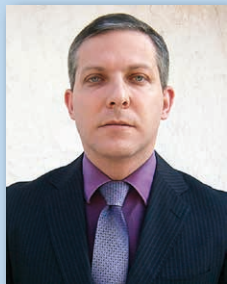


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STRES TESTOVI U FINANSIJSKIM INSTITUCIJAMA

Rezime

Bazelski Komitet za globalni finansijski sistem je 2000. godine definisao stres testiranje „kao opšti pojam koji opisuje različite tehnike koje koriste finansijske institucije, da bi ocenile stepen sopstvene stabilnosti na neočekivane i ekstremne događaje“. Neočekivani događaj se odnosi na onaj događaj koji se odigrava jedanput ili više puta, ali sa dalekosežnim posledicama po samu finansijsku instituciju i stabilnost finansijskog sektora u celini. Takvi neočekivani (ekstremni) događaji su, na primer: bankrot u Argentini 2001. godine, krah berzanskih tržišta („Black Monday“) 19. oktobra 1987. godine ili propast energetskog giganta Enron-a 2001. godine. Donošenjem novog Bazelskog sporazuma (poznatijeg kao Bazel II) 2001. godine, je predviđena primena stres testova za identifikovanje događaja i budućih promena u ekonomskim uslovima koji mogu imati nepovoljne efekte po kreditnu izloženost banke, kao i da se izvrši procena bančine sposobnosti da opstane u novonastalim okolnostima. Negativna iskustva iz prošlosti, koja su do temelja uzdrmala stabilnost finansijskih sistema širom sveta, odlučujuće su uticala da regulatori na svim nivoima dodatno razmotre pitanje povećanja otpornosti finansijskog sistema na nastanak neočekivanih - ekstremnih događaja. U tom cilju uvođenje stres testova je predstavljalo prekretnicu u procesu porasta rezistentnosti bankarskih sistema na šokove. Ovaj rad se prvenstveno bavi stres test metodologijom, kao tehnikom merenja bankarskih rizika, kao i osnovnim rezultatima sprovedenih testiranja, koje imaju direktne posledice po ukupni finansijski sistem.

Ključne reči: stres testiranje, finansijske institucije, bankarski sektor Srbije, Bazel, neočekivani događaji, scenario analiza, menadžment banke

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STRESS TESTING IN FINANCIAL INSTITUTIONS

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Summary

In 2000 the Basle Committee on the Global Financial System defined stress testing as “a generic term describing various techniques used by financial firms to gauge their potential vulnerability to exceptional but plausible events”. Exceptional events refer to one-off or recurring events with far-reaching consequences for the concerned financial institution and the financial sector’s stability overall. Such unexpected (exceptional) events include, for instance: bankruptcy in Argentina in 2001, stock markets collapse (“Black Monday”) on 19 October 1987, or the fall of the energy giant Enron in 2001. The adoption of the new Basle Accord (better known as Basle II) in 2001 envisaged the implementation of stress tests for the identification of events and future changes in economic circumstances that could cause some unfavorable effects on banks’ credit exposure, along with the assessment of banks’ ability to survive in the new circumstances. Negative experiences from the past, having undermined the stability of financial systems worldwide, made a decisive impact on regulators at all levels to additionally consider the issue of increasing the financial system’s resistance to the occurrence of unexpected - exceptional events. To this end, the introduction of stress tests was the turning point in the process of increased banking systems’ resistance to shocks. This paper primarily deals with stress testing methodology and bank risk measurement techniques, along with the main results of conducted tests, directly impacting the entire financial system.

Keywords: stress testing, financial institutions, banking sector of Serbia, Basle, unexpected events, scenario analysis, bank’s management

JEL: C53, G21, G28

Uvod

U okviru upravljanja rizicima, banka je dužna da kada god je to izvodljivo i moguće sprovodi regularne scenario analize i stres testove. Finansijska institucija je slobodna u izboru scenarija, koji se može zasnivati ili na istorijskim podacima ili na empirijskim modelima promena u faktorima rizika. Pri tome, važno je napomenuti da scenario analiza i stres testiranje moraju biti i kvantitativnog i kvalitativnog karaktera i moraju uzeti u obzir i efekte neočekivanih promena na tržištu kao i faktore rizika. Kvantitativni karakter podrazumeva utvrđivanje mogućih stres scenarija kojima će banka biti izložena, dok se kvalitativni kriterijum vezuje za procenu mogućnosti banke da sopstvenim kapitalom apsorbira potencijalne gubitke i utvrđivanje koraka koje banka mora preduzeti da bi se umanjio rizik i sačuvao kapital.

Adekvatno pripremljena scenario analiza i stres testiranje treba da pruže značajnu pomoć menadžmentu banke kako bi što bolje bili procenjeni uticaji različitih tržišnih promena na dobit i kapital banke. Menadžment banke redovno sprovodi kontrolu rezultata do kojih se došlo na bazi primenjenih scenarija i stres testova, kao i reviziju pretpostavki koje su korišćene pri samoj analizi. Ukoliko se na bazi ostvarenih rezultata utvrdi da postoji visok stepen verovatnoće nastanka potencijalnih gubitaka, menadžment banke donosi dopunske mere za upravljanje rizicima ili se odlučuje za uvođenje planova za slučaj nastupanja nepredviđenih događaja.

Većina stres test metoda nisu statističke mere rizika, drugim rečima, ne postoji verovatnoća niti interval poverenja koji se procenjuje za negativne ishode, kao u slučaju Value-at-Risk pristupa. Stres testiranje se mora posmatrati u širem kontekstu, odnosno, načinu na koji obezbeđuje određene inkrementalne vrednosti ili kako doprinosi ostvarenju određenih ciljeva (npr. optimalnoj alokaciji aktive u portfoliju). Stres testiranje predstavlja bitnu stavku u procesu donošenja odluka, a ujedno i parametar i povratni mehanizam prilikom izmene ili unapređenja određenih odluka. Uobičajeno je mišljenje da se stres testiranje mora sprovoditi zajedno sa primenom Value-at-Risk tehnike kako

bi se dobila celovita slika rizičnosti portfolija.

Osnovne karakteristike stres testova

Bazelski Komitet za globalni finansijski sistem je 2000. godine definisao „stres testiranje kao opšti pojam koji opisuje različite tehnike koje koriste finansijske institucije, da bi ocenile stepen sopstvene stabilnosti na neočekivane i ekstremne događaje“. Stres testiranje predstavlja:

1. metod merenja potencijalnih budućih iznenadnih, negativnih ishoda u portfoliju finansijskih instrumenata
2. sredstvo za umirenje menadžera u slučaju značajne izloženosti riziku. (Schachter, 2004)

Zahvaljujući stres testovima, menadžment banke prati izloženost banke cenovnim promenama tokom događaja koji se smatraju verovatnim i definiše rizični profil banke. Generalno gledano, stres testiranje ima komplementarnu ulogu u praksi upravljanja rizicima finansijskim institucijama, iako se na prvi pogled, čini da Value-at-Risk metodologija ima dominantnu ulogu. Koncept stres testiranja je veoma jednostavan, ali specifikacija, implementacija i tumačenje dobijenih rezultata su znatno kompleksniji. Stres testovi zahtevaju rešavanje brojnih praktičnih problema, počev od faktora koji će biti testirani, načina na koji će se kombinovati faktori, raspona vrednosti koji će biti uzet u razmatranje kao i vremenskog okvira koji će biti analiziran.

Stres testovi obezbeđuju podatke o izvorima rizika u portfoliju što je relevantno za donosioca odluka na svim nivoima upravljanja u finansijskim institucijama. Tako će na nivou trgovanja, stres testiranje ukazati na potencijalnu kolebljivost određenih pozicija ili proizvoda, dok će na menadžerskom nivou, omogućiti poređenje rizika između različitih klasa aktive i izloženosti i istaći potrebu za ograničenjem i kontrolom rizika. Za sve nivoe upravljanja, stres testiranje direktno pomaže u utvrđivanju postojanja srazmernog odnosa između prinosa i odgovarajućeg stepena rizika. Sami stres testovi imaju nekoliko nedostataka koji mogu ograničiti njihovu primenu. Ukoliko je osnovni model netačno postavljen ili procenjen, onda ni zaključci doneti na osnovu sprovedenih stres testova ne mogu biti ispravni. Stres testovi koji

Introduction

As part of risk management, a bank is obliged to, whenever feasible and possible, conduct regular scenario analyses and stress tests. A financial institution is free to choose a scenario, which may be based either on historical data or empirical models of risk factor changes. The important thing to underline here is that scenario analysis and stress testing must be both quantitative and qualitative in nature, taking into account the effects of unexpected market changes as well as risk factors. The quantitative character implies determination of potential stress scenarios that a bank will be exposed to, whereas the qualitative criterion is related to the assessment of a bank's ability to absorb potential losses by means of its own capital, along with the definition of steps to be taken by the bank in order to reduce risk and preserve capital.

Adequately prepared scenario analysis and stress testing should provide considerable assistance to the bank's management so that the impacts of various market changes on the bank's profit and capital could be assessed in the best possible way. The bank's management regularly controls the results achieved on the basis of applied scenarios and stress tests, and revised the assumptions used in the analysis itself. If, on the basis of achieved results, it gets determined that there is a high probability of potential losses, the bank's management adopts additional risk management measures or decides to implement emergency plans.

Most stress testing methods are not statistical risk measures, meaning, in other words, that there is neither a probability nor a confidence interval to be assessed for negative outcomes, as is the case in Value-at-Risk approach. Stress testing has to be considered in a wider context, i.e. in the way in which it provides certain incremental values or contributes to the achievement of certain goals (for instance, optimal allocation of assets in a portfolio). Stress testing represents an important item in the decision-making process, at the same time serving as a parameter and feedback mechanism when amending or enhancing certain decisions. The common opinion is that stress testing has to be conducted in parallel

with the implementation of Value-at-Risk technique in order to obtain a comprehensive insight into the portfolio's riskiness.

