

Information technology as a tool for improving banking supervision

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Abstract — The problem of ensuring of the credit institutions' stability requires solving a number of tasks. Analysis of the problem allowed to determine the direction of development of the banking supervision system. Restructuring of the information support system based on business intelligence technologies, such as OLAP, Data Mining, Warehouse will provide a process of assessing the state of a credit institution with representative information. The specifics of the conditions for risk assessment and the formation of a regulatory impact based on the analysis of the parameters of a credit institution's activity determined the need for organizational changes. It should be separated the risk assessment service from the service of curators of credit institutions. The uncertainty of conditions in making a managerial decision by the curator requires the use of special tools for the curator to assess the presence of the threat of bankruptcy. The decision support system uses modeling and forecasting technologies. The diagnostics of a credit organization is considered as a task of classification. Pattern recognition technologies can be used as an effective tool for solving it.

Keywords — banking supervision system, financial stability assessment, information storage, analytical data processing technology, data analysis, decision support system, pattern recognition

I. INTRODUCTION

The effects of crisis in the economy periodically complicate the development of the Russian banking system. [1] The number of banks that lost their license for the right to operate, despite the decline in 2017, is still large (Table 1).

TABLE I. NUMBER OF BANKS DEPRIVED OF A LICENSE

Period	Number of revoked licenses
2014	94
2015	104
2016	101
2017	62
2018 (on 20.09.2018)	53

Sources: www.banki.ru <http://www.banki.ru/banks/memory>

The dominant part of such cases is explained, firstly, by the risky asset allocation policy, the incorrect assessment by credit institutions of their own financial position, the financial strength of their key clients and business associates, and secondly, by the shortcomings of the banking supervision and banking regulation system. The last one is explained by the

use of formal approaches in the implementation of banking supervision functions.

As a result, the further development of methods and tools to enhance supervision is an important issue for the development of the banking system.

The methodology of system analysis allows you to build a hierarchy of goals, the achievement of which will provide a solution to the problem of improving the quality of supervisory activities of the Bank of Russia. Solving the following tasks ensures the elimination of the problem of the imperfection of the banking supervision and banking regulation system:

- Improving the information support system for assessing the financial stability of credit institutions as a source of objective information for decision-making;
- Changing in the organizational structure of the banking supervision system of the Bank of Russia: separation of the risk analysis service and the service of curators;
- Using of special decision-making tools for the curator to assess the threat of bankruptcy.

In the "regulator - bank" system, the managerial impact on the management object is determined in two stages. At first stage, a risk assessment is based on the information system data. The second stage is the curator's assessment of the stability of the bank: decisions are made under conditions of uncertainty. Difference in conditions implies the need to use special methods of making managerial decisions. This determines the need to change the organizational structure of the banking supervision system of the Bank of Russia: the separation of the risk analysis service and the curators' service.

II. A LITERATURE REVIEW

Before The issues of organizing a remote analysis of risks of buckling are considered in the works of a number of Russian scientists. O.I. Lavrushin points out that there should be provided "... correspondence of the volume and structure of the information base in the performance of operations and bank risk management" [2].

Methods of assessing the financial stability of credit institutions do not provide a reflection of an objective picture of the state of the management object. Basically they are based on a formal analysis of groups of indicators of banks. A. Yu. Simanovsky notes: "... banking supervision is sent to the track

of fixing deviations from the established norms and rules, and applying for it measures of influence to banks"[3], A. Kutuzova substantiates the distinction between control and supervisory functions in the activities of state bodies[4].

The interest of the Bank of Russia as a regulator consists not only in fixing the current state of the bank, but also in assessing its ability to maintain positions in the market and perform its inherent functions in an increasingly complex economic environment [5]. It is complicated for the curator to detect hidden adverse trends in time to take measures to eliminate them.

For Russian credit organizations and supervisory agencies, the problem of developing and using special efficient methods for analyzing and evaluating the financial stability of credit organizations that meet the conditions of the Russian market is relevant. The development of theoretical and applied aspects of decision making under incomplete information is contained in the works of A. N. Romanov and V. V. Odintsov, which describes the steps involved in creating advisory systems for approximate reasoning, systems for neural computing [6]. In the work of V. V. Kolbin, decision-making processes are considered with a fuzzy ratio of preferences on a set of alternatives [7]. A. A. Peresetsky explores the possibility of using econometric methods in remote analysis of the activities of Russian banks [8].

