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RISK MANAGEMENT IN THE BANKING SECTOR - STRESS RESISTANCE TESTS

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Abstract: *A modern, turbulent and dynamic global financial environment requires the banking sector to adopt a risk management policy as a starting point that should more closely define the recognition and control of the total exposure of the banking system to different types of risks. The author gives an overview of the role and significance of the stress tests that provide a quantitative assessment of the vulnerability of the banking portfolio and which are most often associated with unexpected but real economic events and shocks. The results of stress tests carried out in the United States as well as in the European Union member states in the context of a crisis with a focus on the framework for testing stress resistance in Basel II and III were also presented.*

Keywords: *stress tests, Basel agreements, economic crisis, banking sector*

1. INTRODUCTION

With the outbreak of the global economic crisis, stress tests are gaining importance in the circles of international financial institutions and regulatory bodies. In that sense, the application of stress tests, as an additional tool in the risk management and capital planning process, has become widespread both internally (ad hoc in the banking sector) and at the level of the financial system of a country. In this context, stress test analyzes play an important role in: providing pre-oriented risk assessments, overcoming model and confidentiality constraints, providing support

to external and internal communication, entering data for capital planning and liquidity processes, providing information on banks' resilience to risk, the process of risk reduction planning and treatment in crisis situations. [BIS, 2009]

In hypothetically created conditions, with the help of stress test, the level of capital, cash flows, deposit, credit potential of the banking sector is checked and the necessary level of liquidity and solvency of financial institutions in crisis situations is defined. The analysis may include relatively simple assumptions about one or more financial, structural or economic variables, as well as the use of more complex, highly sophisticated financial models. The process of measuring risk exposure consists of the following steps: selecting variables and determining the time interval, defining the economic and testing the set model.

Stress tests are one of the most effective preventive techniques that defines the level of banks' sensitivity to changing macroeconomic factors. [Barjaktarović, et al, 2013] This method provides useful information on the financial stability of the banking sector and assesses whether commercial banks will be able to compete with extra turbulence in the economy resulting from unexpected oscillations of macroeconomic factors [Blaschke, et al, 2001] In addition, stress tests can be defined as a technique by which financial institutions are able to measure the potential exposure to negative but possible events (scenarios). [BIS, 2000] Such events are not frequent, moreover they rarely appear, but leave strong negative consequences for both the micro and macroeconomic system and economy.

A stress test is a technique used by risk management managers in banks but also by financial sector supervisors to determine the degree of vulnerability of both the banking and the overall financial system. [Jones, et al, 2004] Testing stress resistance alerts top management the negative, unexpected outcomes generated by the risk group and represents a good method for calculating the potential exposure to extreme loss, since the top management of commercial banks provides assistance: when making decisions in crisis situations, in the risk management process, in assessing the amount of capital that would be needed to absorb losses in the event of major economic shocks.

2. METHODOLOGY OF APPLICATION OF STRESS TESTS IN THE FINANCIAL SECTOR

The Bank for International Settlements (BIS) determines the steps in the stress testing process, which can be presented as follows [BIS, 2009]:

- Defining the species: sensitivity tests or scenario tests
- Determination of the model: deterministic or stochastic
- defining data and parameters: historical or hypothetical
- determining the time interval of the analysis: short-term or long-term.

Stress testing can be carried out through sensitivity analysis and scenario (simulation) analysis. [BIS, 2009] By analyzing sensitivity it is possible to interpret individual stress parameters, that is, input data that are not related to events and consequences in the real world. The main advantage of sensitivity tests is the ability to quickly assess the sensitivity of the portfolio to certain risk factors (a certain risk concentration is identified), while the underlying shortcoming of this scenario is that it does not analyze multiple risk factors at the same time. A scenario or simulation analysis involves simultaneous analysis of several risk parameters in defined extraordinary (stressful) circumstances. This analysis is more complex than the previous, since it takes into account the inverse correlation between the analyzed risks. For example, the lending activity of banks increases the profitability of the bank, but at the same time increases the liquidity risk and credit risk.s

Sensitivity tests and scenario tests are the subject of an analysis of mathematical models: deterministic and stochastic. [O'Brien, 2009] Deterministic models are models whose behavior can be predicted, in which the level of the system state is completely determined by the previous state. In a deterministic approach, possible scenarios for the movement of economic variables are determined and controlled by the users of the model. The results of these models depend solely on the quality of the scenarios used. In other words, if the actual model variables differ from the assumptions, the real risk exposure of the bank will be different from the measured risk. On the other hand, in stochastic models, the behavior of the variables can not be predicted in advance, but the probability of changing the state can be determined. For stochastic models, it is characteristic random behavior, that is, the existence of random variables in the system. The most commonly used method of the stochastic model is the Monte Carlo method, which covers a wide range of possible values of financial variables, wholly taking into account their mutual correlations. [Cvetinovic, 2008]

We distinguish two approaches to the analysis of stress tests: historical and hypothetical. Historical scenarios were often implemented on the basis of a significant market event from the past. According to this approach, certain events occurred in the past and there is a likelihood that they will repeat in the future. Historical approach over time can become less relevant because it looks historical historically and does not take into account the development of financial markets, so stress tests could not include the risks of new products that emerged from the onset of the crisis [Blaschke, et al, 2001] In the Table 1 shows the list of events that is often used in the historical analysis of stress tests.

