

Jolanta Majda
jolantamajda@interia.pl
Ewa Matlak
ewa.matlak@interia.eu

STRESS TESTS AS AN INSTRUMENT OF RISK MANAGEMENT

Introduction

Several financial institutions apply foreign capital to finance their new projects and investments in order to strengthen their position and significance on the financial market. The use of foreign capital is associated with risk taking and requires attention to new hazards; it forces the institutions to search for the ways of defense and to adjust their operations to changing conditions, both internal and external. Stress tests constitute an instrument that supports effective risk management and enables the investigation of a possible reaction of a financial institution to shocks that may appear on financial markets.

The aim of the paper is to present stress tests against the background of financial risk. The most common approaches of conducting stress tests are discussed as well as the significance of the choice of assumptions to test scenarios. The article provides information on legal regulations as regards stress tests that refer mainly to the bank market where such tests are obligatory. The issue discussed raises many questions. First of all, can stress tests predict all the dangers that a given institution is going to face and to what extent do their results influence the quality of risk management?

1. Financial risk

Financial risk is the effect of the contact of a financial institution with its surrounding, it is the result of the time span between the decision on starting an activity and its accounting. The main components of a financial risk are as follows:

- market risk;
- credit risk;
- operational risk;
- liquidity risk.

The first two types of financial risk have been investigated by experts for years and consequently they are the ones whose understanding is the best. Market risk is considered to be neutral as the changes of prices on markets may cause both negative and positive

consequences. The sources of that risk come from market parameters, their variability and correlations.

Credit risk occurs in every situation when one party has liabilities towards the other one and is connected with the danger that the debtor will not respect the commitments stated in the contract. It refers both to direct credits, loans, purchase of receivables, guarantees and bails.

Special attention was focused on the notion of operational risk in 1990s in relation to the collapse of the Barings Bank¹. As the definition of risk is ambiguous, the definition given in the New Capital Accord will be adopted in this paper. Operational risk is the risk of loss resulting from inadequate or failed processes, systems, external events or faults of people. It emerges in the operations of all market players since it also includes the risk of financial fraud and physical and legal risks; consequently it is considered as a negative concept. Operational risk can be divided into internal risk (which includes the personnel and technology) and the external risk (regarding the contacts with the environment)

Liquidity risk is the unexpected loss of financial liquidity of a business subject, i.e. the impossibility to cash the assets at an expected price in a short time². For example, in order to measure the bank's liquidity risk, the management has to determine the desired balance sheet structure and the methods and techniques of measuring the degree of the loss liquidity risk³.

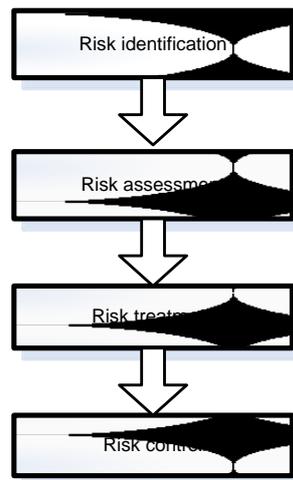
The character of financial risk is so complex that adequate risk management is crucial. It consists of four basic phases.

¹ Barings Bank Barings was one of the eldest commercial banks in UK; it was founded in 1762. Its collapse in 1995 was caused by one person – Nick Leeson, a broker of the Singapore branch, who was responsible for the futures contracts. His operations on the Singapore and Japanese futures markets resulted in the loss of over £800m. In the course of his operations the loss was hidden on a special account No 88888, that was not monitored by the Head Office.

² Cf. Jajuga K., *Zarządzanie ryzykiem*, PWN, Warszawa 2009, p.24,

³ Capiņa M., Gradoń W., Szustak G., *Adekwatność kapitałowa w ocenie bezpieczeństwa banku*, CeDeWu, Warszawa 2011, p.109.

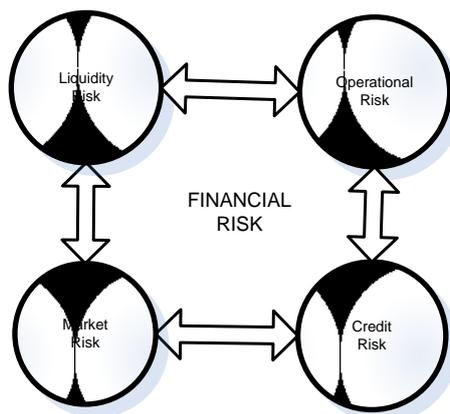
Fig.2. Risk management



Source: based on Krasodomska J., *Zarządzanie ryzykiem operacyjnym w bankach*, PWE, Warszawa 2008.