The tasks of determining the possible prospects for the development of risk assessment methods and the state of credit institutions should be addressed in the process of risk-oriented supervision [9]. Otherwise, the stage of assessing financial stability will be reduced to a statement of the facts that have already been identified, in other words, to the control of "a-posteriori" without the possibility of the banking supervision of a preventive function[10].

Another task is the development of tools that implement these methods. The assessment of the state of the bank should be based on representative information, which imposes special requirements on the banking information system.

III.METHODOLOGY

System analysis and pattern recognition methods were used as the basis for the research methodology.

The main methodological principle of system analysis is the principle of consistency [11]. It assumes the idea of an object of any nature as a set of elements that are in a certain interaction with each other and with the outside world, as well as an understanding of the systemic nature of knowledge. The use of systems analysis methods at the stage of problem statement allowed us to determine the main problem of the research and its external environment. The structuring of the problem provided the definition of the main directions of research, the localization of the boundaries of the problem and the definition of the hierarchy of all the elements that are related to the task. On the basis of the criteria solved in the system analysis, the problem was assigned to the class of semi-structured, which determined the need to use image recognition methods based on the theory of artificial intelligence. Recognition is generally regarded as an information process implemented by some converter (recognition system). At the entrance there are determined signs, which possess the shown objects. At the output of the system, information is displayed on which classes (generalized

images) the recognized objects are assigned to. The recognition result of each object is the distribution or list of all recognition classes in descending order of the degree of similarity of the recognized object with them.

suggestions and recommendations

Well-timed and well-founded decisions within the framework of the supervisory and regulatory activity process can be formed as a result of applying methods and tools that provide the supervisor with information about the nature, level and dynamics of risks taken by credit institutions, about the areas of their greatest concentration.

The implementation of these methods imposes a number of requirements on the information system of complex economic analysis: the unambiguous identification of credit institutions, the expansion of the set of indicators that adequately reflect their activities, the use of information processing and analysis procedures that take into account the nature of connections between objects.

The need to analyze a significantly larger number of indicators to carry out a comprehensive assessment of all parameters of a credit institution's activities determines the feasibility of creating a unified information and analytical system for assessing the financial stability of credit organizations. The assessment should be based on representative data relating to its activities. The composition of the analyzed data should include the full range of information that allows to increase the adequacy of the proposed supervisory measures - internal and external, structured and semi-structured data.

Building effective information systems involves solving a number of information-technical, organizational and methodological objectives. The system architecture should be based on solutions that ensure a unified approach to the interaction of information systems of the Bank of Russia and its components (territorial institutions, main departments, the central office), and the development of coordinated regulatory actions. Solving the problem of fragmentation of incoming information flows, their non-standardization and the impossibility of applying automated processing tools to them, is achieved by creating a unified system for collecting, processing and organizing banking information, introducing real-time analytical processing of OLAP (on-line analytical processing) and information aggregation technology Warehouse (Fig. 1).

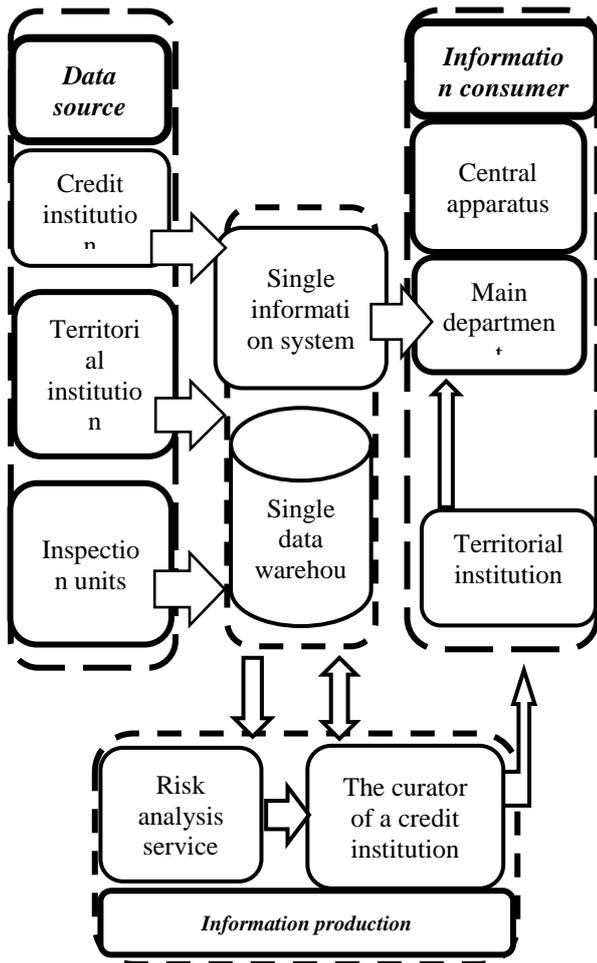


Figure 1. The conceptual diagram of the interaction of elements of the information-analytical system