Table 1 List of events used in historical analysis of stress tests

Year	***Event***
1973	The first oil crisis - OPEC increased the price of crude oil
1979	Second oil crisis

1987	Black Monday - the collapse of the US stock market
1991	Gulf War - the rise in crude oil prices
1992	The crisis of the European monetary systema
1995	Tekila crisis - current account deficit in Mexico
1997	The crisis in East Asia
1998	The Russian crisis and the collapse of the hedge fund LTCM (Long term capital management)
2001	11. IX- a terrorist attack on the United States
2007-2008	Mortgage crisis in the United States

Source: [Matz & Neu, 2007]

In addition to the historical approach, it is possible to use a hypothetical scenario, which is not based on events that have not yet happened in reality. This approach, although more flexible, due to the link between factors that did not actually occur, makes it difficult to determine the likelihood of exposure to risks to the banking sector. When analyzing stress tests, the time horizon to be considered should be taken into account. In order to obtain reliable results, stress testing should be carried out in the short term (up to one year) and in the long term (from one to five years).

3. ROLE AND IMPORTANCE OF STRESS TESTS IN THE BANKING SECTOR ACCORDING TO THE BASEL AGREEMENTS

In its business, a bank meets various types of risks that can lead to negative business results. Risk management in banking operations includes identifying, measuring and assessing risks in order to minimize their negative effects on the financial result and the capital of the bank. The main objective of risk management is to determine the optimal level of risk acceptability, which in correlation with a certain amount of capital can have the most favorable effects on the operations of banks. Risks to which a bank is exposed in its business are liquidity risk, credit risk, market risks (interest rate risk, foreign exchange risk and the risk of changes in market prices of securities, financial derivatives and commodities), risks of bank exposure, risks of bank investments, relate to the country of origin of the entity to which the bank is exposed, operational risk, legal risk, reputation risk and strategic risk. The stability of the financial market and macroeconomic policies depends in large part on the solvency and liquidity of banks and the ability to overcome the negative effects of the crisis and to deal with the recession.

Each financial institution, even the bank, has the obligation to maintain the minimum level of capital. This capital serves financial institutions in the event of unexpected losses (negative effects of the global economic crisis) or as a basis for

further growth and development. [Barjaktarović & Paunović, 2013] Even in crisis situations, well-capitalized banks can unduly lend business entities, thus surpassing overall security in the banking sector. Managing international risks is regulated by agreements on banking standards and capital adequacy, the Basel Agreements

3.1. BAZEL I

At the beginning of the 1980s, Europe faced an oil shock, which soon spilled over to the banking sector and resulted in the bankruptcy of the German bank *Bankhaus Herrstat*. In order to avoid major potential shocks and adverse effects in the banking market, at the end of 1974, the United States and G10 countries (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, England) established the Basel Committee for f Banking Regulations and Supervisory Practices, more commonly known as the Basel Committee (the Bank of England, 1995), which is one of the committees of the *Bank for International Settlements (BIS).*

The first document (Concordat), which requires more complete supervision of the banking sector, came into force in 1975, in order to apply in 1983 the document of the Principles of Control of Banking Foreign Institutions, which represents the revised version of the Concordata. A few years later, the world was beset by another economics crisis, this time there was a talk about a crisis of indebtedness. The Basel Committee, realizing that capital adequacy ratios have deteriorated, decided to develop a new model for measuring risk (and capital adequacy). The system for measuring capital adequacy, known as Basel Agreement I (Basel I), was introduced in 1988, and its implementation started in 1992. The Basel Agreement I, the capital agreement, defines the elements of the capital of banks in the following way:

- core capital (level one or core of capital - Tier 1) comprising: ordinary shares, surplus, unallocated profit (retained earnings), forms of priority shares, minority interests, intangible assets; [Ljubic, 2009]
- Supplementary capital (level 2 - Tier 2) includes reserves for loans and losses on leasing operations, medium-term priority shares, equity securities and other instruments with a limited holding period of 99 years;
- weightings for calculating credit risk on balance sheet assets;
- credit conversion factors for calculating credit risk on off-balance sheet positions;
- the ratio between equity and total assets weighted by credit risk - an indicator of capital adequacy that implies maintaining an adequate level of capital and reserves in order to protect the bank from insolvency.

In addition to the introduction of a unique method for calculating capital adequacy and determining its minimum level, the main goal of Basel I is to strengthen financial stability and establish fair competition in the banking market (no bank

in the market can operate if there is insufficient volume of capital). The first goal of the Basel Committee was to establish contacts between the regulatory authorities of the member states, with special attention being paid to the control of the banking system. The function of the Basel Committee for Banking Supervision was to formulate general standards and guidelines for supervision and propose examples of best banking practice in the expectation that legislative bodies in individual countries will take steps to implement them so that they best suit the specifics of the domicile system. [Barjaktarović, 2009]

In Basel Agreement I, the focus is exclusively on credit risks, as banks' long experience has shown that users of bank loans usually do not comply with their commitments as a whole. By the year of 1992 Basel I enabled the implementation of a framework for determining credit risk, with a minimum capital adequacy ratio of 8%.

