indicators that characterize the financial security state are also studied.

Consider the characteristics of the main approaches to assessing the bank financial security. At the national level, the methodology presented by the Ministry of Economic Development and Trade of Ukraine [3] is used. It provides a series of indicators of the state of banking security in Ukraine: overdue loan arrears in the total volume of loans of Ukrainian banks; the ratio of bank loans and deposits in foreign currency; the share of foreign capital in the total amount of bank's capital; the ratio of long-term loans and others. An approach based on the use of normative values as the main criteria for assessing financial security is quite common, in particular, in the papers [4], [5], [6], [7]. In our opinion, the disadvantage of this approach is that it does not allow to establish the level of financial security, but only to state the degree of its provision for individual components. In addition, the normative values of banks effectiveness indicators are designed for an idealized bank and can't objectively reflect the state of banks financial security. The mentioned disadvantages are eliminated in the methods, which use the tools of economics and mathematical modeling to assess the level and state of financial security. In particular, O. A. Sergienko with co-authors [8], [9], [10], [11] consider a set of models that allow to analyze the state and trends of financial market development, to evaluate and analyze the structural elements of bank financial security, to investigate the degree of influence local indicators to the overall financial security level. The result is scenarios for

ensuring the bank financial security. In our opinion, the given models require rather considerable volumes of the initial data, and the results are based on complicated calculations, which is limited their practical application. In addition, it must be taken into account that ratings are ordinal by their origins, and allow to use a very limited mathematical tools for their correct processing. Scoring models for assessing the financial security level are given in the papers [12], [13], [14]. The advantages of such models are the simplicity of calculations and the clarity of results interpretation. However, the provision of scores for each characteristic always has some subjectivity, which makes the final evaluation results less reliable. In addition, it is indirectly necessary to justify forming an expert group, to carry out agreeing expert views, etc. Among the methods of financial security modeling, of particular note is approach based on comprehensive assessment technology [15], [16], [17], [18], [19]. Assessment methods presented in these papers differ in the set of indicators, the rules for calculating the final result and the choice of weight coefficients of the composite index components. An important problem in assessing the financial security level is the choice and justification of the scale, which allows you to identify this level. These issues are highlighted in [16], [18], [20], [21]. However, it should be noted that the author's proposals don't always sufficiently substantiate the number of financial security levels and the boundaries of these ones.

In this study, we propose an approach that allows you to identify the financial security level, based on the calculation of the comprehensive indicator by the data of the training sample.

## III. RESEARCH METHODOLOGY

The basis of the proposed approach is the technology of comprehensive index assessment. The main idea underlying the approach is that for determining the objects classification under study, they are pictured in some multidimensional space of partial composite indexes, calculated by the subset of the aggregate of initial indicators and reflect a certain characteristic of the bank's activities. The number of such composite indexes is determined on the basis of features of the set of initial banks indicators. The constructed structure of the studied objects is aimed at identifying their grouping by the distinguished characteristics. In order to quantify the financial security level, comprehensive index is used, designed by the totality of initial indicators. The number of financial security levels and their boundaries are determined based on the objects' classification received.

The calculating procedure for the proposed approach consists of the following steps. At the first stage, a set of initial indicators is shaped, which will be used to assess the financial security level. In order to simplify calculations, it is recommended to select indicators can be obtained from the open access banks' financial statements or that can be obtained based on such information. Also, shaping a training sample for the calculations is carried out in this step. Second stage carry out the grouping of initial indicators for the essential characteristics. Next, the procedures for data normalization and establishment of weighting factors within each group are executed. Each group can has its own rules for normalization based on the origins and essence of the indicators selected. Typically, this procedure is based on the

selected sample taking into account the maximal and minimal values for each indicator. But in the presence of normative or recommended values of indicators, you can use the procedure outlined in [22]. In the third stage, the partial composite indexes for each group are calculated and the grouping the set of banks studied in the space of new scales is carried out. At the fourth stage, the calculation of the financial security comprehensive index is executed using the initial indicators whole set. Then, taking into account the classification obtained in the previous step, the number of financial security levels is determined and their quantitative boundaries are established.

The given procedure contains certain universalism and admits adaptation under the application of specific situations. In particular, this concerns the formation of a training sample, the choice of the initial set of banks indicators, their distribution by essential characteristics, the choice of convolution and weighting coefficients to calculate partial composite indexes and comprehensive index, the definition of the number of financial security levels and their boundaries. In our view, some of these issues are not significant, such as the choice of grouping form for the initial set of indicators or the convolution form to design both composite and convolution indexes. Solving other issues should be in line with the results obtained by other methods, in particular the identifying financial security level for a selected sample of banks.