Main Characteristics of Stress Tests

In 2000 the Basle Committee on the Global Financial System defined stress testing as "a generic term describing various techniques used by financial firms to gauge their potential vulnerability to exceptional but plausible events". Stress testing is:

1. A method of measuring potential future sudden, negative outcomes in the financial instruments portfolio; and
2. A means of soothing managers in case of a sudden risk exposure (Schachter, 2004).

Thanks to stress testing, the bank's management monitors the bank's exposure to price changes during events deemed plausible, and defines the bank's risk profile. Generally speaking, stress testing has a complementary role in the risk management practice in financial institutions, although at first glance the Value-at-Risk methodology seems to be dominant. The stress testing concept in itself is rather simple, the specification, implementation and interpretation of obtained results being much more complex. Stress tests require the solution of numerous practical problems, starting from the factors to be tested, the manner in which these factors will be combined, the value spread to be considered, and the time frame to be analyzed.

Stress tests provide the data about the sources of risk within a portfolio, which are relevant for decision-makers on all levels of hierarchy in financial institutions. Thus, at the level of trading, stress testing will indicate potential volatility of certain positions or products, whereas at the management level, it will enable the comparison of risk among various types of assets and exposures, highlighting the need for limitation and control of risk. At all management levels, stress testing directly helps determine the proportionate relation between profit and appropriate risk level. Stress tests themselves have several drawbacks, which may limit their implementation. If the basic model is incorrectly set up or assessed, then the conclusions reached on the basis of the conducted stress tests cannot be correct

ne odgovaraju trenutnom portfoliju banke i koji ne uvažavaju u dovoljnoj meri odnose na relaciji prinos - rizik, mogu dovesti do grešaka menadžera, koji će na taj način potceniti stepen izloženosti banke i pretpostaviti daleko veći rizik. Stres testiranje nam ne ukazuje na verovatnoću dešavanja određenog scenarija, ali može dati odgovor na pitanje „Koliko možemo da izgubimo?“ umesto odgovora na pitanje „Koliko je verovatno da ćemo pretrpeti gubitak?“ (što je u osnovi Value-at-Risk koncepta).

Stres testovi su subjektivnog karaktera i nemaju određenu verovatnoću događanja, te je vrlo teško dati adekvatan odgovor na rezultat sprovedenog stres testiranja. Pitanje stres testiranja najčešće se pojavljuje vezano za Value-at-Risk model, koji pokazuje svoje slabosti u uslovima neočekivanih promena na tržištu. Shodno tome, prema zahtevima Bazelskog Komiteta, institucije koje primenjuju Value-at-Risk model (kao deo internog pristupa) su u obavezi da sprovedu stres testove kao dodatnu aktivnost. Ono što daje argumentaciju za primenu stres testova jesu upravo ograničenja sa kojima je suočen Value-at-Risk model u vidu:

- isključive oslonjenosti na istorijske podatke, što vodi ka precenjenosti ili potcenjenosti rizika. U praksi, tržište nije konstantno tokom vremena, a Value-at-Risk model ne obezbeđuje podatke o potencijalnim gubicima usled negativnih cenovnih promena;
- standardne pretpostavke Value-at-Risk modela da su faktori rizika normalno raspoređeni. U stresnim situacijama, ekstremne vrednosti se dostižu uz znatno veći stepen verovatnoće nego pod pretpostavkom normalne distribucije.

Opšteprihvaćeni stav da se stres testovi mogu koristiti kao dodatak procenama Value-at-Risk modela stoji samo u određenoj meri, jer su i stres testovi opterećeni sopstvenim nedostacima. Pojedini nedostaci se mogu otkloniti stvaranjem dobrih i pouzdanih stres testova sa dovoljnim resursima. Stres testovi prevazilaze nedostatke Value-at-Risk pristupa kroz simulaciju tržišnog

ambijenta, koji ne odražava veze između cena i stopa u normalnim tržišnim okolnostima. Kada kažemo neočekivane situacije na tržištu mislimo pre svega na ambijent koji nije reflektovan u istorijskim promenama cena korišćenih kod Value-at-Risk tehnike. U cilju tačnog obuhvatanja izloženosti portfolija krupnim promenama tržišnih cena, neophodno je odrediti ekonomski scenario koji odražava skup relativnih cenovnih promena svojstvenih određenoj krizi. Nije moguće pridodati objektivne verovatnoće ovim scenarijima da bi se objasnila izloženost velikim promenama cena, pa je tako centralna pažnja usmerena na izbor relevantnog ekonomskog scenarija kao vitalnog za uspeh stres testiranja.

Definisanje scenarija za sprovođenje stres testova

Da bi se potencijalni stresni događaji identifikovali, potrebno je najpre analizirati celokupni ambijent koji uključuje ekonomske, zakonske i dr. faktore. Kod prikupljanja podataka je najbitnije utvrditi da su korišćeni podaci tačni i dostupni u pravom momentu. Podaci obuhvataju sve aspekte kreditnog portfolija banke za potrebe stres testiranja i instrumente trgovačke knjige za potrebe tržišnog stres testiranja. Neophodno je utvrditi koji faktori rizika utiču na svaki finansijski instrument. Analize obavljenih stres testiranja su pokazale značajne varijacije između scenarija koje su banke primenjivale, čak i u uslovima kada su bile pogođene identičnim neočekivanim događajima. Logično objašnjenje se krije u subjektivnom karakteru procene zasnovanog na izboru faktora rizika, njihovim kombinacijama, različitom opsegu kretanja vrednosti kao i vremenskom okviru. Različiti vremenski horizonti posmatranja ili posmatranje razlika u bančinom portfoliju će dati različite rezultate u pogledu obima šokova u većini istorijskih „epizoda“. Proces stres testiranja se odvija u nekoliko faza koje su predstavljene slikom 1:

either. Stress tests which do not correspond to the bank's current portfolio and which do not sufficiently take into account the profit-risk relation, may lead to errors on the part of managers, who will thereby underestimate the bank's exposure and assume much higher risk. Stress testing does not highlight the probability of a certain scenario's occurrence, but can provide an answer to the question "How much can we lose?" instead of providing an answer to the question "How probable it is that we will suffer a loss?" (which lies in the basis of the Value-at-Risk concept).

Stress tests are subjective in nature and do not have a specified probability of occurrence, which is why it is extremely difficult to adequately respond to the result of the conducted stress testing. The issue of stress testing is most often brought up in relation to the Value-at-Risk model, whose weaknesses are demonstrated in the conditions of unexpected market changes. In line with this, according to the requirements of the Basle Committee, institutions implementing the Value-at-Risk model (as part of the internal-ratings based approach) are obliged to conduct stress testing as additional activity. The argumentation for stress testing implementation can be found exactly in the limitations that the Value-at-Risk model is facing in terms of:

- Its exclusive relying on historical data, which leads to overestimation or underestimation of risks. In practice, the market is not constant over time, and the Value-at-Risk model does not provide any data on potential losses due to negative price changes;
- The standard assumption of the Value-at-Risk model that risk factors are normally distributed. In stressful situations, extreme values are reached under considerably higher level of probability than is the case under the assumption of normal distribution.

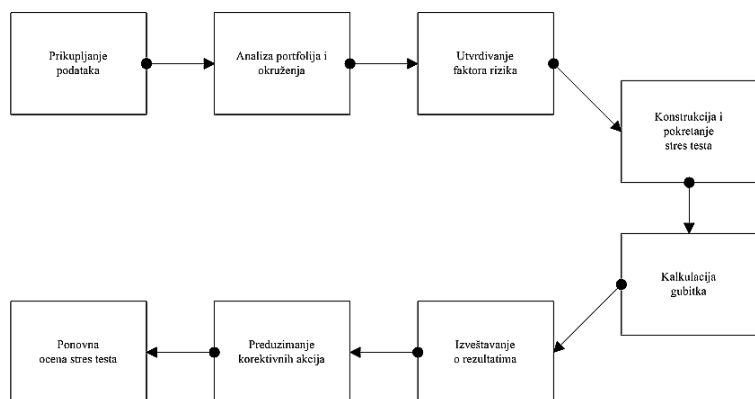
The generally accepted position that stress tests can be used as additional measures to the Value-at-Risk assessments is true only to a certain degree, because stress tests themselves carry the burden of their own drawbacks. Certain drawbacks can be eliminated by designing sound and reliable stress tests based

on sufficient resources. Stress tests overcome the drawbacks of the Value-at-Risk approach by simulating market environment, which does not reflect the relations between prices and rates under normal market circumstances. When we talk of unexpected situations on the market, we mostly refer to the environment which is not reflected in the historical price changes used in the Value-at-Risk technique. In order to accurately encompass the portfolio's exposure to substantial market price changes, it is necessary to determine the economic scenario reflecting a series of relative price changes typical for a certain crisis. It is impossible to ascribe objective probabilities to these scenarios in order to explain the exposure to substantial price changes, which is why the focus of attention is directed at the selection of a relevant economic scenario as vital for the successful stress testing.

Defining Stress Testing Scenarios

In order for potential stressful events to be identified, first it is necessary to analyze the entire environment, including economic, legal and other factors. What is most important in the process of data collection is to make sure that the used data are accurate and available at the right moment. The data include all aspects of the bank's credit portfolio for the purpose of stress testing, and the trading book instruments for the purpose of market stress testing. It is necessary to determine which risk factors impact each of the financial instruments. The analyses of conducted stress tests detected considerable variations among scenarios implemented by banks, even when they were hit by identical unexpected events. The logical explanation lies in the subjective nature of assessment, based on the selection of risk factors, their combinations, different value spreads, and different time frames. Different time horizons or observation of differences in the bank's portfolio lead to different results in terms of shock volumes in most historical "episodes". The stress testing process develops in several stages as shown in Figure 1 below:

Slika 1. Faze procesa stres testiranja



Ideja stres testiranja je da vrednost portfolija zavisi od ponašanja faktora rizika. Ključno za modeliranje rizika i testiranje je da rizik ne procenjuje dovoljno precizno verovatnoću budućih gubitaka. Razlog je to što su uključene razlike između pretpostavljenih i stvarnih distribucija, uz postojanje grešaka u logičnom okviru modela. Brojne su tehnike stres testiranja koje se koriste za merenje veličine promene faktora rizika i uglavnom su vezane za testiranje kreditnog ili tržišnog rizika. Jedna od mogućih varijanti jeste klasifikacija stres testova prema broju uključenih faktora rizika, pa u tom smislu razlikujemo: jednofaktorski test senzitivnosti i multifaktorski stres test.

