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Результаты стресс-тестирования финансовой устойчивости банковской системы Российской Федерации

Крашенинников Н.В., член Британского Королевского института ценных бумаг и инвестиций, г. Лондон, Великобритания

Аннотация. В статье представлены основные результаты научного исследования, посвященного стресс-тестированию финансовой устойчивости банковской системы России. В частности, раскрыта сущность стресс-тестирования. В работе предложен алгоритм формирования количественной модели для стресс-тестирования банков, а также по данным банковской системы и для 5-ти групп банков построены модели стресс-тестирования основных рисков, с помощью кооторых получены результаты стресс-тестирования кредитного портфеля юридических и физических лиц, а также уровня ликвидности банковской системы на макро- и мезоуровнях.

Ключевые слова: стресс-тестирование, банковская система, моделирование.

The results of stress testing the financial stability of the banking system of the Russian Federation

Krasheninnikov N.V., the fellow of the Chartered Institute for Securities & Investment, London, United Kingdom

Annotation. The article presents the main results of scientific research on the financial stability stress testing of the Russian banking system. In particular, the essence of stress testing of financial stability of the banking system is revealed. The article proposes an algorithm for the formation of a quantitative model for stress testing

of banks. According to the data of the banking system and for five groups of banks, stress-testing models were developed for the main risks, with the help of which the results of stress-testing the loan portfolio of businesses and individuals, as well as the liquidity level of the banking system at the macro and meso levels.

Keywords: stress-testing, the banking system, modelling.

Stress testing is not a new tool in the bank risk management system, but its relevance over the last years has been rapidly increasing not only abroad, but also in Russia. First of all, it is associated with increasing political and economic risks of the global economy, as well as the desire of both banks and banking supervisors to improve general financial sensibility of the banking system.

Stress testing of the financial stability of the banking system in itself is a comprehensive, multi-variant assessment of its short-term sensitivity to external and internal stress factors.

Among the methods of scientific research in relation to our subject field, we rely on a systematic approach, which uses allows us considering the investigated field of research with all its variety, as well as achieving the desired goal and solving the tasks.

We believe that the following can refer to the stress testing system elements: object, subject, a mechanism with methods and tools, associated with it, as well as principles and stages. Some system elements play a special part, serving as a systemically important link. Stress factors are systemically important stress testing system elements of the banking system and its individual institutions. We believe that stress testing is a part, a subsystem of a more general system – the risk management system at both micro and macro levels. At the same time, we can talk about a restricted, technical approach, characterising stress testing as an analytical tool and as a process.

The central component, the object of the stress testing system, is the financial stability of the banking system or commercial bank (at the micro-level), since the result of stress testing provides an estimate of the general system vulnerability or the vulnerability of the individual bank to external shocks.

The relevant subdivisions of a commercial bank or central bank, which functions include an obligation to assess the degree of vulnerability of the subject of research to external factors, as well as assess the development of measures for identified damage compensation, serve as the system subjects. The stress testing mechanism includes methods and tools (top-down, bottom-up methods, etc.), which are constantly developed due to the emergence of new risk factors, expansion of the subject scope, degree of volatility of the market, relationship of the banking sector with other sectors of the financial market and the economy, their cumulative impact on financial stability. Describing the stress testing system, we also came to the conclusion that it is a part of a more general system – risk management system.

We present the results of the investigation of approaches and methods of bank risk stress testing, and we specify below the criteria for the classification of stress testing methods:

- According to the type of risk (credit, liquidity, market, operational, etc.);
- According to the number of factors in the model (single and multi-factor);
- According to the method of formation of stress scenarios (scenario analysis, sensitivity analysis, calculation of maximum losses);
- According to the mathematical apparatus (econometric, additive, multiplicative);
- According to the type of basic data (panel, time series, mixed);
- According to the order of the stress testing organisation (top-down, bottom-up, remote)

Systemic risks, which can be localised in different sectors of the economy and then shifted to other sectors, are one of the factors of the vulnerability of financial stability. It follows from this that cross-sectoral stress testing can make a significant contribution to the assessment of the degree of vulnerability and the assessment of the scope of losses, associated with the shift of systemic risks from one segment to another and, accordingly, development of a system of measures to reduce or localise them.

