Information and analytical systems for stress testing of credit institutions

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Abstract. The main concepts of making information and analytical systems of stress testing (IASST) - software and tools for rapid stress tests in the activities of a credit organization are considered. Options for operational modeling of stress scenarios in the activities of a credit institution are discussed. Requirements for IASST are formulated for conducting stress tests both at the macro level and for analyzing selected stress situations when conducting tests of specific scenarios at the local level. Stress testing goals are formulated at each level. The IASST architecture is presented; the structure and interaction of the system modules are analyzed. The use of IASST by different participants in stress testing and the functions of each group of participants are discussed. Requirements for differentiation of access rights to information of various groups of participants of stress testing are formulated. The paper provides a formalization of the source information in the IASST for various stress tests. The main principles of visualization of stress testing results for different groups of participants are discussed. The ways to expand the IASST to include additional indicators in the stress testing process are considered. The positive impact of the use of IASST on the timing, quality, and complexity of conducting stress tests in credit institutions is noted.

1. Introduction

The function of stress testing of credit institutions has significantly expanded in recent years. Now stress testing is used not only in the traditional sense, for example, to fulfill regulatory requirements for updating the financial stability recovery plan [1], but also as a tool for making managerial decisions. At the same time, it is possible to model quickly the activities of a credit institution in sharply changing environmental conditions. In particular, the stress testing methodology can be used to develop responses of credit institutions to changes in the economic situation caused by the rapid spread of the coronavirus pandemic.

In the conditions of unexpected drastic changes in the economic situation and the subsequent high volatility of most macroeconomic factors, credit institutions are forced to adjust their current financial activities, revise their business plans, and conduct shock modeling for most business areas. The financial stability of an organization can be significantly weakened if possible losses and previously unobserved risks are not promptly and accurately taken into account in extreme conditions. Information and analytical systems of stress testing (hereinafter – IASST) are a software tool for rapid modeling of stress scenarios in the activities of a credit institution.

The development of software and tools for the activities of employees engaged in risk assessment in credit institutions, including stress testing, was most actively conducted after the global crisis of
2008. During this period, many technological developments showed their inconsistency with the crisis conditions. Russian specialists K.V. Shimanovsky, A.V. Vinogradov, and K.B. Kuznetsov made a significant contribution to overcoming this gap, as well as to the formation and development of theoretical, methodological and practical developments of the IASST [7-9]. The subject of their research was algorithms and information technologies that made it possible to make decisions in the field of stress testing of the Russian banking sector, CIS countries and distant foreign countries.

The infrastructure of the banking sector is undergoing significant changes over time. Technological breakthroughs are relevant for crisis periods, when the number and variety of tasks increase significantly, and the workforce does not have time to adapt to changing conditions. In such situations, it is absolutely necessary to have an IASST that has flexibility, variability and high speed of conducting a large number of stress tests. Therefore, the purpose of this work is to form the basic concepts for creating an IASST that allows making the right management decisions in conditions of high volatility.

2. Materials and methods: main directions and levels of stress testing
The relevance of stress testing is marked by a variety of international principles and approaches in the field of risk management [2-6]. The Bank of Russia also conducts stress testing on a regular basis. At the state level, systemic risks are identified. At the level of a separately considered supervised organization, the vulnerability of the organization to the risk of loss of liquidity, credit, and market risks is evaluated [10, 11]. Stress testing is considered as a risk tool used by a commercial organization for business purposes.

The following key areas and levels for decision making can be identified:
- higher management bodies of a commercial organization;
- as part of strategic and business planning;
- to determine scenarios that will lead to the financial instability of a commercial organization;
- setting and calibration of risk limit indicators;
- setting of goals for business units;
- pricing in terms of the cost of new services and/or products.

3. Results: Requirements for information and analytical stress testing systems
Stress testing is in demand in most areas of business activity of a commercial organization. Therefore, the IASST should meet the needs in the field of analysis of the macroeconomic situation in the country and abroad (hereinafter – macro ST). In addition, the IASST must be able to perform specialized tasks to solve specific problems (hereinafter referred to as Ad-hoc ST). At the same time, all types of stress tests defined goals and objectives, frequency and timing, functions and powers involved in the procedure of stress testing units, and the use of the results and inform decision-makers about the obtained results. In the case of large-scale stress testing, a generalized block diagram of stress testing is optionally developed with details of each stage.

Macro ST is usually used to calculate the amount of own funds (capital) and capital adequacy ratios, as well as the liquidity of a commercial organization during stressful periods. Macro ST can be performed for the following goals:
- ensuring the financial stability of a commercial organization under stressful conditions;
- support for management decision-making related to actions in a crisis;
- ensuring business continuity and planning optimal business management of a commercial organization, taking into account possible stressful conditions.

Ad-hoc ST can be used to detail and refine individual risk metrics, analyze cases of implementation of non-standard stress scenarios, and perform assessments based on the needs of business units or at the request of regulatory authorities.

The goals of Ad-hoc ST can be:
- ensuring business continuity and planning optimal business management of a commercial organization taking into account possible stressful conditions;
- support for management decisions related to business planning and budgeting;
- support for business units in determining individual parameters of a commercial organization portfolios, industries, and segments of the economy under stressful conditions.

4. Discussion: Structure of information and analytical stress testing systems

In the IASST, it is advisable to allocate separate functional modules for macro ST and Ad-hoc ST, as the purpose of the procedures is different. The composition of the source information may depend on the target task of stress testing. Therefore, in the IASST structure, along with the automated mode for loading source data, the manual loading mode must also be implemented.