Risk management in a business company differs from the one in a bank. Main differences already appear at the moment of the identification of the risk sources and first of all in the determination of the areas and possible events that may lead to a loss. At present, the integration of the risk management process is considered to be the most significant strategic challenge of any organizations as various types of risk are closely interrelated. Thus, it is crucial that management should not refer to each type separately and it should take into consideration the relations between the components of the risk.

Fig.2. Integrated risk



Source: author's investigations

A credit agreement signed on the basis of fake identity documents may be an example of a relationship between operational and credit risks. Another example is an inappropriately or erroneously applied algorithm or method of assessing the creditor's worthiness.

Another step that leads to effective risk management is its assessment, i.e. its measurement. In order to assess the level of risk, quantitative methods are used, among which the methods based on the VaR ratio⁴ are the most common. That ratio may be also applied to identify the reasons of the risk and the methods that will help to reduce it. Recently, stress tests have gained in popularity. They have become another method that is applied to measure the risk and to manage it in an effective way.⁵

2. Stress tests – function and application

Stress tests are applied to estimate the potential impact of various disadvantageous events or changes in financial variables on the economic condition of a business unit. The events are little probable but may significantly or even critically influence the financial situation of a company. According to the IMF working paper⁶ stress test is a set of methods applied to investigate the vulnerability of the portfolio of a financial institution to events that are extreme but probable (the so called *shocks*).

Stress testing began to be used in relation with the Financial Sector Assessment Programs FSAP that were run with the co-operation of the IMF and World Bank. The main aim of FSAP was to create conditions for the development of a uniform financial services market and to the implement modern prudential regulations and a corporate supervisory system on international level. Initially, stress test were meant to assess only the market risk. However, with the development of methodology, they gradually began to be applied in the identification and measurement of all kinds of risk. Finally, they became an assessment tool of the vulnerability to shocks in the whole financial sector.

Stress tests are an analytical method that can be used to estimate the vulnerability of an institution to the change of particular risk factors and to identify the weak points of financial institutions; they most commonly supplement the advanced statistical models. As opposed to VaR, which measures the market value of an asset portfolio during typical movements on financial markets, stress tests are applied to simulate the effect of abnormal

⁴ Value-at-Risk is the loss of value expected to be reached or exceeded over a given time period, equal to the given tolerance level

⁵ Quantitative methods applied to estimate operational risk, apart from VaR and stress tests, include Monte Carlo methods, methods related with Bayesian networks, comparative analysis methods and six sigma methods.

⁶ Jones M.T., Hilbers P., Slack G., *Stress testing Financial Systems: What to do When The Governor Call*, IMF Working Paper WP/04/127, 2004, p.4.

events.⁷ They do not provide the clues concerning the probability of a given scenario but they provide the answer to the question *how big the loss may be*, and not *how probable it is*.

The following elements play a significant role in stress testing:

- the selection of realistic scenarios,
- the selection of adequate scenario assumptions,
- the determination of an adequate time frame,
- the preparation of good quality data indispensable for the tests,
- the choice of adequate methodology.

The access to up-dated, full and reliable information is a crucial element if the tests are to be correct. Such information is the basis for test scenarios, which make it possible to make decisions as regards managing institutions in critical situations.

Constructing test scenarios is the most difficult and very controversial process as it requires making a series of decisions. A perfectly conducted test must be adequate to a particular asset portfolio, must present the changes in market ratios and must take into consideration the changes of liquidity on the markets and the interactions between different types of risks that were mentioned above.

3. Characteristic features of stress testing in banks

Stress testing in a bank consists in a quantitative assessment of the impact of changes (economic in nature) that occur in its surrounding and will have some influence on the requirement to maintain a defined capital level.

According to the New Capital Accord, the bank that wants to apply an internal rating model⁸ to calculate the required capital must meet the following qualitative requirements:⁹

- There should be a risk control unit in the bank (responsible for the design and implementation of a risk management system and reporting on the model results on a daily basis);
- The bank management should participate in the risk management process;
- The risk control unit should have formal procedures and a system that are validated by internal auditing;

⁷ Bank for International Settlements, *Stress testing at major financial institutions: survey results and practice*, 2005, p.4.