Testovi senzitivnosti predstavljaju jednofaktorsku tehniku koja izoluje kratkoročne uticaje promena faktora tržišnog rizika na vrednost portfolija. Ovakvi testovi su odgovarajući kada se želi sagledati efekat velikih promena u faktorima rizika na poziciju u trgovačkom portfoliju. Kada se ocenjuje izloženost portfolija stresnim događajima, onda jednofaktorski model nije adekvatno rešenje. **Multifaktorski stres testovi** podrazumevaju istovremeno testiranje na stresne događaje većeg broja faktora rizika. Zadatak je veoma kompleksan i sastoji se u izboru između brojnih faktora rizika, s obzirom da je sve faktore nemoguće obuhvatiti. Kriterijum kojim se rukovode analitičari jeste relevantnost datih faktora za postojeći portfolio banke. Osnovna klasifikacija multifaktorskih stres testova jeste na one koji su zasnovani na istorijskim scenarijima i stres testove bazirane na hipotetičkim scenarijima.

1. Istorijski stres testovi simuliraju ekstremne

stresne situacije iz prošlosti (npr. kriza u Rusiji, Azijska kriza i sl.) - menadžeri rizika će na bazi analiza stresnih situacija iz prošlosti verovatno pronaći najmanje nekoliko poučnih „epizoda“ koje su značajne sa aspekta njihovih portfolija.

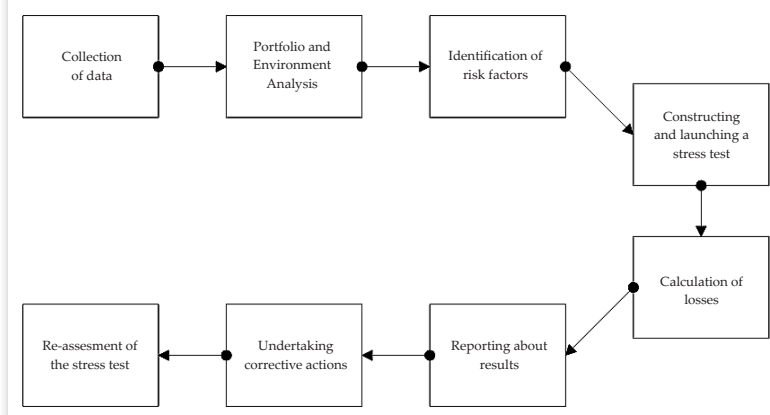
2. Konstrukcija hipotetičkih događaja ili izgradnja scenarija - se primenjuje kada istorijski događaji ne mogu da se povežu sa trenutnim karakteristikama portfolija. Menadžeri rizika

mogu konstruisati scenario na osnovu hipotetičkih promena faktora rizika. Uticaj faktora rizika na portfolio može biti: sistematski i nesistematski. Stres testovi mogu biti konstruisani tako da se krećemo od definicije stresnog događaja ka utvrđivanju promena u faktorima rizika ili su konstruisani na osnovu odluka o promenama faktora rizika bez specificiranja konkretnog događaja.

a) Nesistematsko istraživanje za hipotetičkim scenarijom

- **pesimistički scenario ili scenario maksimalnog gubitka (eng. worst-case scenario)** jeste metod pronalaženja kombinacija kretanja različitih faktora rizika u određenom periodu kada imaju maksimalan negativan uticaj na portfolio, ne uzimajući u obzir stepen korelacije između samih faktora. Zbog ignorisanja korelativnog faktora rizika ovaj tip stres testiranja ima manjak ekonomskog smisla.
- **scenario zasnovan na istorijskim podacima** kombinuje maksimalne promene faktora rizika koje su se odigrale u okviru izabranog istorijskog perioda. Razlikuje se od istorijskih scenarija po tome što nije zasnovan na jednom konkretnom istorijskom stresnom događaju. Ekonomski smisao ovog metoda je takođe vrlo nejasan, ali razlika u odnosu na scenario maksimalnog gubitka je u tome što kombinacija maksimalnih

Figure 1. Stages in the Stress Testing Process



The idea of stress testing is that the portfolio's value depends on the risk factors' behavior. What is crucial for risk modeling and testing is that the risk does not assess the probability of future losses in a sufficiently precise manner. This is due to the involved differences between the assumed and actual distributions, in combination with the existence of errors in the model's logical framework. There are numerous stress testing techniques used to measure the scope of risk factors' changes, mostly related to the testing of either credit or market risk. One of the possible alternatives is the classification of stress tests according to the number of involved risk factors, and in these terms we differentiate between: single-factor sensitivity tests and multi-factor stress tests.

Sensitivity tests are a single-factor technique isolating short-term impacts of the changes in market risk factors on the portfolio's value. These tests are suitable when one wants to view the effect of substantial risk factor changes on the trading portfolio position. When the goal is to assess the portfolio's exposure to stressful events, then the single-factor model is not an adequate solution. **Multi-factor stress tests** imply simultaneous testing of the impact of stressful events on a larger number of risk factors. The task is rather complex and consists of choosing among numerous risk factors, given that it is impossible to include all factors. The criterion guiding the analysts is the relevance of the given factors for the concerned bank's portfolio. According to the main classification of multi-factor stress tests, we differentiate between stress tests based on historical scenarios and stress tests based on hypothetical scenarios.

1. Historical stress tests simulate extreme, stressful situations from the past (for instance, the crisis in Russia, the Asian crisis, etc.) - having analyzed stressful situations from the past, risk managers will probably find at least several instructive "episodes" which are significant from the perspective of their portfolios.

2. Construction of hypothetical events or scenario building - is used when historical events cannot

be related to the current characteristics of the portfolio. Risk managers can construct a scenario based on the hypothetical changes in risk factors. The impact of risk factors on the portfolio can be either systemic or non-systemic. Stress tests can be constructed as to move from the stressful event definition towards the determination of risk factor changes, or can be constructed based on the decisions about risk factor changes without specifying any concrete events.

a) Non-systemic analysis based on a hypothetical scenario

- **Pessimistic or worst-case scenario** is a method of detecting the combinations of different risk factors' trends in the period when they exert maximal adverse impact on the portfolio, disregarding the level of correlation among the factors themselves. Due to ignoring risk factors' correlations, this type of stress testing exhibits a lack of economic sense.
- **Scenario based on historical data** combines maximal risk factor changes which took place within the selected historical period. It differs from historical scenarios because it is not based on a single concrete historical stress event. The economic sense of this method is also rather ambiguous, the difference compared to the worst-case scenario being that the combination of maximal changes does not necessarily have to result in negative portfolio trends.

promena ne mora nužno dovesti do negativnih kretanja portfolija.

- **subjektivne scenarije** uglavnom kreiraju eksterni stručnjaci izvan banaka (konsultanti) na bazi inputa. I pored njihovog ekspertskog znanja postoji mogućnost da se pojedini bitni faktori izostave ili da se njihova korelacija pogrešno utvrdi.

b) Sistematsko istraživanje za scenarijom

- nastoji da obuhvati sve bitne faktore rizika i osigura da će simulacija njihovih promena imati ekonomskog smisla. U ovoj grupi ima nekoliko pristupa:

- **Teorija ekstremnih vrednosti** - statistička teorija distribucije verovatnoća koja služi potpunijem obuhvatu rizika gubitka u ekstremnim situacijama. Ova teorija dodaje verovatnoću rezultatima primenjenog stres testiranja. Prednost teorije se ogleda u izostavljanju pretpostavke normalnog rasporeda. Međutim, zadržana je pretpostavka o nekorelativnosti ekstremnih događaja, što se može u praksi pokazati kao netačno i imati posledice na distorziju portfolija.
- **Korelaciona matrica** treba da bude modelirana i predviđena tačno u mnogim praktičnim aplikacijama, kao npr. modeliranje kolebljivosti tržišta akcija.
- **Monte-Carlo simulacija** se sastoji u simuliranju slučajnog procesa koji se rukovodi tržišnim cenama i stopama. Svaka simulacija (scenario) generiše moguće vrednosti portfolija u ciljnom trenutku. Ukoliko je generisan dovoljan broj scenarija, simulirana distribucija vrednosti portfolija konvergira sa pravom distribucijom.

U pojedinim situacijama istraživanje uticaja jednog faktora je sasvim dovoljno (npr. kada banka očekuje da će centralna banka smanjiti dugoročne kamatne stope). Simulacijom određenog istorijskog događaja, veći broj faktora rizika treba da bude inkorporiran, kada već nije moguće obuhvatiti sve faktore. Odluka o broju faktora rizika je uvek kompromis između tačnosti rezultata i potreba

za procesuiranjem i obračunom pokazatelja. Uobičajeno je da se koristi više scenarija i više vrsta stres testiranja za procenu rizika različitih instrumenata u portfoliju. Vrlo je bitno odrediti statistička svojstva faktora rizika i distribuciju verovatnoće. Tako je u slučaju tržišnih rizika pravilo da se pođe od pretpostavke normalnog rasporeda, dok to nije slučaj kod kreditnog rizika. Pojednostavljeni modeli se primenjuju po cenu preciznosti dobijenih rezultata. Kod stres testiranja često se preporučuje primena Monte Carlo simulacije, ali mnoge banke nisu spremne da prihvate takve preporuke, pošto sam obračun zahteva duži vremenski period.