$$\textit{Capital / Weighted assets (credit risk)} \geq 8\%$$

At the end of 1993, all banks in the group of G10 countries whose operations were of an international type met the basic requirements regarding the decision of the Basel Agreement I. After eight years in 1996, the Committee published an addendum to the Capital Agreement, which, in addition to the credit risk, extends to capital requirements that cover the bank's exposure to market risk and the introduction of a new instrument for measuring market risk VaR (value at risk), whereby the minimum amount of capital ade- quate remains unchanged

$$\textit{Capital / Weighted assets (credit risk)} \geq 8\%$$

Two years later, in 1998, the Basel Committee for Supervision of Banks published a document entitled *Operational Risk Management*, which forms the basis for the development of operational risk as an independent discipline. In 1999, the Basel Committee published a draft of a new standard that should be replaced by Basel I and two years later document Other Consulting Paper CP2 (*Consultative Paper*). In 2001, the Bank for International Settlement published the document *The New Basel Capital Accord*, which defines that each bank must perform stress testing in the process of determining capital adequacy. Stress testing should include the identification of future possible events or changes in the economy that could have adverse effects on the bank's credit exposure and the ability of the bank to withstand such changes. [BIS, 2001] Furthermore, stress testing should include the identification of possible events or future changes in economic requirements that could have adverse effects on the bank's credit exposure, and an assessment of the bank's ability to make such changes. [BIS, 2001]

The third consulting paper CP3 was published in 2003, as well as the *Sound Practice for Management and Supervision of Operational Risk* document, a set of principles that form the framework for managing operational risk and supervision.

3.2. BAZEL II

The rapid development of financial markets, the emergence of new products and services, financial structures (mergers and acquisitions) as well as new risk management techniques have necessitated the adoption of the provisions of Basel II and supporting documents. The Basel II agreement arose from the need for changes in the method of calculating the capital adequacy ratios. In co-operation with financial institutions, in the first place with the banking sector, in 2004, the Committee published the final version of the document entitled *International Capital Measurements and Standard*s, Revised Framework, widely known as Basel II (*Basel II Acord*). Although Basel II did not have a binding character after its introduction, since January 2007 all EU countries should start with the process of introducing standards, which represents a new set of provisions for determining the minimum capital adequacy of banks. The European Commission has adapted the provisions of Basel II to domestic credit institutions and investment companies through the *Capital Adequacy Directive* CAD3 adopted in 2005, while other European countries (including Serbia) are trying to implement it through its laws and regulations [Ljubić , 2011] In addition to assets weighted by credit risk, the novelty in relation to Basel I is the introduction of capital requirements for market and operational risk, the inclusion of external credit agencies in the process of classification of all companies from the bank's portfolios, as well as providing the banks with the ability to define models for risk measurement in their business, which is the biggest novelty in relation to the previous agreement.

The main characteristic of Basel II is its structure, which includes three pillars:

- requirement for a minimum amount of capital (credit, market and operational risk);
- the process of supervision, control over capital adequacy (frameworks and guidelines for the supervision of financial institutions);
- Market discipline (framework and guidelines for publicly publishing bank reports) - Requests the bank to publicly present the amount of capital costs as well as the procedures and mechanisms for risk oversight.

The first pillar of the Basel II Agreement includes and defines in detail the ways to determine the minimum amount of capital by allowing each bank to adjust that amount to the level of risk from the economic losses to which the bank is exposed. [Barjaktarović, 2009] In addition, the first pillar of Basel II defines the minimum requirements for credit, market and operational risk. The banks have also been given the possibility of more flexible risk calculations, since they also have *Advanced Internal Rating-Based* (ARIB) systems that are adapted to the needs and specifics of each bank, specifically the characteristics of the banks' portfolios.

The Basel Committee has defined the necessary minimum of capital, the rules that define the minimum capital ratio in relation to risk weighted assets. The statutory minimum capital adequacy ratio (*Capital Adequacy Ratio-CAR*) is that the ra-

tio of the Bank's total capital (capital) and risk measures (*risk weighted Asset-RWA*) must not be less than 8%. This capital adequacy for a bank is a type of depreciation in case of occurrence of credit and / or currency risk, insufficient knowledge of the client's bank, and the like.

Capital / Weighted assets (credit, market or operative risk) ≥ *8%*

The second pillar of Basel II introduces a supervisory assessment as one of the elements of regulatory policy. This pillar is based on the following four principles:

- Internal Capital Adequacy Assessment Process (ICAP) requires each bank to assess the capital adequacy, taking into account the overall risk assessment. Setting up a procedure for measuring capital adequacy includes the continuous provision of an adequate level of capital, as well as work on improving risk management methods. The supervisory authorities of the bank should develop internal capital assessment procedures, are responsible for assessing capital adequacy oversight in relation to the risk that banks face. [Barać, et al, 2005]
- Supervisory Review and Evaluation Process (SREP) - Supervisors should evaluate the indicator of capital adequacy, the bank's strategy and to determine whether there is compliance with regulatory indicators of the bank.
- Equity above the minimum level - supervisors expect banks to own capital above the minimum level defined by the first pillar.
- supervisor intervention - supervisors should, at an early stage, intervene preventively in stressful economic situations in order to prevent a fall in capital adequacy above the minimum, legally prescribed level. In addition, supervisors need to warn the bank and demand a quick reaction from them if the capital is not at the required level.