⁸ According to the Capital Accord, bank can use one of the two methods to estimate the capital requirement as regards credit risk: the standard approach or the advanced one: the IRB - *Internal Ratings-Based Approach*),

⁹ Basel Committee on Banking Supervision, *Amendment to the Capital Accord to Incorporate Market Risk* art. B2, 1996.

- Regular (at least quarterly) stress tests should be conducted that are used in effective risk management;
- Regular back testing should be carried out.

The analysis of stress tests makes it possible to monitor and determine the ways to react to extreme situations so that the loss is as small as possible.

The following situations may be considered as extreme:

- word/European financial crisis;
- withdrawal of deposits by the greatest depositors (which results in the loss of the bank's solvency);
- significant decrease of the credit portfolio value;
- drawdown of unconditional lines of credit;
- breakdown of bank data bases and computer systems responsible for customer service.

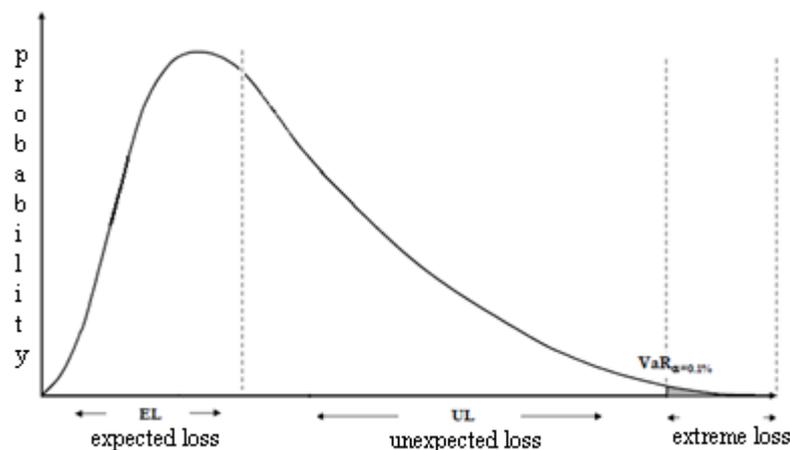
Stress tests should consider extreme disturbances in¹⁰:

- price parameters;
- market liquidity level;
- the strengths of correlation relationships of price parameters changes;
- the structures and amounts of primary items and other bank conditions as regards market risk.

Stress tests in banks focus on credit, market and operational risks. Every risk should be defined precisely as regards the extent of its appearance and the method of measurement. Operational risks involve such factors as internal and external frauds, breakdowns of systems (the ones that are not the result of a purposeful action) or operational procedures applied. Banks divide losses related to operational risk into two categories, EL – expected losses and UL – unexpected losses; unexpected losses include also extreme losses. Regulation No 1/2007 of KNB, the Commission for Banking Supervision stated that both categories of losses should be taken into account when calculating the required capital for operational risk.

Figure 3. Loss distribution

¹⁰ Marcinkowska M., *Standardy kapitałowe banków - Bazylejska Nowa Umowa Kapitałowa w polskich regulacjach nadzorczych*, Regan Press, Gdańsk 2009, p.133



Source: Jobst A.A., *Operational Risk –The Sting is Still in The Tail But the Poison Depends on the Dose*, IMF 2007, p.48.

Banks are free to choose and work out the approach that is the best to show their real vulnerability to operational risk.¹¹

The Committee of European Banking Supervisors presents guidelines as regards stress testing of operational risk whose results must have an impact on planning the capital requirements against this kind of risk.¹² Apart from the standard approaches of risk measurement (BIA – Basic Indicator Approach, TSA – Standardized Approach) , advanced methods (AMA – Advance Measurement Approaches) are recommended. Four major components, i.e. internal and external data, scenario analysis, business environment and internal control factors that should be considered in the quantitative AMA operational risk analysis were defined. However, neither the combinations of the components nor their weights were determined and, consequently, every institution conducting stress tests is obliged to consider AMA as a risk measurement technique typical only for itself. Banks face the problem of how to introduce a risk measurement system simple enough to be implemented, applied and analyzed and, on the other hand, complex enough for the risk to be measured in an adequate way.