Nakon što se odredi scenario i identifikuju faktori rizika, može se pokrenuti stres testiranje i izvršiti revalorizacija portfolija. Menadžment, koji uspostavlja politike i limite je dužan da ih uključi u procedure stres testiranja. Periodično, menadžment treba da bude upoznat sa rezultatima sprovedenih stres testiranja i da donošenje odluka bazira upravo na tim saznanjima. Primarna svrha kojoj služi stres testiranje jeste ocena kapitala banke i utvrđivanje mera za minimiziranje rizika. Prilikom interpretacije rezultata, menadžment treba da odluči da li je banka sposobna da apsorbuje potencijalne gubitke uključene u stres scenario, ili da pokrije druge gubitke, manifestovane izvan stres scenarija, ukoliko su se odigravali istovremeno.

Kada je izloženost banke visoka na određenim tržištima, tada banke najčešće konstruišu scenario maksimalnog gubitka. Gubitak koji se dobija iz takvog scenarija predstavlja dobru meru izloženosti na posmatranim tržištima. Nakon toga se mogu jednostavno identifikovati faktori rizika koji najviše doprinose gubicima u scenariju i menadžment može da preduzme odgovarajuće mere. Hitne mere podrazumevaju restrukturiranje pozicija ili portfolija, hedžing strategije i sl. Prilikom prezentiranja rezultata stres testova, banke uzimaju u obzir svoju poziciju na tržištu i strateške aspekte upravljanja rizicima.

Uključivanje stres testova u postupak modeliranja tržišnih rizika

Prema mišljenju *Alan Greenspan*-a (2000), dugogodišnjeg predsednika američke centralne banke - FED, počeci korišćenja stres

- **Subjective scenarios** are typically created based on inputs provided by external experts outside the banks (i.e. consultants). Despite their expert knowledge there is a possibility for certain significant factors to be left out or for their correlation to be incorrectly determined.
- b) **Systemic scenario-based analysis** - tends to address all significant risk factors and ensure that the simulation of their changes will have economic sense. This group includes several approaches:
 - **Extreme value theory** - is a statistical theory of probability distribution, used to obtain a wider scope of risks of potential losses in extreme situations. This theory adds probability to the results of applied stress testing. The advantage of this theory is reflected in leaving out the normal distribution assumption. On the other hand, the assumption of uncorrelated extreme events remains, which can in practice turn out to be inaccurate and cause distortion of the portfolio.
 - **Correlation matrix** should be modeled and accurately used in many practical applications, such as the modeling of stock market volatility.
 - **Monte Carlo simulation** refers to the simulation of a random process guided by market prices and rates. Each simulation (scenario) generates potential values of the portfolio in the given moment. If a sufficient number of scenarios is generated, the simulated distribution of portfolio values converges with the real distribution.

In certain situations, it is quite sufficient to research the impact of a single factor (for instance, when a bank expects that the central bank will decrease long-term interest rates). The simulation of a certain historical event should at least incorporate a larger number of risk factors, given that it is impossible to include them all. The decision on the number of risk factors is always a compromise between the accuracy of results and the necessity to process and calculate the indicators. It is typical to use several scenarios and several types of stress

tests to assess the risks of various instruments in the portfolio. What is very important is to determine statistical characteristics of risk factors and probability distribution. Thus, in case of market risks, the rule is to start from the normal distribution assumption, whereas this is not the case when it comes to credit risk. Simplified models are applied at the expense of the obtained results' precision. Frequently recommended in stress testing is the implementation of Monte Carlo simulation, but many banks are unready to accept such recommendations, because the calculation itself requires a longer period of time.

After determining the scenario and identifying the risk factors, one can begin stress testing and conduct the portfolio's revaluation. The management, establishing policies and limits, is obliged to incorporate them into the stress testing procedures. Periodically, the management should get familiar with the results of the conducted stress tests, and it should base its decision-making on these findings. The primary purpose of stress testing is to assess the bank's capital and determine risk minimization measures. During the interpretation of results, the management should decide whether the bank is capable of absorbing potential losses incorporated into the stress scenario, or of covering other losses, manifested outside the stress scenario, if they were occurring simultaneously.

When banks' exposure on certain markets is high, they most often construct the worst-case scenario. The loss generated in such a scenario represents a good measure of exposure on the observed markets. After that, one can simply identify the risk factors which contribute to the scenario losses in the highest degree, and the management can undertake the appropriate measures. Urgent measures include the restructuring of positions or portfolio, hedging strategies, etc. When presenting their stress testing results, banks take into account their market position and the strategic aspects of risk management.

Incorporating Stress Tests into Market Risk Modeling

According to Alan Greenspan (2000),

testova treba da dobiju svoju formalizaciju i uniformnost među bankama, jer su u prošlosti banke bile fokusirane na realizaciju malog broja ad-hoc scenarija. Pri tome, dobijeni rezultati o kojima je izveštavan menadžment nikada nisu uključivani u jedan sveobuhvatan proces modeliranja rizika. Zato je prema njegovima rečima od izvanrednog značaja, čak i primarnog, da se izvrši inkorporiranje stres scenarija u formalni model rizika.

Reči *Alan Greenspan*-a su najbolju potvrdu dobile tokom poslednjih poremećaja u sektoru finansija krajem XX veka, kada se pokazalo da Value-at-Risk modeli, iako korisna alatka, nisu dovoljno podesni u uslovima velikih finansijskih šokova. Zato je prirodno bilo sve veće insistiranje na komplementarnom korišćenju Value-at-Risk modela i stres testova. Stres testiranje je imalo vrlo bitnu ulogu u proceni izloženosti riziku firme i svojom „opremljenošću“ da na adekvatan način izmeri rizik kada nastupe neočekivani događaji. U tom smislu mnogi subjekti koji su počeli da primenjuju stres testiranje su stavljali znak jednakosti između stres testova i Value-at-Risk modela kada je u pitanju njihov značaj za preduzeće u proceni izloženosti rizika. Osnovni problem koji se javlja kod stres testiranja je što na bazi dobijenih rezultata menadžeri nisu sigurni koliki je stepen verovatnoće analiziranih scenarija. Razlog ovakvom stavu leži u činjenici da je tradicionalno stres testiranje razvijeno kao samostalna tehnika i dobijeni rezultati su ocenjivani u odnosu na rezultate dobijene primenom tradicionalnog Value-at-Risk modela.

Berkowitz (1999) je predložio rešavanje problema kroz integraciju stres testiranja u formalni model rizika pripisivanjem verovatnoća stres test scenarijima. Rezultirajuće procene rizika obuhvataju i tradicionalne procene tržišnog rizika i rezultate stres testiranja, kao i verovatnoće svakog od njih. Dobijeni rezultati se podnose u vidu izveštaja menadžerima i predstavljaju jedinstven skup procena rizika na osnovu kojih menadžeri mogu donositi odluke. *Berkowitz* je istakao da „odsustvo verovatnoće dovodi stres testiranje u statistički pakao“, jer se raspolaze podacima o gubitku, ali nije dovoljno jasno koliko značaja treba pridati tim podacima. Proizilazi da se suočavamo sa dve vrste različitih procena rizika - statistička procena (kao što je Value-at-Risk model) i procena gubitka na

osnovu stres testiranja - pri čemu se ne vidi racionalan način njihovog kombinovanja. U takvoj konstelaciji stvari, jedino što preostaje jeste da se sa pomenutim procenama radi nezavisno i da se iskoristi jedan skup procena za procenu budućih gubitaka, koje su drugi izostavili ili potcenili.

Dodatni problem je što su stres testovi još u fazi razvoja, pa su mnoga pitanja i dalje otvorena kada je reč o ovoj temi. Na primer, uobičajena procedura stres testiranja podrazumeva „šok terapiju“ odgovarajućih prinosa i cena, dok se pretpostavlja da ostale cene uzimaju svoje uobičajene vrednosti i na osnovu ovih podataka se utvrđuje izloženost preduzeća riziku. Opisani pristup je konceptualno ispravan i jednostavan za realizaciju, ali zanemaruje korelacije između stresiranih cena i drugih cena, a to može biti uzrok značajnih razlika u dobijenim rezultatima. *Schachter* (1998) je istakao da ne postoji mogućnost naučnog ocenjivanja kompletnosti i pouzdanosti informacija dobijenih primenom stres testiranja. Takođe, ne može se utvrditi validnost hipotetičkih stres scenarija na osnovu stvarnih tržišnih događaja. Drugim rečima, čak i da se realno odigraju oni događaji koji su navedeni u hipotetičkom scenariju, ne postoji jednostavan način da se odredi šta je bilo tačno, a šta pogrešno u scenariju u odnosu na hipotetički scenario da bi se on mogao poboljšati. Zaključak je da se ne možemo osloniti na back-testing proceduru koja bi nam ukazala na razliku između dobrog i lošeg pristupa stres testiranju.

Rešenje većine istaknutih problema se krije u uvođenju stres testiranja u proces modeliranja tržišnog rizika koji koristi preduzeće - unificiranje stres testiranja i statističke procene rizika - tako da se verovatnoće mogu uneti u scenarija korišćena pri sprovođenju stres testova. Kada se scenariji oblikuju u statističkoj formi, dobijamo jedinstven i koherentan sistem merenja rizika koji će nam omogućiti i primenu back-testing procedure i proveru ispravnosti scenarija. Neizbežno je da izbor scenarija ostaje subjektivan, ali potreba da se pripišu verovatnoće scenarijima utiče na disciplinu menadžera rizika i stavlja ih pod pritisak da naprave jasnu razliku između datih scenarija.

Razlikujemo 4 faze u procesu modeliranja rizika:

longtime Chairman of the Federal Reserve of the United States, the beginnings of stress testing should undergo a certain formalization and uniformity among banks, because in the past banks used to be focused on realizing a small number of *ad hoc* scenarios. Thereby the obtained results reported to the management were never incorporated into a single, comprehensive risk modeling process. This is why, according to him, it is of extraordinary, even primary importance, to incorporate stress scenarios into a formal risk model.