We believe that stress testing at the meso and micro levels shall be based on the same principles as cross-sectoral stress testing; namely, stress testing of the

vulnerability of bank's financial stability shall consider the results of the assessment and the impact of risk transfer to the bank from its direct contractors.

Such an approach allows assessing the degree of vulnerability of the financial stability of an individual bank, considering the probability of transfer of the contractors' risks to the bank. At the same time, this will require a justification of the choice of tested subjects, reasonable limitation of such tests conduction by a group of the largest borrowers and creditors of the bank. We believe that the accuracy of the results of stress testing largely depends on how well the stress testing is conducted at the micro level and whether the risks are reflected in the financial statements. In this regard, we believe that the cross-sectoral stress testing model should be three-level, combining an assessment of the business stress level of the bank's contractor, probability of the contractor's risks transmission to the stability of a commercial bank and comprehensive stress testing of the bank's financial stability, including the results of testing of its clients and macroeconomic stress factors.

In other words, we propose to introduce a mandatory requirement for stress testing conduction for principal contractors of the bank, which will make it possible to identify the risks of their vulnerability and assess the prospects for credit requirements meeting in case of negative scenarios of changes in the macroeconomic situation.

Considering the analysis of the current state, regulatory and methodological support, as well as prospects for the development of stress testing of the banking system, certain trends and problem fields can be identified. The analysis made by us has shown the following trends:

- complication of stress testing tools (use of complex mathematical constructions);
- the gradual expansion of the sectors' coverage subject to stress testing;
- consideration of intersectoral and intrasectoral relations, secondary effects of the impact of financial sector risks on the real economic sector;
- the weak methodological and regulatory framework for the organisation and maintenance of stress testing, recommended by the regulator for banks.

Problem fields of stress testing remain:

- remaining privacy of the main amount of information about methods and results of stress testing;
- unavailability of the well-knit system of guidelines for stress testing conduction for credit institutions;
- prevalence of control and administrative functions in the practice of stress-testing of the CBR at an insufficient level of development of expert-analytical functions;
- low level of forecasting function in relation to the determination of parameters of the stress testing scenarios.

In addition, the vector of development of stress testing towards the consideration of intersectoral relations and their mutual influence remains only an upcoming trend and will be implemented in stages.

Based on the RiskLikv metric, calculated as a ratio of the most liquid assets to current liabilities, specified in our previous article[1], the assessment of the level and dynamics of liquidity of the Russian banking system was made. This metric characterises the measure of the risk of formation of a liabilities and assets unfavourable ration, which can potentially lead to an increase in crisis phenomena in the fields of maintenance of an acceptable level of liquidity of the banking system.

Calculations of the RiskLikv indicator based on data obtained from the Bank of Russia[2] for the Q4 2007 – Q2 2018, show that the average level of liquidity using the method described earlier is equal approximately to 15%, minimum level is equal to 11%, maximum level is equal to 23%, and the variation of the average deviation from the arithmetic mean is equal approximately to 17%. There is a trend of slight reduction of the calculated level of liquidity of the Russian banking system for this indicator.

As a result of summarising of the state bodies data, a set of quarterly data was collected from the Q4 2007 to the Q2 2018, including 38 periods and 277 variables, and a model of the following type was prepared:

[1] Krasheninnikov N. V. Stress testing of principal risks of the Russian bank system [Electronic source] / N. V. Krasheninnikov // Russian Economical Internet Magazine. 2016. – No. 1. P. 1-16. – Access mode: http://www.e-rej.ru/publications/163/%D0%9A/.