Market discipline is the third pillar of Basel Agreement II. The Bank is obliged to publish data on operations (on the risks and level of capital adequacy). By this standard, the data on banks' operations became more transparent, since the competent institutions prescribed the cycles of mandatory provision of information on the bank's financial indicators. In this way, all market participants have information on exposure and risk management in the banking market.

Basel II allows banks to independently measure their risk exposure using the Internal Rating-Based Approach (IRB) approach. Each bank should develop its own internal risk management models and tests for stress in assessing its own degree of risk exposure. The approach of internal rating measurement is based on the assumption that banks have the choice to decide themselves how they will measure the rating of their clients, whereby the supervisor of the bank must approve this method of control. The Basel II agreement distinguishes three basic models of measuring the risk exposure of financial institutions within the framework of capital adequacy, which differ from one another to the level of sophistication and degree of risk sensitivity:

- Access to the Basic Indicator Approach (BIA), which is the simplest form of calculating the minimum required capital;
- Standardized Approach (TSA);
- Advanced Measurement Approach-AMA measurement approach, which can be basic: internal measurement, Foundation Internal Ratings Based (FIRB), and Advanced Internal Rating-Based (AIRB)

The first pillar, the requirement for a minimum amount of capital, includes the measurement of credit, operational and market risk.

The set of approaches for measuring credit risk exposure includes:

- standardized access to TSA, which is the simplest approach to risk measurement. It is conceptually the same as the existing framework from 1988, but it defines a higher risk sensitivity. This approach allows risk weightings to be applied to the calculated exposure of the bank in accordance with rating agencies rating (Standard & Poor's, Moody's and Fitch). For each category of placements, the prescribed risk weight is applied, while the sum of these products gives the total amount of risk weighted assets. [Barjaktarović, 2009]
- An AMA-based approach is based on the assumption that banks have the choice to decide themselves how they will measure their clients' ratings (basic FIRB approach or advanced version of the internal scheduling system AIRB), whereby the banking supervision sector must approve this control method. FIRB represents the first level of credit risk approach, which includes the application of the Bank's internal methodology for measuring exposure, as well as the assessment of capital adequacy only in relation to one risk component, probability of failure of the client's obligations (Probability of Default-PD). On the other hand, AIRB represents the highest and most sophisticated level of credit risk approach, which fully enables the bank to apply internal methodologies for measuring exposure and capital adequacy assessment (Table 2). The Bank performs a classification of client accounts and for each of the placements it has to define four key risk factors:

1.Probability of Default-PD is a parameter indicating the likelihood that the client will not be able to settle his obligations on time.
2.Loss due to Loss Given Default (LGD) is an indicator that determines a portion of the placements that will constitute a loss in case the client can not settle his obligations.
3.The amount of placements at the moment when the client is unable to execute his obligations (Exposure at Default - EAD) measures the amount of placements (with credit lines) which will most likely be withdrawn when the client can not fulfill his obligations.

4.Maturity - which measures the remaining economic maturity of the placements

Table 2 Credit risk assessment based on an internal rating

Risk components	***FIRB***	***AIRB***
PD	Assessed by the bank	Assessed by the bank
LGD	Defined by supervizor	Assessed by the bank
EAD	Defined by supervizor	Assessed by the bank
Maturity	Defined by supervizor	Assessed by the bank

The approaches for calculating capital requirements for operational risk are:
- *access to the basic BIA indicator* that represents capital issuance for operational risk, which is determined on the basis of a certain risk indicator at the entire bank level. [Barjaktarović, 2009] BIA is calculated on the basis of a formula that includes gross annual income and certain percentages (15%). The application of this approach is specific to small domestic banks that do not have foreign capital.
- *TSA's standardized approach* is a more complex method of calculating operational risk in relation to the BIA, since capital requirements for operational risk are calculated for individual types of business activities (between 12% and 18%).
- *The Advanced Measurement Approach* is the most sophisticated method for calculating capital reserves for operational risks. In order to calculate the minimum amount of capital, banks use an internal operational risk management system, if approved by the supervisor. The procedure for calculating the required capital is as follows [Barjaktarović, 2009]:
- All areas of the bank's operations are categorized into a number of types of activities that are then grouped into a broad list of operational losses that may arise within each type of activity
- The control body specifies the Exposure Indicator (EI) for each combination of type of activity and type of operational loss;
- Based on the bank loss data, we can determine the following two parameters: Probability of Loss Event-PE and Loss Given Event (LGE);
- Based on predetermined parameters, it is possible to calculate the expected loss factor for each type of activity (Expected Loss-EL) that represents the exposure index, the probability of occurrence of the event that causes the loss and the parameter loss caused by the event itself.