We can also use traditional methods of multidimensional statistical analysis, such as factor or component analysis, clustering technology to group banks. However, for the first specified group of methods, there may be difficulties in meaningful interpretation of the latent characteristics obtained. To group object using cluster analysis technology, there are problems with the interpretation of clusters. We recommend to use these methods to reconcile the results obtained by the proposed procedure.

#### IV. RESULTS AND DISCUSSION

Let we consider practical use of the approach proposed. To rich this aim, we select a set of initial indicators and shape a training data sample. The information source is the official data of the National Bank of Ukraine [1].

So, for analysis we were selected the following set of indicators:  $X_1$  – index of assets coverage by equity;  $X_2$  – index of assets coverage by authorized capital;  $X_3$  – the share of current deposits in the bank's deposit base, %;  $X_4$  – the share of retail deposits of in the bank's liabilities, %;  $X_5$  – ratio of loans and deposits;  $X_6$  – loan reserve ratio;  $X_7$  – the ratio of assets coverage to liquid assets;  $X_8$  – coefficient of coverage of attracted resources by liquid assets;  $X_9$  – the ratio of liabilities coverage to liquid assets;  $X_{10}$  – ROA, %;  $X_{11}$  – ROE, %;  $X_{12}$  – net interest margin. The indicators  $X_1 - X_6$  reflect the effectiveness of shaping competitive capacity of bank, the rest of the indicators  $X_7 - X_{12}$  – the effectiveness of banks' operational and financial activities. The selection of two groups of indicators in this case has the advantage that the results of grouping can be reflected graphically in a form that is convenient for perception, and therefore subject to a clear and understandable interpretation.

The training sample was made by such Ukraine's banks: C\_1: Public Joint-Stock Company "Commercial Bank

Privatbank" (PJSC CB Privatbank); C\_2: Public Joint-Stock Company "State Savings Bank of Ukraine" (PJSC Oshcadbank); C\_3: Joint Stock Company "The State Export-Import Bank of Ukraine" (JSC Ukreximbank); C\_4: Public Joint-Stock Company "Joint Stock Bank "Ukrgezbank"; C\_5: Joint-Stock Company "Raiffeisen Bank Aval"; C\_6: Joint-Stock Company "First Ukrainian International Bank" (FUIB); C\_7: Joint-Stock Company "Alfa-Bank Ukraine"; C\_8: Joint-Stock Company "Ukrsibbank"; C\_9: Public Joint Stock Company "Joint-Stock Commercial Industrial Investment Bank" (PJSC Prominvestbank); C\_10: Joint-Stock Company "Megabank".

Initial data for calculation of indexes for the selected groups are given in Tables 1, 2 respectively.

TABLE I. INITIAL DATA FOR FIRST GROUP OF INDICATORS

Bank's Code	Indicator's Values					
	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$X_6$
C_1	10.4	80.5	36.1	72.6	20.1	525.7
C_2	13.6	21.8	34.1	44.8	47.3	87.7
C_3	5.3	24.3	56.2	16.0	74.6	106.4
C_4	7.4	17.9	48.4	25.2	47.0	29.0
C_5	17.7	9.0	79.4	37.6	75.3	21.8
C_6	10.4	6.6	51.0	35.1	60.4	35.1
C_7	8.1	25.2	36.2	54.8	65.5	35.4
C_8	13.5	11.7	91.3	33.5	61.3	46.1
C_9	32.7	284.7	40.8	32.5	167.1	288.5
C_10	10.3	6.7	24.9	40.6	97.4	9.1

TABLE II. INITIAL DATA FOR SECOND GROUP OF INDICATORS

Bank's Code	Indicator's Values					
	$X_7$	$X_8$	$X_9$	$X_{10}$	$X_{11}$	$X_{12}$
C_1	7.6	9.4	8.5	-8.3	-81.9	3.9
C_2	4.6	6.6	5.3	0.2	1.6	2.9
C_3	3.5	6.6	3.7	0.5	7.6	2.3
C_4	5.9	6.5	6.0	1.0	12.5	4.3
C_5	12.2	16.0	14.9	7.0	37.1	12.8
C_6	5.1	6.1	6.0	1.7	16.3	7.7
C_7	4.3	4.9	5.0	1.9	23.8	8.4
C_8	9.7	12.8	11.0	4.3	35.9	12.5
C_9	2.9	6.6	4.3	-35.8	-168.1	5.1
C_10	4.7	6.3	5.0	0.8	9.0	2.1