Improving the methodology for assessing financial sustainability requires separating the processes for evaluating banking risks and processes, and forming a regulatory impact based on the analysis of the parameters of a credit institution. [12] Currently, this process involves only the curator of the credit institution. The results of the analysis largely depend on the level of his special knowledge.

The need to change the organizational structure of the banking supervision system - the allocation of risk assessment and risk management services, due to the specifics of the methods used to form decisions. The implementation of special formalized methods for calculating indicators will reduce the time spent on performing the analysis, increase the objectivity of the assessment, reduce the level of influence of the corruption component in the risk assessment, and improve the adequacy of the supervisory measures proposed by the supervisor.

The separation of supervisory processes will allow the supervisor to use the already prepared data on risks in standardized numerical terms when conducting a financial sustainability analysis, which should help increase the efficiency of supervisory response proposals made by the supervisor. The methodology for data preparation includes the technology of "cleaning" - the transformation of primary data and the extraction of information - Data Mining. The obtained analytical information is used to simulate risk analysis processes based on machine learning algorithms. [13]

Curators of credit institutions use a number of criteria by which one can assess the presence of the threat of bankruptcy. A significant number of factors taken into account when choosing a criterion and evaluating its significance makes it difficult to obtain a guaranteed objective solution. When analyzing data on the activities of a credit institution, two alternative hypotheses arise: H0 — there is a threat of bankruptcy, H1 — there is no threat. In the decision-making process, the curator may make mistakes of the first and second kind, as a result of which the probability of forming the wrong decision is increased. The error of the first kind is in the rejection of the correct hypothesis, and the error of the second kind is in the acceptance of the wrong one. These errors affect the performance of supervisory authorities. In the first case, the tendency of instability of a credit institution will not be established in a timely manner; in the second case, the level of reputational risk of a bank will unreasonably increase. The latter can lead to bankruptcy of a credit organization despite the absence of objective reasons.

The mechanism for the formation of decisions made by the curator is characterized by considerable structural complexity. A significant factor affecting the quality of the curator's work is a high level of uncertainty, (the presence of non-factors) that we face in the process of risk assessment. On the one hand, the lack of clarity of information on the state of the external environment is due to the instability of the external conditions (macroeconomic, political). On the other hand, the uncertainty of conditions when making decisions is aggravated by the incompleteness of estimates of the characteristics of internal conditions (financial, economic). And finally, the decision-making task in the face of uncertainty belongs to the class of weakly formalized tasks based on fuzzy heuristic rules. This makes significant the problem of expert preparedness, his ability to perceive large amounts of information, analytical skills.

All this determines the need to include in the structure of an integrated information-analytical system components - decision support systems (ESS - Executive support systems), whose work is based on the principles of artificial intelligence. [14] The component provides effective solutions for unstructured and semi-structured multi-criteria tasks based on already "cleaned" data and accumulated knowledge. (Fig.2).