When it comes to calculating capital adequacy for market risk, we distinguish two methodologies:

- *standard TSA approach* distinguishing two types of risk: issuance of capital for specific risks (protect issuers of securities from falling prices) and issuance of capital for general market risks (aims to protect against the risk of loss arising from the fall in the market price of securities);
- *internal models of AMA* distinguish two ways to determine the level of capital: using the VaR method (Value at risk) or by calculating the average daily risk exposure value for the previous 60 days and the minimum factor

The main novelty brought by Basel II is the concept of risk management and the application of VaR analysis (Value at Risk), that is, the assessment of the bank's market risk. The basic elements of risk (VaR) are based on [Rose & Hudguns, 2005]:

- Estimates of the maximum amount of losses in the value of a bank's assets that could occur at a specific level of risk (such as 1%);
- estimates of the time period in which the assets would be reduced if conditions on the market would deteriorate;
- The reliability level that the management submits to estimate the likelihood of loss at any given time (95% or 99% as the level of reliability that is most commonly represented).

The Basel II agreement is designed to increase the sensitivity of financial organizations to risk, as well as requiring banks to develop far more robust risk management frameworks. The improvement and more flexible methods of Basel II (in relation to Basel I) measuring credit, market and operational risk, as well as a new approach to supervision and transparency of banks' operations, should contribute to establishing the stability of the financial secrecy, since the calculation of the level of necessary capital for risk coverage should be more realistic to show the degree of risk to which each bank is exposed. The goal of Basel II is to improve risk management at the micro level and thus provide additional elements for maintaining financial stability at the macro level. Stress test, as a compulsory tool applied by banks in accordance with Basel II and the *Capital Requirements Directive* (CRD), is an effective method for managing banking risks.

In May 2009, the Bank for International Settlement published a document entitled Principles of Sound Stress Testing Practices and Supervision. This document states that stress tests are an important tool that banks use in the risk management process within Basel II. In addition to the risk management process, the principles for stress testing from banks require that they anticipate economic shock (scenarios), test the internal model and evaluation procedures, while on the other hand require supervisors to consider how banks assess "unexpected events" in the capital budget . In order for a bank to carry out a risk test, it must design and implement one of the following scenarios: the functioning of an economy in difficult circumstances, market risks or insufficient liquidity, an extremely negative scenario that predicts

a slowdown in the economy and a recession, banks should use their own valuation data ratings, banks should conduct a stress test in the event of a potential deterioration in the credit environment. [Engelmann & Rauchmeier, 2011

The first pillar of Basel II (minimum capital requirements) requires banks that use an internal model for determining the level of capital at risk, establishing a precise program of stress testing. On the other hand, banks that use an advanced or basic model (based on internal ratings for credit risk, the so-called IRB approach) must carry out stress tests to assess the endurance of capital. For this reason, banks are required to provide a level of capital above the statutory minimum. [BIS, 2009]

Although the requirements of Basel II in terms of stress tests are not clearly defined, they can be displayed as follows [Engelmann & Rauchmeier, 2011]:

- The task of each bank that applies the internal risk measurement approach is to determine stable, reliable and meaningful stress in order to successfully assess the level of capital. Stress tests should be an integral part of the process of determining capital adequacy of banks, and in particular part of the bank's strategy and risk management process.
- Banks must provide the required minimum capital.
- Banks should anticipate future shocks in the economy that could adversely affect the credit exposure of the bank.
- Banks should determine the probability of a client's non-fulfillment obligation - PD (pillar 1), loss due to the client's failure to fulfill its obligations - LGD (pillar 2), amount of placements at the moment when the client can not settle his obligations - EAD (pillar 2) .

Stress testing is very present in the context of Basel II, where stress tests are:

- means for adjusting the average probability of non-performance (PD) for stress conditions (pillar 1);
- procedures for assessing the robustness of IRB risk parameters such as PD or

Loss Given Default (LGD) (pillar 2); (iii) a request for the assessment of the effect of an economic downturn on regulatory capital requirements (column 1 "stress test of the conjuncture"; and (iv) a way to assess the global effect on the bank's risk profile and capital adequacy in the event of different events or changes in market conditions, foreign parties to comply with financial contracts (pillar 2)

3.3. BAZEL III

In the conditions of the global economic crisis, the banking sector as part of the financial system, due to its sense of existence and the nature of business, should depreciate the negative factors of the crisis and initiate the economic development of a country. Since the banking sector was the initiator and the cause of the recession,

it is not surprising that this segment of the financial market was the most affected by the negative effects of the crisis. Two years after the collapse of Lehman Brothers, the Basel Committee for Supervision of Banks issued new guidelines in the form of the Basel III regulatory framework. Basel III is not just a direct response to the global financial crisis, but also the continuous efforts of the Basel Committee to strengthen the regulatory framework for banks, bank supervision and the risk management function in banks. [Ekoleks, 2011a]

The G20 member states at the Seoul summit in September 2010 discussed the adoption and implementation of the new Basel Agreement, which was adopted after three months [Delahaye, 2011] The adoption of Basel III by the EU member states is expected by the end of July 2012 through the Fourth *Capital Requirements Directive* (CRD4) and the *Capital Requirements Regulation (CRR).*

The main objectives of introducing the new regulatory framework are [Kilibarda, et al, 2011]:

- Improving the ability of the banking sector to absorb shock resulting from financial and banking pressures (thus reducing the risk of their further transfer to the real sector);
- improvement of risk management and general management in banks;
- Increasing transparency of banks' operations.