The words of Alan Greenspan found their best confirmation during the recent disturbances in the financial sector in the late 20th century, when it turned out that Value-at-Risk models, though useful tools, were insufficiently adequate in the circumstances of large financial shocks. This is why it was only natural to increasingly insist on complementary usage of Value-at-Risk models and stress tests. Stress testing had a really important role in the assessment of a company's risk exposure thanks to its being "equipped" to adequately measure the risk in case of unexpected events. In this sense, many entities which started to implement stress testing did not differentiate between stress tests and Value-at-Risk models when it came to their importance for the company in terms of risk exposure assessment. The main problem occurring in stress testing is that, based on the obtained results, managers cannot be sure about the level of probability of the analyzed scenarios. The reason for this lies in the fact that stress testing was traditionally developed as an independent technique, and the obtained results were assessed in comparison with the results obtained by applying the traditional Value-at-Risk model.

Berkowitz (1999) proposed a solution to this problem through the integration of stress testing into a formal risk model by ascribing probabilities to stress test scenarios. The resulting risk assessments would include traditional market risk assessments and stress testing results, along with the probabilities of each of them. Thereby obtained results are submitted in form of reports to the managers, representing a unique set of risk assessments based on which managers can make decisions. Berkowitz underlined that "the lack of

probability hurls stress testing into a statistical hell", because even though the data on losses are available, it is insufficiently clear how much importance these data should be ascribed to. It can be further deduced that we are facing two types of different risk assessments - statistical assessment (such as Value-at-Risk model), and loss assessment based on stress testing - with no rational way in sight as to how to combine these two. Under such circumstances, the only remaining thing is for the mentioned assessments to be conducted independently, and for one set of assessments to be used to assess future losses, that others might have left out or underestimated.

An additional problem is that stress tests are still in their development stage, which is why many issues are still open concerning this topic. For instance, the typical stress testing procedure implies a "shock treatment" of appropriate revenues and prices, under the assumption that other prices hold their usual values, based on which data the company's risk exposure gets determined. The described approach is conceptually correct and simple to implement, but it disregards the correlations among the stressed prices and other prices, which may be the cause of substantial differences in the obtained results. Schachter (1998) underlines that there is no possibility to scientifically assess the completeness and reliability of information received by means of stress testing. Also, there is no way to determine the validity of hypothetical stress scenarios based on real market events. In other words, even if the events stated in the hypothetical scenario took place in the real world, there is no simple way to determine what was correct, and what was incorrect in the scenario, compared to the hypothetical scenario, in order to be able to improve it. The conclusion is, therefore, that we cannot rely on back-testing procedure which would otherwise indicate the difference between the good and bad approach to stress testing.

The solution to most underlined problems lies in the introduction of stress testing into the market risk modeling process of the company - i.e. unification of stress testing and statistical risk assessment - so that the probabilities can be incorporated into the scenarios used to conduct stress tests. When the scenarios are presented in

1. tradicionalno stres testiranje i rezultati procesa, koji će biti postavljeni kao skup realizovanih dobitaka/gubitaka povezanih sa svakim scenarijom
2. pripisivanje verovatnoće svakom od scenarija
3. formalni proces modeliranja rizika na tradicionalan način i modeliranje rizika primenom tehnika merenja rizika. Rezultat ove faze se može tretirati kao skup podataka vezanih za dobitak/gubitak i njihovih verovatnoća
4. sjedinjuju se dve grupe podataka o dobitcima/gubicima i njima pripisanih verovatnoća i sprovodi se integrisana procena rizika.

Uključivanje stres scenarija u Value-at-Risk model obezbeđuje da su scenariji direktan input u modelu rizika što povećava transparentnost procesa merenja rizika. Novi pristup ima dve izražene dobre karakteristike - teoretski je ispravan, u smislu da omogućava primenu teorije ekstremnih vrednosti na jasan način, i uključuje scenarija koja su definisali sami korisnici. Ne treba izgubiti iz vida da je za efikasnu upotrebu ovog pristupa potrebno da raspoložemo dobrom bazom podataka, uglavnom nekoliko godina unazad ili većim brojem prikladnih dnevnih istorijskih posmatranja. Na većini tržišta to nije problem, ali na finansijskim tržištima nedovoljno razvijenih zemalja ili tržištima zemalja koje su doživele krupne strukturne promene (npr. u režimu deviznih kurseva) to može biti problem. Uvođenje subjektivnih scenarija sa odgovarajućim verovatnoćama omogućava potpunije sagledavanje rizika, zajedno sa svim raspoloživim informacijama koje se prenose menadžerima rizika. Izbor scenarija i pripisane verovatnoće će odrediti i kvalitet analize rizika. U svakom slučaju je bolje imati model koji je približno tačan, nego model koji je tačan sa matematičkog aspekta, ali bez ekonomskog smisla i mogućnosti upotrebe. Upravo je korišćenje stres testiranja u okviru formalnog modela rizika doprinelo stvaranju pogodnog načina uključivanja u bazu podataka onih događaja, koji se još nisu dogodili a za koje postoji visok stepen verovatnoće da će se dogoditi.

Praktični rezultati primene stres testova u finansijskim institucijama u Evropi i SAD

Finansijske institucije koje svoju delatnost obavljaju na internacionalnom nivou su razvile čitav spektar različitih kompleksnih aktivnosti. Tendencija ka većoj kompleksnosti, zajedno sa iskustvom u uslovima nastupanja kriznih događaja, je iznudila povećano interesovanje u oblasti merenja i praćenja izloženosti riziku finansijskih institucija. Poseban skup tehnika upravljanja rizicima, nazvan stres testiranje, je privukao pažnju mnogih institucija, ali i zakonodavaca. Preko stres testiranja finansijske ustanove su u mogućnosti da utvrde stepen sopstvene „ranjivosti“ u slučaju da nastanu neočekivane promene na tržištu. Dakle, stres testovi pomažu u proceni promene vrednosti portfolija preduzeća ukoliko se odigraju određeni neočekivani događaji na tržištu. Poslednjih godina stres testiranje ima rastući značaj i koristi se i kao dopunski metod zajedno sa nekim već poznatim i priznatim tehnikama merenja rizika, kao što je recimo Value-at-Risk metod.

U martu 2000. godine, Odbor za globalni finansijski sistem (CGFS) je doneo odluku da, za potrebe merenja i praćenja upravljanja rizicima, organizuje globalnu procenu primene stres testiranja u najvećim finansijskim institucijama. Analiza je izvršena na slučaju 44 komercijalne i investicione banke u 10 država sveta. Svaka institucija je imala obavezu da sastavi sopstvene scenarije i glavne faktore rizika i cena aktive. Takođe, potrebno je bilo da se istraži kako preduzeća primenjuju stres testiranje i kako koriste rezultate istih. Kao rezultat sprovedenog istraživanja, dostavljeno je ukupno 293 stres scenarija i 131 test senzitivnosti.

Stres scenariji su klasifikovani po temama na bazi dominantne klase aktive ili geografskog regiona. Četiri oblasti koju su zajednički testirane su: cene hartija od vrednosti, kamatne stope, tržišta zemalja u razvoju i kreditne/likvidne marže. Samo nekoliko scenarija je u fokusu imalo robni rizik ili stres test na tržištu opcija. Pokazalo se da su banke različite faktore rizika uzimali kao najbitnije pri sprovođenju testova. Razlog je što banke polaze od sopstvene aktive i pozicija derivata, pa se samim tim i

statistical form, we get a unique and coherent system of risk measurement that will enable us to implement the back-testing procedure and check the scenarios' accuracy. Inevitably, the selection of scenarios remains subjective, but the need to ascribe probabilities to scenarios impacts the risk managers' discipline, putting them under pressure to clearly differentiate between the given scenarios.

There are 4 stages in the risk modeling process:

1. Traditional stress testing and the results of the process, to be set up as a group of realized gains/losses related to each scenario;
2. The process of ascribing probabilities to each scenario;
3. The formal process of traditional risk modeling and risk modeling through the implementation of risk measurement techniques. The result of this stage can be treated as a set of data related to gains/losses and their probabilities;
4. The two groups of data on gains/losses, along with the probabilities ascribed to them, are combined, based on which an integrated risk assessment is conducted.

Integrating stress scenarios into the Value-at-Risk model enables the scenarios to serve as direct input into the risk model, which increases the transparency of the risk measurement process. The new approach has two prominent positive characteristics - it is theoretically correct, meaning that it enables a clear implementation of extreme value theory, and it integrates user-defined scenarios. One should bear in mind that the efficient implementation of this approach requires a sound database at hand, typically reaching several years back, or a larger number of suitable daily, historical observations. In most markets this does not pose a problem, but on the financial markets of developing countries or countries which underwent major structural changes (for instance, in the FX rates regimes), this may be a problem. The introduction of subjective scenarios with appropriate probabilities enables a more comprehensive risk assessment, together with all available information reported to risk managers. The selection of scenarios and ascribed probabilities will determine the quality of risk analysis. In any case, it is better to

have a model which is approximately accurate, than a model which is mathematically accurate, but with no economic sense or usability. It was the usage of stress testing within the formal risk model that contributed to the creation of a suitable way to integrate into the database those events which have not yet occurred, but which have a high probability of occurrence.

Practical Results of Stress Testing in Financial Institutions in Europe and the USA

Financial institutions conducting their operations at the international level have developed a whole array of various complex activities. The tendency towards higher complexity, in combination with experience under the conditions of emergency events, has forced an increased interest in the field of measurement and monitoring of financial institutions' risk exposures. A special set of risk management techniques, called stress testing, drew the attention of many institutions, but also of law-makers. Through stress testing financial institutions are in the position to determine the level of their own "vulnerability" in case of unexpected market changes. Therefore, stress tests facilitate the assessment of changes in a company's portfolio value if certain unexpected events take place on the market. In recent years stress testing has had an increasing importance and has been used as an additional method alongside some already known and recognized risk measurement techniques, such as, for example, Value-at-Risk method.