A procedure for data normalizing is carried out in accordance with the formula:

$$u_{ij} = 1 - \left| x_{ij} - x_j^* \right| / (x_{j\max} - x_{j\min}), \quad (1)$$

where  $u_{ij}$  are normalized values of indicators,  $x_{ij}$  – initial values of indicators,  $x_{j\min} = \min_i x_{ij}$ ,  $x_{j\max} = \max_i x_{ij}$ ,

$i=1..m, j=1..n, m=10$  – number of objects observed (banks),  $n$ – number of initial indicators,  $n=n_1=6$  for first group and  $n=n_2=6$  for the second group,  $n=12$  for the whole set of data.

Values  $x_j^*$  are obtained by the formula:

$$x_j^* = \begin{cases} x_{j\max}, & \text{when } X_j \text{ is a incentive;} \\ x_{j\min}, & \text{when } X_j \text{ is a disincentive;} \end{cases} \quad (2)$$

It should be noted that in this case all the initial indicators are incentives.

The next step is to execute the procedure for designing partial composite indexes. To do this we use a weighted linear additive convolution of data according to the formula:

$$Q_{Ai} = \sum_{j=1}^n w_j u_{ij} \quad (3)$$

where  $Q_{Ai}$  is the values of composite index,  $i=1..m$ ;  $w_j$  – weight coefficients of initial indicators,  $j=1..n$ , which should meet the condition:

$$\sum_{j=1}^n w_j = 1. \quad (4)$$

Since in our study we didn't possess any valid information about the weight of the initial indicators, their weight coefficients were chosen equal:  $w_j=1/6$  for the first group;  $w_j=1/6$  for the second group;  $w_j=1/12$  for the whole set of initial indicators.

Results for partial composite indexes  $I_1$  and  $I_2$  calculated by the formula like (3) are shown in the Table 3. Also, we add to this table the values of the comprehensive financial security index  $I_{COM}$  calculated as a weighted convolution of partial composite indexes  $I_1$  and  $I_2$ . Data in Table 3 is located in descending order of values of  $I_{COM}$ .

TABLE III. VALUES OF PARTIAL COMPOSITE INDEXES AND COMPREHENSIVE INDEX OF FINANCIAL SECURITY

Bank's Code	Indexes' Values		
	$I_1$	$I_2$	$I_{COM}$
C_5	0.34	1.00	0.67
C_8	0.33	0.83	0.58
C_1	0.44	0.43	0.43
C_9	0.68	0.08	0.38
C_6	0.21	0.47	0.34
C_7	0.23	0.45	0.34
C_2	0.22	0.37	0.30
C_4	0.14	0.44	0.29
C_10	0.19	0.36	0.27
C_3	0.18	0.32	0.25

Graphic representation of banks in the space of partial integral indicators is shown in Figure 1.

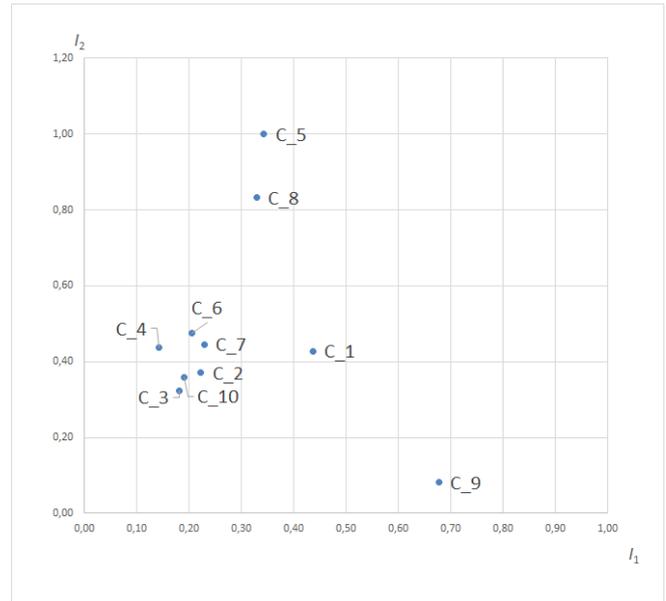


Fig. 1. Graphic representation of banks in the partial composite indexes space

Figure 1 analysis shows, that we can select four homogeneous group of objects researched (banks) in this case. First group consists of objects C\_5 and C\_8 (banks JSC "Raiffeisen Bank Aval" and JSC "Ukrsibbank"); second group includes object C\_9 (Joint-Stock Commercial Industrial Investment Bank); third group includes object C\_1 (PJSC "CB Privatbank"); the rest of the objects located into fourth group. In this case, the object C\_1 may not form a separate group, but to be located either into the first or into the fourth group of objects. It is less obvious to combine it into one group with the object C\_9, but the location of the values of the comprehensive index in Table 2 indicates in favor of such a grouping.