One of the main tasks of the new Basel III regulatory framework is to strengthen two complementary approaches that support the basic concept of bank stability: macro and micro prudential regulation (access to security).

Macroprudential policy uses prudential tools to limit systemic or financial risks, thus limiting disturbances in providing key financial services that can have serious implications for the real economy [FSB Macroprudential Policy, 2011] Macroprudential approach introduces completely new elements in the regulatory framework:

- capital buffer (Capital Conservetion Buffer = 2.5%), helps banks fight credit card fraud. Its function is protection in conditions of stress, that is, its purpose is to absorb losses in conditions of financial crisis.
- Introduction of Leverage Ratio (3%) represents the ratio between Tier 1 and

Exposure Measure, which follows the accounting measure of exposure;

- introduction of two standards for liquidity coverage [BIS, 2010]:
- liquidity coverage ratio LCR Ratio (*Liquidoty Coverage Ratio≥100*%) should ensure the Bank's liquidity disturbance over a period of more than 30 days. This ratio should be implemented by 2015 with defined minimum standards.
- Stability Net Financing Ratio NSFR Ratio (*Net Stable Funding Ratio≥100*%) requires a minimum amount of stable sources of funding in the bank in relation to the liquid asset profile. [Ekoleks, 2011b] This account should be implemented by 2018.

Micro-sectoral regulations at the banking sector level increase the level of resilience of banking institutions in the period of stress through the following regulations:

- higher and better quality of the bank's capital (focus on joint equity);
- Cover the risk in relation to capital market activities;
- Supervision, risk management and standards on the disclosure process.

Basel III introduces an additional requirement for capital, which allows banks to absorb potential losses in the period of negative effects or financial and economic pressures. In other words, banking systems will be able to withdraw capital in stressful situations, but the level of the bank's capital is closer to the minimum requirement, the more restrictive the distribution of profits (the less money available for dividend payments, bonuses and other compensations). [Kilibarda, et al, 2011] The global economic crisis has shown that banks can be much more exposed to risks, while not being able to make additional capitalization in changing market conditions. For this reason, unlike its predecessors, Basel III devotes more attention to share capital and instead introduces a new term common equity, which includes retained capital and capital acquired through the sale of ordinary shares instead of Tier 1 capital. Compared with Basel II, the minimum requirement for basic (equity) capital and the minimum Tier 1 capital requirement have been increased from the existing 2% and 4% to 4.5% and 6% risk weighted assets, respectively (Table 3).

Table 3 Implementation of Bazel III

Pokazatelj/ Godina*	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***
Equity capital indicator	3,5	4,0	4,5	4,5	4,5	4,5	4,5
Capital shock absorber	-	-	-	0,625	1,25	1,875	2,5
A sum of share capital and capital amortization	3,5	4,0	4,5	5,125	5,75	6,375	7,0
Minimum basic capital	4,5	5,5	6,0	6,0	6,0	6,0	6,0
Minimum regulatory capital	8,0	8,0	8,0	8,0	8,0	8,0	8,0
Indicator of liquid assets coverage			Min. standard				

Indicator of net stable sources of financing						Min. standard	

*(starting date 1 January, u %)
Source: [BIS 2010a, 2010b]

Tier 2 capital can represent a maximum of 2% of capital, and Tier 3 (or Tier 2 supplementary capital) used to cover market risk will be fully discontinued from 2013. [Bašić, 2012] In addition, banks will are required to hold a protective capital buffer or capital reserves to limit the distribution of profits of 2.5% of the share capital, which raises the total regulatory requirement for share capital to 7% (4.5% + 2.5%) in 2019. The capital buffer should be introduced in phase with the beginning of implementation in 2016 (0.625% of risk weighted assets, with each subsequent year gradually increasing by 0.625 percentage points by 2019, when it should be reduced to 2.5%). . Raising the level of capital of banks is foreseen for 2013, while the new rules should be fully implemented by January 2019.

4. RESULTS OF THE RESILIENCE TO THE STRESS OF THE BANKING SECTOR IN THE PERIOD OF THE GLOBAL ECONOMIC CRISIS

4.1. Practical results of the application of stress tests in the banking sector of the United States

In 2009, Federal Reserve (FED) conducted stress tests, known as the Supervisory Capital Assesment Program (SCAP). This analysis included 19 banking companies (domestic banks and banks owned companies), which accounted for 2/3 of the total capital of the United States banking sector with assets over $ 100 billion. Stress testing should have shown that in the event of a worsening of the global economic situation, the bank will be able to deal with negative effects or will need help in the form of strengthening the level of capital adequacy (recapitalization). Stress tests were conducted in a two-year interval (2009-2010) and were based on two scenarios: the basic (forecast of experts, somewhat more optimistic scenario) and extremely negative. The scenarios included the following changes in macroeconomic indicators: an increase in the unemployment rate (from 8.8% to 10.3%), a fall in property prices (between 4% and 7%), a decrease in gross domestic product, an increase in inflation (the result of state intervention in the banking sector).

The results of the baseline scenario showed that the US banking sector was financially more stable compared to the original projections, as 10 of the 19 banks successfully passed the test, and it was found that they would not need recapitalization.