[2] Information on credit organizations. Reporting Forms [Electronic resource] / CBR. - 2018. - Access mode. - URL: http://www.cbr.ru/credit/forms.asp.

$$RiskLikv = -0.000007 \times Res - 0.001774 \times Def + 0.000854 \times U + 0.169 \quad (1.1)$$

where Res – loss provisions, billions of roubles;

Def – consolidated budget deficit to GDP, %;

U – Index "Bank crediting terms for large enterprises"[3].

As a result of the conducted stress testing, the most optimistic scenario implies an increase in the RiskLikv indicator to the level of 0.16 (or 4% in percentage terms to the actual value of the Q2 2018), which is 13% more than the actual level achieved in the Q3 2015 and slightly higher than the average value for 9.5 years.

Considering the tendencies towards a growing budget deficit, deterioration of credit conditions in Russia and growth in the share of overdue debts in the non-financial sector, stress tests are most likely, which results are to reduce the liquidity level of the Russian banking system by 31% and 43%, respectively.

While applying the factor analysis approach that we used to build the RiskLikv model to assess the level of credit risk for stress testing of the Russian banking system, we present a model of credit risk stress testing CredRiskUr (1.2):

$$CredRiskUr = 0.084135 \times RasVVP - 0.000608 \times UbkTr \quad (1.2)$$

where CredRiskUr – loan delinquency rate in the corporate credit portfolio of the banks;

RasVVP – share of expenses for final consumption in GDP %;

UbkTr – Index "Bank requirements to the borrower" using methods of the CBR[4].

Based on the stress testing of the quality of the loan portfolio of the corporate segment of the Russian banking system (in terms of the level of problem loans in the total loan portfolio of the corporate sector), the following results were obtained:

- while maintaining the share of GDP aimed at final consumption as of Q2 2018 and the liberalisation of credit conditions to the highest level within the last seven years, there is a decrease in the quality of the loan portfolio (as compared with the average value for the analysed period) by 18%;
- the most realistic scenario – the deterioration in factors by 20% will lead to a drop in the quality of the loan portfolio by 30%;

[3]Change of the conditions of bank crediting in 2Q 2018 [Electronic resource] / Information and Analytical Bulletin of the CBR. – 2018. – Access mode: http://www.cbr.ru/dkp/surveys/ubk/.

[4] Change of the conditions of bank crediting in Q2 2018 [Electronic resource] / Information and Analytical Bulletin of the CBR. – 2018. – Access mode: http://www.cbr.ru/dkp/surveys/ubk/.

- real stress scenario – interpretation – deterioration in the macroeconomic environment with banks' requirements levelling down for borrowers by 70% will lead to an increase of the level of soured (delinquent) loans to 9.4%.

The characteristics of the investigated data set allowed us creating two independent models within the econometric analysis – CredRiskFiz1 and CredRiskFiz2 within the framework of a binary (two-component) model system:

$$\begin{cases} CredRiskFiz1 = 0.001361 \times Inf - 0.117444 \times RasVVP \quad (1.3) \\ CredRiskFiz2 = 0.002357 \times StFiz - 0.00349 \times UbkP \quad (1.4) \end{cases}$$

where CredRiskFiz – soured loan (loan delinquency) rate, granted to individuals;

Inf – consumer price index, quarter to corresponding quarter of the previous year, %;

RasVVP – share of expenses for final consumption in GDP;

StFiz – average rate of credits of individuals in roubles up to 1 year, %;

UbkP – Index «Bank crediting terms for the population» (index «Bank crediting terms for the population»)[5].

According to the results of the stress test of the Russian banking system conducted using the CredRiskFiz binary model, we obtained estimates of an increase in the share of soured loans in the retail loan portfolio, considering eight different macroeconomic scenarios. The worst-case scenario is to achieve the share of soured (delinquent) loans at a level of 0.1 (10%) with inflation of 4% and a sharp drop in the share of GDP directed at final consumption to the level of 39%.