Let's we analyze the results. The highest levels of financial security of 0.67 and 0.58 are observed respectively in JSC "Raiffeisen Bank Aval" and JSC "Ukrsibbank", due to the high level of effectiveness of banks' operational and financial activities. The basic dominants of the creation of this position, in the conditions of instability of the development of the Ukraine's banking system is the formation of assets of these banking institutions by attracting foreign investment and the rapid response of the bank's management to the challenges of the competitive environment by applying the mechanisms of the bank's additional capitalization.

According to the study results, it was determined that the largest by the asset PJSC "CB Privatbank" has a rather high level of the effectiveness of shaping competitive capacity in comparison with other banks of the sample due to aggressive development strategy, the use of advanced innovative and information technologies, it ability to function under uncertainty and risk. In addition, it is characterized by significantly lower values of effectiveness of operational and financial activities. As a result of the total impact of the above-mentioned factors, the value of the bank financial security by the comprehensive index is 0.43, which is considerably lower than that of JSC "Raiffeisen Bank Aval" and JSC "Ukrsibbank".

As calculations results show, PJSC "Prominvestbank" is in the fourth place among investigated banks with a level of financial security of 0.38. It is one of the first banks in Ukraine, founded in 1992, it is one of the twenty banks of Ukraine in volumes of assets. However, accumulated losses affecting the level of indicators of effectiveness of bank's operational and financial activities are the signal of the deterioration of financial security with the established basis of competitive capacity due to the factors of capitalization, funding and asset quality. The bank's ineffective management policy related to the ownership of its bank capital is a destabilizing factor in the bank's activities on the market (99.77% of total investment are owned by Russian shareholders). It should be noted the dominant tendency to reduce the level of financial security of the bank. The vast majority of investigated banks like PJSC "Oshcadbank", JSC "Ukreximbank", PJSC "Ukrgasbank", JSC "FUIB", JSC "Alfa-Bank Ukraine", JSC "Megabank" demonstrate the level of financial security in range from 0.25 to 0.36, which is an average value relative to the values of the sample studied. In this case, the established level of financial security of banks don't depend from the key characteristics of these banking institutions and their environment, including: the size of the bank's assets: in particular, PJSC "Oshcadbank", JSC "Ukreximbank", PJSC "Ukrgasbank" have different asset volumes; ownership form: for example, PJSC "Oshcadbank" has Ukrainian State property, JSC "FUIB" has a private property; sources of funding: for example, JSC "Alfa-Bank Ukraine" has 100% of foreign capital, JSC "Megabank" is a bank with combined capital.

Let we group the banks by the same source data, using a hierarchical cluster analysis. The clustering dendrogramme, obtained using the Statistica package, is presented in Figure 2.

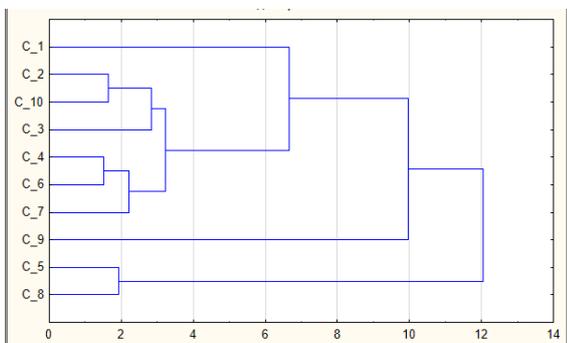


Fig. 2. Graphic representation of banks in the partial composite indexes space

The figure analysis allows us to conclude that dividing of the sample into clusters generally coincides with the grouping obtained in the space of partial composite indexes (Figure 1). In so doing, clustering provides only the ability to determine grouping of objects by a set of initial indicators in a whole, but doesn't allow to identify the causes of such clustering, which was done for grouping objects in the partial composite indexes space.

Let we use principal component method. We determine the most significant components and locate the studied banks in the appropriate space. The graphic representation of objects in the space of the first two principal components is shown in Figure 3. We note, that the first two principal

components explain 75% of the variance of the initial indicators, which is quite high value.