On the other hand, the results of an extremely negative scenario have shown that the analyzed banks could end up losing $ 600 billion, and even 9 should be further capitalized. FED has given this group of banks an order to increase their own capital to 75 billion USD in the form of shock absorbers against potential losses. [FREN, 2009] Table 4 shows that the largest recapitalization is needed by Bank of America (33.9), Wells Fargo (13.7) and GMAC (11.5).

Table 4 Results of stress tests in the United States in 2009

Bank	***Recapitalization,mlrd. USD (maj 2009)***	***Loss***	***Necessery recapitalization, mlrd. USD***
JP Morgan Case	136,2	97,4	-
Citigroup	118,8	104,7	5,5
Bank of America	173,2	136,3	33,9
Wells Fargo	86,4	86,1	13,7
Goldman Sachs	55,9	17,8	-
Morgan Stanley	47,2	19,7	1,8
GMAC	17,4	9,2	11,5
American Express	10,1	11,2	-
Fifth Third Bancorp	11,9	9,1	1,1
Regions Financial	12,1	9,2	2,5
Ukupno (10 banaka)	*669,2*	*501,0*	*70,0*
Total	*836,7*	*599,2*	*74,6*

Source: [Wiszniowski, 2010]

The Federal Deposit Insurance Corporation (FDIC) at the end of November 2011 issued a decision requiring that:

- banks with assets over $ 50 billion deliver unscheduled contingency plans;
- banks with assets over 250 billion USD (currently seven) should display their plans against negative economic effects by July 2012;
- The deadline for the remaining 30 banks will be moved by 2013.

The US Deposit Insurance Agency has proposed a special regulation requiring banks with assets over $ 10 billion to carry out internal stress tests, which should show financial stability and the ability to survive in a variety of crisis situations. The adoption of this proposal is expected by the end of July 2012.

At the beginning of March 2012, the FED released a second round of stress test results [FED, 2012] in the banking sector of the United States. Out of a total of 19 tested banking companies, four of them (Citigroup, SunTrust, Ally Financial, Met Life) failed to prove that they would survive a new wave of crisis like that of

the beginning of 2008. This scenario implied a 13% unemployment rate, a drop in Dow Jones average stock index (Dow Jones industrial average) by 50% and real estate value shrinkage by 21%. The amount of share capital and reserves (Tier 1 Captal) at Ally Financia amounts to 4.4%, SunTrust 4.8%, Citigroup is at 4.9%, which is below the minimum requirement of capital adequacy of 5%. On the other hand, the banks with the best capital adequacy are Bank of New York Mellon with 13.1%, State Street with 12.5% and American Express with 10.8%.

Table 5 Results of stress test, level of basic capital in 2012

Banks which didn't pass stress test		***Banks with best results***	
Bank	***Tier 1 kapital (u %)***	***Bank***	***Tier 1 kapital (u %)***
Ally Financial	4,4	Bank of New York Mellon	13,1
SunTrust	4,8	State Street	12,5
Citigroup	4,9	American Express	10,8

Source: [FED, 2012]

The stress test has shown that the largest banks will continue to meet capital adequacy targets, despite the large losses and unfavorable economic developments projected in the hypothetical scenario. According to this stress test scenario, a decrease in Tier 1 capital and risk assets was recorded from 10.1% in the third quarter of 2011 to 6.3% in the fourth quarter of 2013.

4.2 . Practical results of the application of stress tests in the banking sector of the Member States of the European Union

In July 2010, the European Banking Authority (EBA) conducted stress tests in 91 European banks (from 20 EU Member States), accounting for 65% of the total assets and 50% of the banking sector of the European Union. The stress test was based on the analysis of credit and market risk, while the liquidity risk was not directly analyzed. In cooperation with the European Central Bank (ECB), EBA has developed two stress test scenarios. The first, basic scenario was forecast by a slight recovery of the economy, GDP growth in the EU-27 member states of 1% and 1.7% (in 2010 and 2011, respectively), while the second, pessimistic scenario projected a decline in economic activity and a decline in GDP 0.4% in 2011. According to the pessimistic scenario, the results of the stress tests carried out showed that 7 banks did not meet the test criteria and that they need additional capital of 3.5 billion euros (4.5 billion USD). In the event of a "state shock" or the inability of the state to pay off government bonds in which these banks invested, their capital would fall below the level considered adequate and these seven banks could not withstand another wave of the global economic crisis.

After the first round of stress tests in economic circles, the objectivity of published results was discussed. It was justifiable to ask whether it is possible to believe in stress tests, given that only a few weeks after the publication of positive test results, the banking sector of Ireland could have led the country to bankruptcy. Due to the negative effects of the global economic crisis and turbulence in the financial markets, economists have forecast far less amounts of recapitalization of the European banking system. Namely, the analysts' projection stopped at an amount of 37.6 billion euros, which is compared to the published official data ten times less. [FREN, 2010] Learned from the first round, EBA has decided to tighten the test criteria and gain investor confidence in the economically shaky European financial system.