Therefore, using the created models, we obtained the results of stress testing of the loan portfolio of legal entities and individuals, as well as the level of liquidity of the banking system at the macro and meso-levels. It has been established that the influence of three liquidity risk factors will lead to a change in the liquidity risk of the

[5]Change of the conditions of bank crediting in Q2 2018 [Electronic resource] / Information and Analytical Bulletin of the CBR. – 2018. – Access mode: http://www.cbr.ru/dkp/surveys/ubk/.

banking system from -43% (the most pessimistic scenario) to + 4% (the optimistic scenario). As a result of stress testing of credit risk, it has been established that in case of taking the worst historical values by all risk factors, the level of legal entities delinquent loans can grow by 32% in the banking system, and individuals' delinquent loans can grow by 42%.

Passing to the issue of creation of effective stress-testing systems for banking risks, it should be noted that there is a necessity to created general scientific and objective models containing an «outside view». We present below a general algorithm for the creation of a quantitative model for bank risk stress testing:

Firstly, a theoretical economic interpretation, a stable relationship between the stress-factor and the bank risk indicator shall be available.

Secondly, an optimal number of stress factors is selected describing the sources of stressful influence on the business model of the bank. Factors shall reflect different directions of stress influence and shall be weakly interconnected.

Thirdly, the possibility of a quantitative assessment of the relationship between the stress factor and the banking risk parameter with the selection of the method for assessment of the relationship is checked.

Fourthly, a quantitative model of stress testing is created.

While implementing stress-testing procedures in an economic downturn (crisis), avoid the characteristic methodological errors resulting from the analysis of the practical activities of Russian and foreign banks:

- the disregard of the synergistic effects of stress factors under the conditions of the economic downturn;
- the change of the type of correlation relationships during periods of economic recession in comparison with the pre-crisis values;
- the underestimation of the possible hidden power of action of the stress factors;
- the inaccurate assessment of the inertia degree of the relationships between risk triggers and risk factors;
- the revaluation of financial capabilities and available reserves;

- the disregard of changes and forecasts of key parameters for the development of the internal and external environment of the bank, which have been recognised within a long period as stable and have not been previously considered as stress factors[6].

To solve the problem of transmission of macroeconomic risks and triggers to the financial stability of individual banks, solve the problem of methodological support for the corresponding calculations. The combination of a large number of banks in the Russian banking system and multi-directionality of their activities allow using probabilistic methods at the macro-level. While lowering to meso- (level of industry, territory, group of subjects of analysis) and micro-level (individual subject), further application of the method of correlation and regression analysis becomes problematic.

The actual state of the Russian banking system, the level and accuracy of banking statements, despite their detailed elaboration and efficiency, do not allow using the methods for direct calculation of the risk level and effective conduction of «remote» stress tests effectively.

The tools offered in the modern literature for the analysis of key risks and conduction of stress testing often do not correspond the data sets, the essence of socio-economical events, and the specifics of the investigated indicators. The use of "double-entry book-keeping" in the operational and strategic management of the bank (this practice is also typical for the non-financial sector) reduces the effectiveness of stress testing based solely on the official statements of the banks.

Moreover, the problem also lies in the intentional falsification of the financial statements of the banks (for example, granting of consciously impaired loans, granting of loans to affiliates to withdraw funds to the unofficial segment, foreign exchange and financial market operations, offshores operations, etc.). The consequences of such events that affect the subject of our research are the following:

– the incomplete accounting of the amount of bank losses and the assessment of potential key risks (liquidity, credit, market and reputational risks);

[6] Krasheninnikov N.V. Bank risk stress testing under the crisis conditions / N.V. Krasheninnikov // Economics and management: problems, trends, development prospects: materials of II International research and practice conference – Cheboksary: Scientific Cooperation Centre, 2016, p. 182–186.