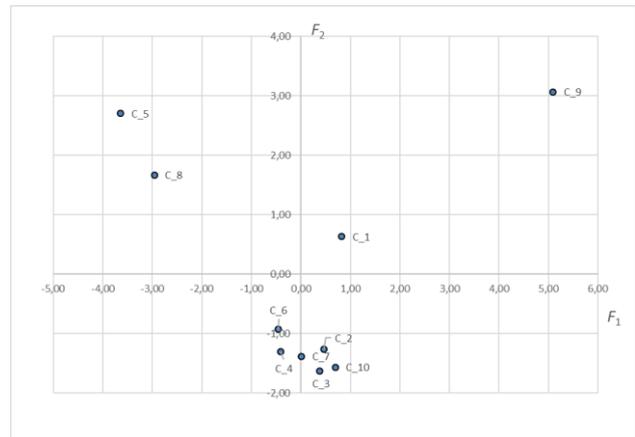


Fig. 3. Graphic representation of banks in the principal components space

Figure 3 confirms the group configuration of the studied sample, which was obtained in the partial composite indexes space.

The next step is to identify the levels of financial security based on the values of the resulting comprehensive index. Analyzing the values presented in Table 2, we can conclude that in this case, it is expedient to allocate three levels: sufficient, satisfactory and low. Sufficient security is observed for JSC "Raiffeisen Bank Aval" and JSC "Ukrsibbank", satisfactory – for banks PJSC "CB Privatbank" and PJSC "Prominvestbank", for other banks the level of security can be identified as low. The result of banks allocation is conditional and is determined by the available sample. For a more correct identification of groups it is expedient to increase the sample volume.

To identify the boundaries of intervals for each financial security level we use the formula:

$$l_i = (\alpha_{i+1} + \beta_i)/2, \tag{5}$$

where  $l_i$  is a right bound for  $i$ -th interval,  $i=1..k-1$ ,  $k$  – number of intervals;  $\alpha_{i+1}$  – minimal value of comprehensive index, which corresponds to  $(i+1)$ -th financial security level;  $\beta_i$  – maximal value of comprehensive index, which corresponds to  $i$ -th financial security level. In this case, using the results of calculations in Table 2 and the results of grouping banks according to the levels of financial security, given above, we have the following boundaries for levels: for sufficient level:  $I_{COM} \geq 0,51$ ; for satisfactory level:  $0,36 \leq I_{COM} < 0,51$ ; for low level:  $I_{COM} < 0,36$ .

If there are statistics for several time periods, the boundaries for intervals can be specified using, in particular, the iterative procedure presented in [23]. Note that the first interval, which corresponds to a sufficient level, has very wide boundaries. It would be expedient to divide it into two intervals, highlighting a level with a high degree of financial security. However, within the framework of this study, it is not possible to determine the boundaries of such level. Similar conclusions can be drawn about the third interval. Such transformations can be made by expanding the sample. Despite the remarks made, the resulting comprehensive

index of financial security and the appropriate scale can be used to identify the financial security level for other banks.

## V. CONCLUSIONS

The national economy effective functioning is largely determined by the banking system development level and its ability to respond in a timely manner to changes taking place in financial markets and in the banking sector, ability to withstand external and internal threats. Therefore, it is important to assess the level of bank financial security, which allows timely identification of problems and develop adequate managerial decisions to neutralize them. The paper proposes an approach to assess the bank financial security based on technology for comprehensive index assessment. The presented evaluation tools are aimed to take into account in maximum the reality of the functioning of financial institutions, are accessible and intuitive to use, and involves the use of indicators that have a clear quantitative dimension, are freely accessible on the web pages of specialized institutions or can easily be calculated on such data. The scale of financial security levels is calculated by aggregating the initial indicators. The scientific novelty of the study is that the number of levels and their boundaries are determined based on the configuration of objects in the two-scaled space of partial composite indexes, each of which reflects a certain latent bank characteristic and is calculated on the basis of the aggregate of the initial data subset. Comparison of the results of the practical implementation of the proposed approach with the results of grouping objects, obtained using methods of multivariate statistical analysis showed their identity. The banks sample used in the study and the selected set of indicators don't claim to be universal and are given only to illustrate the proposed approach. The field for further research is to improve the procedure for assessing the level of banks financial security aimed at taking into account nonmetric indicators in it, in particular, expert assessments; establishing the importance of the components of financial security comprehensive index by justification and calculation of their weights; designing an universal scale for assessing financial security levels.

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