4. Stress testing methodologies

Stress testing can be carried out with the application of various tools. Their choice depends on the type of institution, the quality of data and the financial means that can be

¹¹ Bancarewicz G., *Wybrane zagadnienia dotyczące strat i modelowania ryzyka operacyjnego w ramach zaawansowanej metody pomiaru AMA*, Bank i Kredyt 8-9, 2007, pp.104-105

¹² Committee of European Banking Supervisors, *Guidelines on Stress Testing*, CP32, 2009, p.34

involved. Below, basic approaches used in stress testing are presented. They are: the Sensitivity Analysis, Scenario Analysis and Extreme Value Theory. Their choice depends on the situation on the market and other crucial factors that were mentioned above. The Sensitivity Analysis and Scenario Analysis are the most popular ones and widely applied as they are easy to implement and finance.

Sensitivity Analysis (also called an algorithm method due to its similarity to algorithm techniques applied in programming) is typical for small institutions with a simple form of operations. It consists in an attempt to estimate the disadvantageous impact of one risk factor or of a small number of inter-related risk factors on the financial condition of the company. The time horizon for the sensitivity analysis is much shorter than in the case of the scenario analysis.

Scenario Analysis includes several risk factors and investigates the impact of catastrophic events (less probable than in the case of sensitivity analysis) as regards the risk profile of the financial institution. The approach consists in the analysis of historical or hypothetical scenarios. Historical scenarios are based on significant events that occurred on a financial market in the past, while hypothetical scenarios are concerned with the events that may happen in the future. The weak point of historical scenarios is that they do not take into consideration the new, crucial trends that appear on the market. Thus, the analysis based on hypothetical scenarios with the application of historical movements on the market is most commonly used in practice; however periods of crisis are not necessarily taken into consideration. Scenario analysis is typical for big institutions and requires a vast specialist knowledge.

Table 1. Comparison of stress tests

	SENSITIVITY ANALYSIS	SCENARIO ANALYSIS
Risk factors	Analyzes one risk factor	Analyzes several risk factors and their inter-relations
Type of institution	Applied in small institutions with a simple activity profile	Applied in big institutions. Vast specialist knowledge required
Method of measurement	Estimation of the negative impact of a risk factor	Scenario analysis
Historical data	Not required.	Significant amount of historical data indispensable
Time Horizon	Short time horizon	Long time horizon

Source: Author's investigation.

In stress tests some more advanced methods that require complex operations and a substantial amount of data are also applied. The Extreme Value Theory is one of them.

The EVT (Extreme Value Theory) is a typically statistical tool that enables the estimation of tail risk. The test conducted with the use of this method are based on skewness and thickness analyses and other features of the distribution tail. The amount of loss is approximated by the generalized Pareto distribution¹³, and its frequency by the Poisson distribution. The application of this method requires a substantial amount of information. It is used mainly to model rare events (i.e. the ones with a low probability) that cause extremely significant losses. It is the only method that aims at assigning the probability to the effects that may occur after an extreme condition occurred.

After stress tests are conducted and their results are interpreted, it has to be remembered that if a test is carried out improperly, it gives a false feeling of security in the field of risk management. This may have disastrous effects on the institution when such conditions occur.

5. Conclusion

In conclusion one can state that stress tests are a tool that is complementary to other measurements and approaches to risk management and they play an important role in:

- estimating prospective risk,
- overcoming the limitations of models and historical data,
- supporting internal and external communication,
- determining risk tolerance in banks,
- supporting capital and liquidity planning procedures .

The growing interest in stress tests shows that financial institutions are ready to introduce their own, innovative methods in order to implement them. Stress tests are not only an inseparable element of risk management but they are also used to estimate the resistance of financial institutions to a disadvantageous development of economic situation. From this point of view, the significance of stress tests started to be appreciated in relation to the global crisis.

¹³ *Generalized Pareto Distribution* for parameters ξ, β is given by $GPD(\xi, \beta, x) = 1 - (1 + \frac{\xi x}{\beta})^{-\frac{1}{\xi}}$.

From the point of view of a bank, their most important function, apart from the estimation of risk profile, is to inform whether its capital base will be sufficient to survive in extremely difficult times.

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Abstract

The paper shows that stress tests are a tool that supports financial risk management. It consists of three basic parts; the first section focuses on financial risk and its components, especially credit risk, market risk, operational risk and liquidity risk. It also contains some information about risk management process and integrated risk. The second one gives an overview of issues involved with stress tests including some concepts and techniques of stress testing. Moreover, this part of the article provides the information about stress testing in

banks, where tests are an essential element of Basel II Framework. Finally, the paper contains a description of the most common approaches applied in conducting stress tests.