– the change of types of relationships between economic indicators, which complicates economic analysis and risk modelling;

– the incorrect conception of cause-effect relationships in the dynamics of indicators of the Russian banking system both at the macro- level and at the bank level;

– as a result, the low level of efficiency of traditional methods of economic analysis of the banking system indicators (index, additive, multiplicative, dispersive, regression analysis, etc.), widely used by most researchers and supervisors.

In this article, we identify these trends to increase the effectiveness of the developed stress-testing methods in practice. Considering the specified issues, in our opinion, the solution lies in the planning of the following methods:

– the reduction of the heterogeneity level of the set of banking information by way of consideration of dependencies at the meso-level;

– the combined use of the method of correlation and regression analysis, which will partially eliminate errors and distortions of information by way of mutual exclusion of the multi-directionality of their influence on large data sets along with other analytical techniques, in particular, grouping methods, classification and multiplicative analysis;

– the creation of practice-oriented models of bank stress testing with an interpreted methodological apparatus, appropriate for application in the practice of stress testing of the banks and the CBR;

– the expansion of the information base of econometric modelling using the maximum amount of macro-economic information and bank statements and the use of OLAP-technologies while processing and analysing multi-dimensional sets. In addition, an orientation not towards complication of the methods, but towards identifying theoretically grounded dependencies, as well as their modelling (confirming theoretically grounded dependencies of quantities using econometric methods) shall be the main direction in modelling.

Let's consider the implementation of recommendations for the creation of models of stress testing at the level of bank groups by the practical example. To create

a model of stress testing of banks at the meso-level, banks were grouped in terms of significant criteria. We present the analytical conclusions on the results of the research:

– the heterogeneity of groups of banks is expressed in the differentiation of the coefficients of correlation of the liquidity index with macroeconomic indicators, as well as in the differentiation of the parameters of regression models, which has a theoretical justification;

– the largest banks (namely, six banks that represent half of the assets of the credit and deposit portfolio of the Russian banking system) are less sensitive (in comparison with other groups of banks) to the terms of crediting and more sensitive to the macroeconomic level of credit risk;

– corporate and investment banks are most sensitive to the level of state finances, while banks with state participation are less sensitive to all three macroeconomic factors, and retail banks are most sensitive to macroeconomic credit risk factors;

– the low level of sensitivity of unprofitable banks is associated with the leading influence of macro-economic factors, i.e. the reasons for the loss are beyond the macroeconomic factors, but rather related to the peculiarities of bank business model.

An adapted regression model RiskLikv was created for every group of the banks. In each case, the models are created with a high coefficient of determination (from 0.91 to 0.96). The compliance of the models and their coefficients with the Fisher and Student statistical criteria is observed, which indicates the correctness and efficiency of the specification of the basic macroeconomic model and the set of regressors.

Consistently applying the created models for four hypothetical variants of macroeconomic scenarios, we obtained forecasts of the level of liquidity for each group of banks, which may differ significantly from the results of basic stress tests performed using a macroeconomic model. According to the results of forecasts of liquidity indicator of the distinguished groups of banks, the stress effects of macroeconomic factors were compared with different groups of banks.

Therefore, our hypothesis that the sensitivity of different groups of banks to the action of macro-triggers is significantly different – different groups of banks specifically respond to certain macroeconomic scenarios was confirmed.

Based on the obtained results, the following practical recommendations for the application of the developed stress testing approach were identified:

– the application of the «medium bank» method (direct broadcast of the stress effect of the model on the bank statements) using the adapted models specifies substantially the scope of the stress effect in relation to the bank;

– the priority application of one of the five regression models over the basic macroeconomic model since they consider the specifics of the bank more accurately.

Let's consider the possibility of application of a similar approach to credit risk stress testing of the banks. To ensure the comparability of the results with the liquidity risk analysis, the level of soured loans of legal entities in terms of the Russian banks over the period of 2009 was calculated – Q2 2018 according to the data, contained in the reports of 101 form. Specification of private models allows including one factor – the level of GDP and structure of its distribution.