In July 2011, EBA released the results of the stress tests conducted in 21 countries in 90 banks, accounting for around 65% of the European banking market and 50% of the domestic financial market. During the testing, two macroeconomic scenarios were used: basic (real) and extremely negative scenario (with more stringent assumptions compared to 2010):

- According to the baseline scenario, banks have projected their business on the basis of optimistic forecasts of the European Commission (main macroeconomic assumptions)
- Extremely negative scenario (assuming a worsening picture of the economy and financial markets, but also the collapse of the real estate market, interest rates or excessive government debt) was forecast by a new wave of the global economic crisis and a continuing recession, a 4% decline in GDP, a decline in stock values on average by 15 %, growth of unemployment rate by 10%, as well as reduced demand for real estate of 10%.

The results of the EU stress test for 2011 [EBA, 2011], according to the extreme negative scenario, show that at the end of 2010, 20 banks have a capital adequacy ratio below 5%. The total lack of capital of the banking sector amounts to 26.8 billion. while the total Tier 1 capital was reduced from 8.9% in 2010 to 7.4% in 2012.

Table 6 Capital ratio without additional capitalization

	<2%	*<3%*	*<4%*	*<5%*
Austria	0	0	0	1
Cuprys	0	0	1	0
Germany	0	0	1	0
Spain	4	0	3	2
Greece	1	0	0	1
Ireland	2	0	1	0

Italy	0	0	0	1
Portugal	0	0	1	0
Slovenia	0	0	1	0
Total banks	7	0	8	5

Source: [EBA, 2011]

In order for banks to cope with economic shock, they had to have a minimum margin of solvency ratio, ie a Tier 1 capital adequacy ratio of 5% of risk assets. [BIS, 2011] In the period between January and April 2011, an additional 50 billion was collected. euro (net). Taking into account the capital raising measures implemented until April 2011, the capital adequacy of 8 banks fell below 5% over a two-year observation period, with a total deficit of 2.5 billion. Euro [EBA, 2011], while 16 banks ranged between 5% and 6%. According to the criteria of capital adequacy, the table shows that the most vulnerable banking sector in Spain, as many as five banks do not meet the prescribed minimum requirements. In addition to Spain, one bank is threatened in Austria and Greece.

Table 7 Capital ratio with recapitalization (as of April 30, 2011)

	<2%	***<3%***	***<4%***	***<5%***
Austria	0	0	0	1
Spain	0	0	3	2
Greece	1	0	0	1
Total banks	1	0	3	4

Source: [EBA, 2011]

World analysts agreed that the obtained stress test results were optimistic and insufficiently realistic since the test stress methodology did not take into account the possible insolvency of Greece and Italy. In 2011, EBA issued a recommendation according to which national supervisors should require banks that recorded a capital adequacy ratio of less than 5%, to compensate for the shortage of capital as soon as possible, or to recapitalize. Banks are instructed to use private sources of additional capital financing: reinvesting profits, reducing bonuses, new ordinary shares and other liability management measures. [Zivkovic, 2011] According to EBA, total shortfall capital (both by country and by bank) is defined at the level of 114.7 billion euros (Table 8). The largest problems with capital were recorded in the banking sector of Greece, Estonia, Italy and Germany, which together account for ¾ of the total missing capital.

Table 8 Lack of bank capital, by country (in millions of euros)

Country	*The amount of necessary recapitalization*
Austria	3.923
Belgium	6.313
Cuprys	3.531
Germany	13.103
Estonia	26.170
France	7.324
Greece	30.000
Italy	15.366
Holland	159
Norway	1.520
Portugal	6.950
Slovenia	320
Total	114.685

Source: [Živković, 2011]

5. CONCLUSION

The rapid development of financial markets, the emergence of new products and services, financial structures and new risk management techniques have necessitated the adoption of the provisions of the Basel Agreements. Each financial institution, even the bank, has the obligation to maintain the minimum level of capital that is used by financial institutions in the event of unexpected losses (due to the negative effects of the global economic crisis) or as a basis for further growth and development. In order to maintain financial stability, it is widespread to test stress resistance, which analyzes the capabilities of individual financial institutions or the entire financial system in order to absorb various types of shocks. Stress test analysis is an instrument for assessing the risk of banking sector operations in the conditions of the global economic crisis. Stress tests are a tool that early diagnoses and warns of possible bankruptcy of the banking sector in times of crisis. Additionally, stress tests represent a mechanism for simulating different scenarios of negative events on the market and assessing the ability of banks to sustain them without the necessary recapitalization.

Prior to the onset of the global economic crisis and recession, most of the stress tests carried out by banks around the world were not designed to include extreme market events. Moreover, scenarios of stress tests carried out mitigated economic shocks: losses that did not exceed ¼ realized revenue, as well as shorter duration of negative effects of the crisis. With the outbreak of the global economic crisis, stress tests are gaining importance in the circles of international financial institutions and regulatory bodies. The results of stress tests conducted by FED in 2009 showed that 10 of the 19 analyzed banks successfully passed the test. On the other hand, the results of an extremely negative scenario projected the loss of the banking sector of 600 billion US dollars. At the beginning of March 2012, the FED released a second round of stress test results. Of the total of 19 tested banks, 4 of them had a capital adequacy level below 5%.

The results of stress tests conducted in the European Union's banking sectors conducted in 2010 showed that seven banks did not meet the test criteria and that they need additional capital of 3.5 billion euros. The results of the second round of stress tests show that 20 banks recorded a capital adequacy ratio below 5%.

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