In March 2000 the Committee on the Global Financial System (CGFS) decided to organize, for the purpose of measurement and monitoring of risk management, a global assessment of stress testing implementation in major financial institutions. The analysis was conducted based on the cases of 44 commercial and investment banks in 10 countries in the world. Each institution was obliged to put up its own scenarios and major risk factors and asset prices. Moreover, it was necessary to explore how companies implement stress testing and how they use the results obtained thereby. As a result of the conducted research, a total of 293 stress scenarios and 131 sensitivity tests were submitted.

percepcija verovatnoće razlikuje od jedne do druge banke. Detaljnom analizom dostavljenih stres scenarija moglo se doći do nekoliko vrlo zanimljivih nalaza.

Prvo, primećen je osetan stepen asimetričnosti rizika. Finansijski lomovi su mnogo više bili podvrgnuti testiranju, nego finansijski usponi, potom povećanja kamatnih stopa i kreditnih i likvidnih sredstava su mnogo više testirana nego smanjenja itd. Menadžeri rizika su asimetriju pripisivali asimetričnim izloženostima (rizik porasta kamatnih stopa, rizik smanjenja cena akcija i širenja kreditnih marži, kao rizika karakterističnih za banku), asimetričnim verovatnoćama (viši rizik vezan za kolaps tržišta akcija usled istorijski posmatrano visokih tržišnih vrednosti akcija) i ličnom iskustvu menadžera u stresnim situacijama, koje je takođe asimetrično.

Drugo, čini se da su se banke oslonile na stres testiranje samo za ona tržišta ili proizvode čiji rizik nije adekvatno obuhvaćen statističkim merama rizika (kao što je na primer Value-at-Risk). Takođe, istaknuto je da su tržišta zemalja u razvoju veoma dobar primer podesnih tržišta za primenu stres testova.

Treće, postoji visok stepen heterogenosti između scenarija, koji samo na prvi pogled liče jedni na druge. Pretpostavljena veličina šokova varira značajno čak i kada scenariji treba da predstave identične događaje. Moguće objašnjenje ovih razlika jeste u korišćenju različitog vremenskog horizonta za merenje istorijskih šokova. Tako na primer, jedna banka može da pođe od jednodnevnog šoka, druga banka da koristi dvonedeljni šok i slično. Na osnovu izvršene analize prikupljenih podataka u „šok situacijama“, moglo se nedvosmisleno zaključiti da su banke koristile veoma različite šokove da bi obuhvatile finansijske lomove (naročito na tržištu akcija).

Na kraju, banke su dostavile odgovore koji su se odnosili na način implementacije stres testiranja. Na osnovu odgovora, jasno je da je stres testiranje postalo standardna tehnika upravljanja rizicima za izveštajne potrebe banaka. Sve banke koriste stres testiranje da bi definisale svoj rizični profil i da bi rezultate prezentirali menadžmentu. Prema rezultatima analize, preko polovine ukupnog broja analiziranih banaka koristi stres testiranje za

postavljanje limita, dok samo jedna petina njih koristi stres testiranje za alokaciju kapitala. Dve trećine banaka je istaklo da su rezultati primenjenih stres testova, barem u jednom slučaju, vodili direktno ka zaštiti ili otvaranju pozicije. Većina banaka koristi neki oblik stres testiranja veoma često, odnosno, na dnevnom ili nedeljnom nivou. Za sprovođenje složenijih scenarija potrebni su i veći izdaci ali i duži vremenski period, pa se oni sprovode znatno ređe, recimo mesečno ili kvartalno.

Odbor za superviziju evropskih banaka (Committee of European Banking Supervisors - CEBS) je tokom 2010. godine sproveo stres testiranje na uzorku od 91 evropske banke, koje čine 65% od ukupne aktive bankarskog sektora EU. Glavnina testiranja je bila usmerena na kreditni i tržišni rizik, uključujući i izloženosti država članica EU. U slučaju nastupanja negativnog scenarija, prema ovom stres testu, ispravke vrednosti i gubici bi iznosili 566 milijardi evra zbirno u 2010. i 2011. godini. Ukupni osnovni kapital bi se smanjio na 9.2% u 2011. godini, uz napomenu da bi se nakon negativnih događaja po suverenitet države, ukupno 7 banaka suočilo sa problemom smanjenja pokazatelja Tier 1 ispod 6% što je definisano kao granična vrednost samo za potrebe stres testiranja. Inače, banke u EU su dužne da ovaj pokazatelj održavaju minimalno na zakonskom nivou od 4%. One banke koje nisu ispunile uslove stres testiranja su pod monitoringom od strane supervizora na nacionalnom nivou, u procesu sagledavanja potreba za sprovođenjem njihove dokapitalizacije.

Kao sledbenik Odbora za superviziju evropskih banaka, 1. januara 2011. godine je sa radom počela EBA (European Banking Authority) sa prvenstvenim ciljem obezbeđenja finansijske stabilnosti u okviru bankarskog sektora država članica EU. EBA je u julu 2011. godine objavila rezultate analize, koja je jasno ukazala da negativni šokovi mogu prouzrokovati značajne probleme u finansijskom sektoru, odnosno, da je neophodno preduzeti značajne mere kako bi se postigla opšta finansijska stabilnost. Osam evropskih banaka: 5 iz Španije, 2 iz Grčke i jedna iz Austrije nisu prošle stres testiranje, ne uspevši da pređu postavljeni prag adekvatnosti kapitala od 5%. Temeljna analiza je pokazala da ovaj

Stress scenarios were classified according to topic, based on the dominant asset type or geographical region. The four areas commonly tested included: securities prices, interest rates, developing markets, and credit/liquid margins. Only a few scenarios focused on commodity risk or stress tests on the options market. It turned out that banks took different risk factors as most important during the implementation of tests. The reason for this is that banks start from their own assets and derivatives position, which, in turn, makes the perception of probability differ from bank to bank. A detailed analysis of the submitted stress scenarios led to several, rather interesting findings.

First of all, considerable asymmetry of risks was observed. Financial collapses were much more tested than financial peaks, just as the increases of interest rates and credit and liquid spreads were much more tested than their decreases, etc. Risk managers ascribed this asymmetry to asymmetric exposures (interest rate risk, risk of reduced stock prices and credit margin expansion, as the risks characteristic for a bank), asymmetric probabilities (higher risk related to a stock market collapse due to historically observed high market values of stocks) and the personal experience of managers in stressful situations, which is also asymmetrical.

Secondly, it seems that banks relied on stress testing only for those markets or products whose risk was inadequately addressed by statistical risk measures (such as, for instance, Value-at-Risk). Also, it was underlined that developing markets are an extremely good example of markets suitable for the implementation of stress testing.

Thirdly, there is a high level of heterogeneity among the scenarios, which look alike only at the first glance. The assumed size of shocks considerably varies even when the scenarios are supposed to represent identical events. The possible explanation of these differences lies in the usage of different time horizons for the measurement of historical shocks. Thus, for instance, one bank can start from a single-day shock, whereas another one uses a two-week shock, etc. Based on the conducted analysis of the collected data on "shocks", the unambiguous conclusion was reached

that banks resorted to substantially different shocks in order to address financial collapses (especially on the stock market).

Finally, banks submitted the responses relating to the manner of stress testing implementation. Based on these responses, it was clear that stress testing became a standard risk management technique for banks' reporting purposes. All banks use stress testing to define their risk profiles and to present the obtained results to their management. According to the results of the analysis, over a half of the total number of analyzed banks uses stress testing to set up limits, whereas only one fifth of them uses stress testing for the allocation of capital. Two thirds of banks highlighted that the results of applied stress tests at least in one case directly led to the protection or opening of a position. Most banks use some form of stress testing very often, i.e. on a daily or weekly basis. The implementation of more complex scenarios requires bigger expenditures, and longer time periods, hence they get implemented less frequently, say, on a monthly or quarterly basis.

In 2010 the Committee of European Banking Supervisors - CEBS conducted a stress testing on a sample of 91 European banks, accounting for 65% of the EU banking sector's total assets. The majority of tests were targeted at credit and market risk, including the exposures of the EU member states. In case of the adverse scenario, according to this stress test, impairments and losses would amount to EUR 566 billion in 2010 and 2011 together. Total core capital would decrease to 9.2% in 2011, and following the events adversely affecting the state's sovereignty, 7 banks in total would face the problem of Tier 1 indicators reduced below 6%, which was defined as the floor value only for the stress testing purposes. Other than that, banks in the EU are obliged to maintain this indicator at the minimal regulatory level of 4%. The banks which failed to meet the stress testing conditions have been monitored by the supervisors at the national level, as part of the process of considering the necessity of their additional capitalization.

As the successor of the Committee of European Banking Supervisors, the European Banking Authority - EBA started operating on 1 January 2011, its primary goal being to

grupi banaka nedostaje ukupno 2.5 milijarde evra kapitala u slučaju nastupanja pesimističkog ekonomskog scenarija. Adekvatnost kapitala između 5% i 6% je ostvarilo još 16 evropskih banaka, a još više može da brine podatak da bi još 20 banaka bilo "u crvenom" da im nije priznat kapital koji su prikupile od početka testiranja krajem 2010. godine.

Dobijeni podaci potvrdili su da iznenadni i neočekivani šokovi značajno utiču na finansijsku stabilnost evropskih zemalja. Pad cena državnih obveznica država sa problematičnom fiskalnom situacijom, poput: Grčke, Italije, Španije i Portugala, je imao negativan uticaj na bilanse banaka, koje su u svojim portfolijima držale obveznice zemalja PIIGS-a (akronim za: Portugaliju, Italiju, Irsku, Grčku i Španiju; kao zemlje sa velikim problemima, koji su naročito došli do izražaja nakon globalne ekonomske krize). Neravnoteža u makroekonomskoj sferi je i dalje prisutna uz neizvesne i nedovoljno jasne signale budućeg oporavka. Tendencije u bankarskim sektorima zemalja EU u problemima se kreću u pravcu konsolidacije finansijskog sistema, koja sa sobom povlači i smanjenje ukupnog broja banaka tj. sprovođenje merđžera i akvizicija.