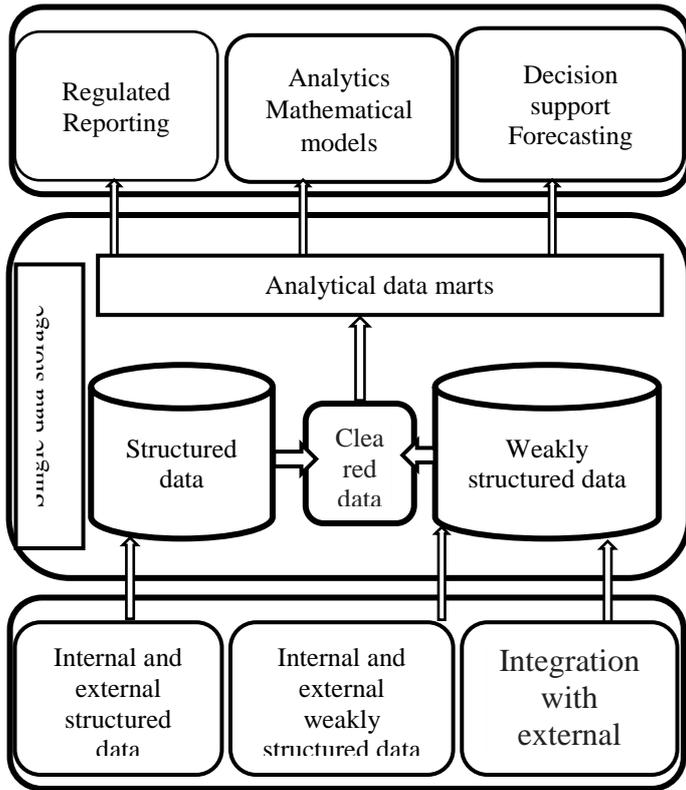


Figure 2. Architecture of the decision support system

The recognition system can make a mistake if it assigns to the class ω_1 an object that actually belongs to the class ω_2 . Accepting the assumption that the prior probabilities of the appearance of objects of each class are the same, that is, the vector X can equally treat both one and another class, the probability that a vector belongs to a class, the probability P_1 that the vector belongs to the class ω_1 – there is no risk, determined by the expression

$$P_1 = \frac{p(X / \omega_1)}{p(X / \omega_1) + p(X / \omega_2)} \quad (1)$$

where $p(X / \omega_1)$ – s the distribution density of the vector X provided that it belongs to the class $\omega_i, i = \overline{1,2}$

In this case, the probability of error:

$$1 - P_1 = 1 - \frac{p(X / \omega_1)}{p(X / \omega_1) + p(X / \omega_2)} \quad (2)$$

An optimal decision function $d(x)$ is a tool that relates a vector of credit organization characteristics to the class ω_1 only if the inequality holds [15].

$$p(X / \omega_1) > p(X / \omega_2) \quad (3)$$

It is assumed that in the case of splitting into two classes, the decision function has the property:

$$d(x) > 0, \text{ if } X \in \omega_1 \quad (5)$$

$$d(x) < 0, \text{ if } X \notin \omega_1 \quad (6)$$

If the image lies on the dividing border, there is a case corresponding to the condition of uncertainty $d(x) = 0$. For decision-making, it should be used knowledge obtained from deep data mining.

The process of diagnosing the state of a credit organization is considered as a sequence of information processing operations implemented within the framework of an information and analytical system using information technologies.

- At the entrance of the system, data flows from credit organizations arrive at a certain frequency.

- The system performs data cleansing: selects their significant part, using the technology of analytical data processing in real-time OLAP (On-Line Analytical Processing)

- Data is stored in a single database implementing the Data Warehouse technology, aggregating information using the technology of creating hypercubes.

- The accumulated information identifies new knowledge based on in-depth data mining using Data Mining data mining technology.

- A single data warehouse of Data Warehouse and specialized data Mart information warehouses are created - data marts that are supposed to be used for risk assessment.

- Bankruptcy risk assessment with formalized methods for assessing financial sustainability, supplemented by modeling and forecasting methods.

- The curator is implementing an intellectual technology based on pattern recognition methods (pattern recognition) to resolve the issue of the threat of bankruptcy.

- The curator forms and transmits proposals on supervisory response measures to higher levels of the banking supervision system for making decisions on the application of regulatory measures.

IV.CONCLUSION

The study of the specifics of the supervisory activity of the Bank of Russia and the analysis of the main tasks solved by the curator in the process of remote supervision of credit institutions allows us to formulate the following conclusions based on the proposed model for improving the mechanism of integrated financial sustainability of credit organizations:

The full cycle of remote banking supervision should be based on a process approach, which involves the implementation of procedures for monitoring the activities of banks with subsequent analysis of bankruptcy risks by a special risk analysis service.

To achieve the maximum effect from the ongoing comprehensive analysis of information on the activities of credit institutions and subsequent decision-making, it is necessary that all information and the results of its analysis are accumulated in a single data warehouse.

For the most effective implementation of supervisory activities in the system being created, business intelligence approaches and technologies should be integrated: OLAP, Data Mining, Warehouse. At the same time, these methodological approaches within a single information infrastructure should be based on common architectural solutions.

In order to improve the methodological basis for the analysis of banking activities that meets the principles of risk-based supervision, it is necessary to supplement the methods of formal assessment of quantitative characteristics with algorithms based on the principles of artificial intelligence. As a tool for solving the problem of the threat of bankruptcy, it is proposed to use the pattern recognition mechanism.

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