As a result of this calculation, it seems obvious that for the credit risk indicator («the share of overdue credit debt of legal entities») the differentiation of the power of influence of the macroeconomic factor is statistically proven. The category «unprofitable banks» also has low sensitivity to macroeconomic factors as categories in the liquidity model. We believe that the theoretical justification for this pattern has the same nature in case of liquidity analysis risk, as well as for the latter model, which describes credit risk. Therefore, the application of adapted meso-economic models for groups of banks is methodologically efficient, since this will lead to an improvement in the quality of the forecast for stress testing of credit risk.

Considering the results of modelling and stress testing of the main risks of the banking system, we note that a further increase in the effectiveness of stress testing cannot be based solely on the improvement of the methods. Due to the need for regulatory (legislative and administrative) support of stress testing both at the CBR level and at the bank level, recommendations to improve the stress testing methods of banks should consider organisational and legislative aspects, including the following:

1) the ensuring distinction of the principle of developing an «ideal model»;

2) the use of more informative indicators of credit risk for further expansion of the information base of stress testing;

3) the use of more detailed indicators in the process of risk modelling and indicators of the financial stability of banks for stress testing;

4) the use of rating not only of the corporate debtor clients, but also private clients of the bank to forecast the risk of «flight of investors» by the way of direct calculation of the probability of withdrawal of deposits in terms of private clients;

5) the use of special collateral ratings for stress testing purposes, since market risk, has a strong impact on the value of collateral;

6) the implementation of a supervisory control system for the effectiveness of stress testing conducted by banks;

7) Professional development and certification of bank management to increase the level of management in the bank.

Accumulating the history of quarterly scenario forecasts and factor analysis of their implementation will allow identifying banks with high and low forecasting levels, monitoring the quality dynamics of stress testing for each bank, and considering this information while creating integral indicators of quality management by rating agencies and the CBR. We have developed appropriate methods that can serve as a basis of the letter of the CBR.

To determine the direction of development of methodological approaches to the organisation of stress testing, it is important to distinguish levels of common use and performance of stress tests by the banks. We believe that it is reasonable to distinguish the following levels of application of stress testing with the distribution of banks by categories, presented in table 1.

Table 1

Classification of banks according to the level of the stress-testing business[7]

Bank class	Business characteristics
Leaders	A comprehensive process of stress testing was implemented, and professional management of the process was organised; Purpose personnel, organisational (individual specialised units) and financial resources (business process budget) were distinguished for stress testing conduction; High level of formalisation and integration of the business process in the activities of the bank; Extensive use of internal and external models and stress testing systems with a comparison of the results obtained using various approaches. The scenario approach prevails in determining of stress effect; a methodological framework is being developed; According to the results of the fulfilment/non-fulfilment of the forecasts of stress effects, a factor analysis of deviations is carried out with an executive correction of models; The necessity for stress testing conduction is considered while developing a bank strategy
Profes-sionals	The priority of stress testing using for business purposes over the requirements of the regulator; There is a complex process of stress testing, and its implementation is regulated; Generally, a quantitative sensitivity analysis is performed using an external method with adaptation to the internal one; Certain human and financial resources have been distinguished for the business process; All types of risks are subject to the stress testing
Executors	Fulfil primarily minimum requirements of the regulator; The resources of other divisions (risk management, planning, analytical) are used as a functional task with appropriate management; Only quantitative sensitivity analysis is performed; Only main risks are subjected to stress testing: credit and liquidity
Outsiders	The initial stage of implementation of the business process, lack of experience, lack of internal methods and methodology; Rely solely on the professional judgement of external experts; Special resources for the business process are not distinguished; Only market risks are subjected to stress testing, possibly – credit risks at the minimum level

Source: prepared by the author

To create an effective organisation and implementation of the process of stress testing, most banks shall pass certain stages. Each stage includes a set of activities required to achieve the goal and the desired results. The greater the number of banks maturing into the «professionals» and «leaders», the more confidently it will be possible to state qualitative changes in the field of stress testing of banks and banking system.

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