U SAD, značaj stres testiranja je posebno istaknut kroz donošenje Dodd-Frank dokumenta, u delu koji se prvenstveno odnosi na kvantifikovanje mogućnosti velikih bankarskih grupacija da poseduju dovoljan nivo kapitala i u periodu nastupanja neočekivanih i vanrednih događaja. Dodd Frank dokument je najznačajniji dokument iz oblasti finansijske regulative, kojim su uspostavljena nova pravila za funkcionisanje banaka, hedž fondova i obavljanje transakcija sa derivatima. Prema pomenutom dokumentu, FED godišnje sprovodi stres testiranje kod banaka u cilju procene dovoljne pokrivenosti kapitalom, neophodnog za apsorpciju gubitaka i nastavak poslovanja uz pristup sredstvima finansiranja, izmirenje obaveza prema klijentima i vršenje uloge finansijskog posrednika čak i kada nastane neočekivani događaj. U tom smislu, FED vrši projekciju prihoda, rashoda, gubitaka i rezultata nakon sprovedenog stres testova

u pogledu: nivoa kapitala, pokazatelja regulatornog kapitala i pokazatelja osnovnog kapitala.

FED je realizaciju stres testova sproveo kroz 3 odvojena scenarija i to: inicijalni (bazni) scenario, negativni scenario i izrazito negativni scenario. Poslednje pomenuti, strogi ili izrazito negativni scenario (engl. *severe adverse scenario*) je konstituisan kao hipotetički scenario koji procenjuje sposobnost i otpornost banke na negativne ekonomske događaje. Izrazito negativni scenario uključuje 26 varijabli, pri čemu 14 varijabli obuhvata ekonomsku aktivnost, cene aktive i kamatne stope u američkoj privredi i na finansijskim tržištima, dok su 3 varijable (realni rast američkog BDP-a, inflacija i devizni kurs američkog dolara prema drugim valutama) posmatrane u okviru bloka od 4 grupacije država: evrozoni, Velikoj Britaniji, azijskim zemljama u razvoju i Japanu.

Izrazito negativni stres scenario uključuje sledeće pretpostavke: stopa nezaposlenosti od 12.1%, pad cena akcija za više od 50%, smanjenje cena nekretnina za više od 20% kao i oštar negativni trend velikih trgovinskih preduzeća - projektovani gubitak za 18 bankarskih holding kompanija bi iznosio 462 milijarde dolara tokom hipotetičkog stres scenarija, čije trajanje obuhvata vremenski horizont od ukupno 9 kvartala. Zbirni Tier I ratio osnovnog kapitala (definisan kao odnos visoko kvalitetnog kapitala i ponderisane rizične aktive) se, na bazi ovog hipotetičkog scenarija, smanjuje sa 11.1% u trećem kvartalu 2012. godine na 7.7% u četvrtom kvartalu 2014. godine. Uprkos pesimizmu koji se može izraziti nakon sagledavanja rezultata na bazi iznetog scenarija, treba napomenuti da su ovo prvi stres testovi sprovedeni pod kriterijumima definisanim Dodd-Frank dokumentom, kao i da se komparativnom analizom može zaključiti da zbirni ratio kapitala nakon stres testiranja nadmašuje za oko 5.6% zbirni Tier I ratio posmatranih 18 preduzeća u odnosu na period krajem 2008. godine, kada su usled globalne krize sprovedena stres testiranja na inicijativu Vlade.

ensure financial stability in the banking sectors of the EU member states. In July 2011 the EBA published the results of the analysis, which clearly indicated that negative shocks can cause considerable problems in the financial sector, i.e. that it is necessary to undertake substantial measures in order to achieve general financial stability. Eight European banks: 5 from Spain, 2 from Greece and one from Austria, did not pass the stress testing, having failed to exceed the set 5% capital adequacy threshold. The thorough analysis showed that this group of banks lacks EUR 2.5 billion in total in case of the occurrence of a pessimistic economic scenario. Capital adequacy between 5% and 6% was achieved by another 16 European banks, and what can be even more alarming is the fact that another 20 banks would have been "in the red" if the capital raised since the commencement of testing in late 2010 had not been recognized to them.

The obtained data confirmed that sudden and unexpected shocks considerably influence the financial stability of the European countries. The drop of prices of government bonds issued by the countries with problematic fiscal situation, like: Greece, Italy, Spain and Portugal, adversely impacted the balance sheets of banks which held in their portfolios the bonds issued by PIIGS (an acronym referring to: Portugal, Italy, Ireland, Greece and Spain, as countries with huge problems, which particularly became prominent after the global economic crisis). The disequilibrium in macroeconomic sphere is still present, with uncertain and insufficiently clear signals of future recovery. Tendencies in the problematic EU banking sectors have been shifting towards financial system consolidation, which implies the reduction of the total number of banks, i.e. mergers and acquisitions.

In the USA, the significance of stress testing was particularly underlined through the adoption of Dodd-Frank Act, in the section primarily referring to the quantification of large banking groups' capabilities to possess sufficient capital levels even in the period of occurrence of unexpected and extraordinary events. Dodd-Frank Act is the most important document in the field of financial regulation, which has established new rules for the functioning of banks, hedge funds and derivatives transactions. According to the mentioned

document, the Fed annually conducts stress testing in banks in order to assess sufficient coverage of capital, necessary for the absorption of losses and business continuity with access to finance, servicing of liabilities to clients and conducting the role of financial intermediaries even in case of an unexpected event. To this end, the Fed provides the projections of revenues, expenditures, losses and results after the conducted stress tests in terms of: capital levels, regulatory capital requirements and core capital requirements.

The Fed implemented these stress tests through 3 separate scenarios: initial (basic) scenario, adverse scenario and severe adverse scenario. The last one, strict or severe adverse scenario is constituted as a hypothetical scenario assessing the bank's capability and resilience to adverse economic events. The strict adverse scenario includes 26 variables, with 14 of them referring to economic activity, asset prices and interest rates in the US economy and financial markets, and 3 of them (real growth of the US GDP, inflation and FX rate of the US dollar against other currencies) being assessed within a block of 4 country groups: Eurozone, Great Britain, Asian developing countries and Japan.

The severe adverse stress scenario includes the following assumptions: unemployment rate of 12.1%, drop in stock prices by over 50%, lower real estate prices by over 20%, and a severe negative trend of large trading companies - the projected loss for 18 bank holding companies would amount to USD 462 billion during the hypothetical stress scenario, whose duration includes the time horizon of 9 quarters in total. According to this hypothetical scenario, the aggregate Tier 1 core capital ratio (defined as a ratio of high quality capital and risk weighted assets) decreases from 11.1% in the third quarter of 2012 to 7.7% in the fourth quarter of 2014. Despite the pessimism that might arise after reviewing the results based on the presented scenario, it is worth noting that these are the first stress tests conducted according to the criteria defined by Dodd-Frank Act, and that the comparative analysis leads to the conclusion that the aggregate capital ratio after this stress testing exceeds by about 5.6% the aggregate Tier 1 ratio of the observed 18 companies, compared to the period of late

Tabela 1: Stres test 2013 - Dodd Frank dokument

	Realizovano	Koeficijent kapitala pod stresnim okolnostima	
	K3 2012	K4 2014	Minimum
Koeficijent osnovnog akcijskog kapitala Tier 1 (%)	11.1	7.7	7.4
Koeficijent kapitala Tier 1 (%)	12.9	9.1	8.9
Koeficijent ukupnog kapitala zasnovanog na riziku(%)	15.7	11.7	11.6
Koeficijent leveridža Tier 1 (%)	8.0	5.9	5.9

Izvor: <http://www.federalreserve.gov/bankinfo/stress-tests/stress-test-results.htm>

Dostignuti rezultati u oblasti stres testiranja u bankarskom sektoru Srbije

Centralna banka Srbije je 2009. godine u okviru aranžmana sa MMF-om testirala 16 banaka koje u ukupnom bankarskom sektoru učestvuju sa 83% u ukupnoj aktivni, sa ciljem da proceni uticaj pretpostavljenog stres scenarija na kvalitet kreditnog portfolija, a preko toga, i na adekvatnost kapitala. Kao osnovna postavka modela stres testiranja uzet je regresioni model u kojem se kao nezavisne varijable koriste: proizvodni jaz, deprecijacija, promena kamatnih stopa i njihov uticaj na pogoršanje kreditnog portfolija i gubitke po osnovu porasta problematičnih kredita od dve godine - 2009. i 2010. godine. U sprovođenju ovog stres testiranja, korišćene su pretpostavke pesimističkog scenarija i standardizovan MMF-ov “bottom-up” pristup (testiranje sprovede pojedinačne institucije na bazi sopstvenog upravljanja rizikom). Pretpostavke koje su korišćene u modelu su prikazane u tabeli 2:

Tabela 2: Osnovne pretpostavke modela stres testiranja

Elementi	2008	Pretpostavke	
		2009	2010
Promena BDP (%)	5.4	-6	-3.5
Proizvodni jaz (%)	0.7	-5.8	-8.5
Deprecijacija (%)	11.8	12	10
Promena kamatnih stopa (%)	-	0.1	2

Izvor: Narodna banka Srbije, www.nbs.rs

Polazna osnova u analizi je bila adekvatnost kapitala banaka u iznosu od 19%. Nakon primenjenih pretpostavki u pesimističkom scenariju pokazalo se da bi u 2009. pokazatelj adekvatnosti bio na nivou od 18,04%, a u 2010. godini - 16,42%. Vrednosti

oba pokazatelja su znatno iznad propisanog minimuma za banke u Srbiji tj. 12%. Nedvosmislen zaključak primenjenih stres testiranja jeste da je bankarski sektor u Srbiji pokazao izuzetan stepen „otpornosti“ na eventualne neočekivane ekonomske šokove. Takođe, jasno proizilazi da banke u Srbiji nemaju potrebu za vanrednim dokapitalizacijama, čak i da dođe do iznenadnih tržišnih promena. Kao direktna posledica opšteg smanjivanja ekonomske aktivnosti (izraženog kroz pad BDP-a), došlo bi do porasta obima problematičnih kredita za 13,9%.