The IASST role model and the composition of roles available to users are essential. A user role is defined as a set of capabilities of a user who has a specified set of access rights. The stress testing process is a large-scale process within a commercial organization (figure 1) and involves a large number of different departments. Typically, the involved participants are:

- coordinators for stress-testing (develop plan/schedule for conducting stress-testing, to coordinate the results at different stages, carry out the aggregation of results, etc.);
- analytical divisions (form the prerequisites for the used stress scenario, forecast macro-and micro-economic indicators, etc.)
- financial divisions, treasury (provide the necessary statistical and forecast indicators, calculate regulatory indicators, provide a forecast for risk metrics, etc.);
- risk committees (review and make adjustments to stress scenarios, reports on the results of stress testing, etc.);
- commercial bank management (approve stress scenarios, review the results of stress testing, etc.).

Based on the large number of departments involved in the process, the allocation of roles should meet the needs of all participants.

**Figure 1.** Key elements of the stress testing procedure.

In the IASST architecture, the connecting element is the IASST functional menu. The functional menu should meet the user’s needs for visualization of the main calculation and auxiliary directions of the IASST. For data that is used for calculating risk metrics and models, we suggest using a separate item in the function menu and certain templates. Templates are a fixed set of source data, portfolios, tables, and coefficients. These parameters are created on the required date (Figure 2).
When creating a new calculation that is used for conducting a stress test, the necessary templates are selected and the calculation is performed. The results of the calculation are saved in the IASST database. The necessary functions for working with data templates and calculations based on templates are the ability to view, copy, change, delete, and manually adjust at all stages (Figure 3). Additionally, data templates and stress test calculations provide consistency checks, for example, for invalid values in cells, and detected errors.

Before conducting stress testing, it is necessary to create an extensive database of macro- and micro-economic indicators (Figure 4). These indicators allow evaluating the dynamics of the economic cycle, predicting the trading volumes of various segments of the economy and the dynamics of prices for various financial instruments. We suggest using a separate module to load, adjust, and analyze historical and current values of such macro- and micro-economic indicators. It implements operators for comparing data for previous periods, converting it to relative changes, and calculating the final total based on quarterly values. In addition, this module includes features for calculating regression models, smoothing models, trend models, and others.
As part of stress testing, losses are calculated for multiple types of risk, one of which is credit risk. A number of analytical methods that can be used to assess the impact of risk parameters on the loan portfolio are shown in figure 5.

During the development of the IASST, additional modules-superstructures can be created (Figure 6). These modules-superstructures will be used for simulation calculations of additional resulting indicators, such as economic capital for the loan portfolio or the calculation of capital adequacy standards after stress tests are calculated.
Figure 6. Illustration of additional modules—superstructures.

Visualization of the results is included in IASST. It is advisable to display the results of the conducted scenario in the same window with either the original stress scenario or the stress scenario that was found during the reverse stress testing procedure (Figure 7). When visualizing, it is advisable to show the dependence of each value of the macro- or micro-economic indicator on the target losses. If the resulting distribution has a form significantly different from the normal distribution, it is advisable to increase the number of simulations during the calculation.

Figure 7. Illustration of visualization of the stress test results.

5. Summary
In conclusion, we note that IASST as an automated tool for assessing the financial stability of a commercial organization allows:

- optimizing labor and resource costs by automating a large number of steps in the stress testing procedure;
- increasing efficiency and speeding up preventive risk assessment of a commercial organization;
- improving the quality of management decisions by using the results of stress testing;
- expanding the applied approaches to the development of methodology, tools and approaches to forecasting.
6. References

[1] Central bank of the Russian Federation 2018 Regulation of the Bank of Russia “On the requirements for content, order and timing of the submission by credit institutions to the Bank of Russia plans to restore fiscal sustainability, changes made to the plans to restore financial stability, the order of assessment by the Bank of Russia, and also about the procedure for informing by the credit organizations of Bank of Russia on the offensive in their activities and events envisaged by the recovery plan financial stability and deciding on its implementation” (October 4, 2018 653). Moscow, Russia

[2] The Federal Reserve System 2018 Dodd-Frank Act Stress Test 2018 “Supervisory Stress Test Methodology and Results” (June, 2018). Washington, The USA

[3] The European Banking Authority (EBA) (2018). EU-wide stress testing (June, 2018). Courbevoie, France

[4] The European Banking Authority (EBA) (2018). Final Report: Guidelines on the revised common procedures and methodologies for the supervisory review and evaluation process (SREP) and supervisory stress testing (July, 19, 2018). Courbevoie, France

[5] The European Banking Authority (EBA) (2017). Consultation Paper: Draft Guidelines on institution’s stress testing (October, 31, 2017). Courbevoie, France

[6] The Monetary Authority of Singapore (2018). Guidelines on Liquidity Risk Management Practices for Fund Management Companies (August, 16, 2018). Singapore, Singapore.

[7] Vinogradov A V, Kuznetsov & K B, Shimanovsky K V 2011 Complex of stress testing models Russian banking sector (Money and credit) 3 29-33

[8] Shimanovsky K V 2011 Methods of assessing the probability of default of industries Economics for the purposes of banking supervision (Vestnik Permskogo University. Economy Series) 1(8) 84-93

[9] Efremova T A & Shimanovsky K V 2012 Use of simulation balance sheet models for solving the problem of Bank stress testing (Management of economic Moscow: electronic scientific journal) 2 (38)

[10] Krasheninnikov N V 2016 Stress testing of banking risks in a crisis (Economics and Management: Problems, Trends, Development Prospects: Proceedings of the II International Scientific and Practical Conference - Cheboksary: Center for Scientific Cooperation) 182-186

[11] Krasheninnikov N V 2016 Stress testing of the main risks of the Russian banking system (Russian economic online journal) 1 1-16