Stres testove, tehniku simulacije uticaja različitih scenarija na finansijsku poziciju i sposobnost određene institucije da apsorbuje gubitke, Narodna banka Srbije primenjuje u obavljanju poslova supervizije od 2007. godine, a posebno su dobili na značaju u periodu globalne krize. Rezultati stres testova treba da identifikuju najosetljivije oblasti poslovanja na promene u makroekonomskom okruženju. Stres testovi počivaju na različitim pretpostavkama čija je realizacija neizvesna, naročito u uslovima

većih ekonomskih potresa, te zbog toga rezultati testova ne predstavljaju egzaktnu podatke i procene. U svakom slučaju, realno je očekivati da će se u srpskom bankarskom sektoru ova tehnika merenja rizika sve više primenjivati kao i da će davati značajan doprinos u donošenju odluka top menadžmenta, koje su od suštinskog značaja za funkcionisanje banaka.

2008, when stress testing was conducted at the Government’s initiative due to the global crisis.

The starting point in the analysis was the banks’ capital adequacy of 19%. After implementing the worst-case scenario assumptions, it turned out that in 2009 the capital adequacy ratio would amount to 18.04%, and in 2010 to 16.42%. The values of both indicators are substantially above the prescribed minimum for banks in Serbia, i.e. 12%. The

explicit conclusion of conducted stress tests is that the banking sector of Serbia demonstrated an exquisite level of “resilience” to potential unexpected economic shocks. Moreover, it can clearly be deduced further that banks in Serbia do not need extraordinary additional capitalizations, not even in case of sudden market changes. As a direct consequence of general decrease in economic activity (expressed through the drop of GDP), there would be an increase in the volume of NPLs by 13.9%.

Stress testing, the technique simulating the impact of various scenarios on the financial position and capability of a certain institution to absorb losses, has been implemented since 2007 by the National Bank of Serbia in its supervision-related operations, and gained particular importance during the global economic crisis. Stress testing results should identify those areas of business most sensitive to changes in the macroeconomic environment. Stress tests rest on various assumptions whose realization is uncertain, especially in the conditions of large economic shocks, which is why the results of

these tests do not represent exact data and assessments. In any case, it is realistic to expect that in the banking sector of Serbia this risk measurement technique will be increasingly implemented, and that it will considerably contribute to top management’s decision-making, which is of crucial importance for the banks’ functioning.

Figure 1. 2013 Stress Test - Dodd-Frank Act

	Actual	Stressed capital ratios	
	Q3 2012	Q4 2014	Minimum
Tier 1 common ratio (%)	11.1	7.7	7.4
Tier 1 capital ratio (%)	12.9	9.1	8.9
Total risk-based capital ratio (%)	15.7	11.7	11.6
Tier 1 leverage ratio (%)	8.0	5.9	5.9

Source: <http://www.federalreserve.gov/bankinfo/foreg/stress-tests/stress-test-results.htm>

Achieved Results in the Field of Stress Testing in the Banking Sector of Serbia

In 2009, as part of the arrangement with the IMF, the National Bank of Serbia tested 16 banks accounting for 83% of the banking sector’s total assets, with the objective to assess the impact of the assumed stress scenario on the credit portfolio’s quality, and, through that, on capital adequacy. The basic assumption of the stress testing model was the regression model, whose independent variables include: production gap, depreciation, interest rates fluctuation and their impact on the credit portfolio’s worsening and losses in respect of NPLs growth in two years - 2009 and 2010. What was used in the implementation of this stress testing are the pessimistic (worst-case) scenario assumptions and the IMF’s standardized bottom-up approach (the testing was conducted by individual institutions based on their own risk management). The assumptions used in this model are shown in Table 2 below:

Figure 2: Basic assumptions of the stress testing model

Elements	2008	Assumptions	
		2009	2010
Change in GDP (%)	5.4	-6	-3.5
Production gap (%)	0.7	-5.8	-8.5
Depreciation (%)	11.8	12	10
Change of interest rates (%)	-	0.1	2

Source: National Bank of Serbia, www.nbs.rs

Bankarski sektor Srbije zaostaje u primeni ove tehnike za razvijenim zemljama. Međutim, u ovoj oblasti su učinjeni krupni pomaci. Dobijeni rezultati primenjenih stres testova su ohrabрили sve učesnike u bankarskom sektoru, jer su pokazali da banke u Srbiji imaju dobre pokazatelje adekvatnosti kapitala, koji ne mogu biti u značajnoj meri urušeni u slučaju da nastupi najgori mogući scenario u vidu finansijskog šoka.

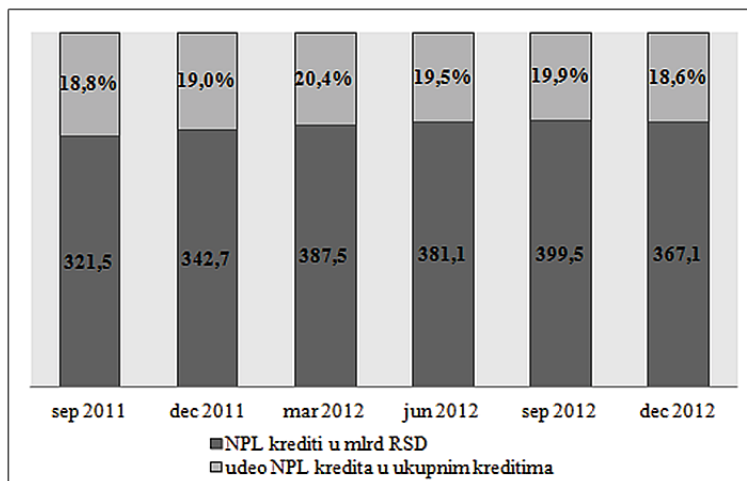
Ovi rezultati, iako ohrabrujući, moraju biti uzeti u obzir u kontekstu celokupne problematike stres testiranja. Naime, mnoge druge države, koje već duži niz godina primenjuju stres testove, suočene su sa problemom „rigoroznosti“ tih testova, odnosno, smatra se da nisu dovoljno strogi da mogu dovesti do nedvosmislenih zaključaka koji će uputiti bankarski sistem u pravom smeru. A upravo to je ono na čemu se i zasnivala ideja stres testiranja, da pored sagledavanja otpornosti na neočekivane događaje, dovede do određenih zaključaka i zakonitosti u ponašanju tržišta, što menadžment banaka može iskoristiti za donošenje racionalnih odluka i u turbulentnim uslovima.

Za razliku od pristalica metoda stres testiranja, kritičari ove metodologije najčešće zastupaju Talebovski pristup (po ekonomisti Nasimu Nikolasu Talebu, autoru čuvenog dela „Crni labud“) u osnovi pobijajući primenjene metode u upravljanju rizicima i stavljajući zamerke na prediktivnu sposobnost modela da predvidi nastanak neočekivanih događaja. Da pomenute kritike u određenim segmentima imaju svoju težinu, govore i praktična događanja na primeru bankarskog sektora Srbije. Iako je u periodu globalne ekonomske krize bankarski sektor Srbije pokazao visok stepen rezistentnosti na iznenadne događaje, dešavanja u poslednje dve godine naročito narušavaju kreiranu idiličnu sliku. U maju 2012. godine, Narodna banka Srbije je oduzela dozvolu za rad Agrobanci zbog operativnih nepravilnosti u radu, odnosno, utvrđivanja

kritične neusklađenosti kapitala banke i ukupne izloženosti riziku. Početkom aprila 2013. godine, slična sudbina je zadesila i Razvojnu banku Vojvodine. Novembar 2013. i kraj januara 2014. godine su obeleženi gašenjem još dve državne banke: Privredne banke Beograd i Univerzal banke, usled ostvarenih gubitaka u poslovanju i potkapitalizovanosti. U pomenutim slučajevima četiri državne banke zaključujemo da je u segmentu upravljanja rizicima izostala adekvatna reakcija, kao i da je izvesno kašnjenje u reagovanju centralnog monetarnog organa, stvorilo loš publicitet u javnosti dodatno ugrožavajući stabilnost finansijskog sistema Srbije.

Kriza finansijskog sektora ima svoju refleksiju i u realnom sektoru ekonomije, tako da se neraskidiva povezanost između realnog i finansijskog sektora a samim tim i „zdravlje“ finansijskog sektora može sagledati kroz stanje problematičnih - NPL kredita. Problematici krediti već duži vremenski period u Srbiji pokazuju trend porasta, tako da je nedvosmisleno jasno da je njihov iznos na dugi rok posmatrano neodrživ.

Slika 2: NPL krediti u bankarskom sektoru Srbije



Izvor: Narodna banka Srbije

Visok iznos problematičnih kredita, karakterističan za Srbiju i generalno za zemlje u razvoju, jeste zaostavština prethodnog - kriznog perioda, tako da se ekonomski rast i privredni oporavak postavljaju kao neophodan, ali ne i dovoljan uslov za stabilnost finansijskog sistema. Dodatno, potrebno je rešiti problem

The banking sector of Serbia lags behind the developed countries when it comes to the implementation of this technique. Nevertheless, major progress has been made in this field. The obtained results of the applied stress tests have encourages all stakeholders in the banking sector, because they showed that banks in Serbia have sound capital adequacy indicators, that cannot be substantially undermined if a worst-case scenario occurs in the form of a financial shock.

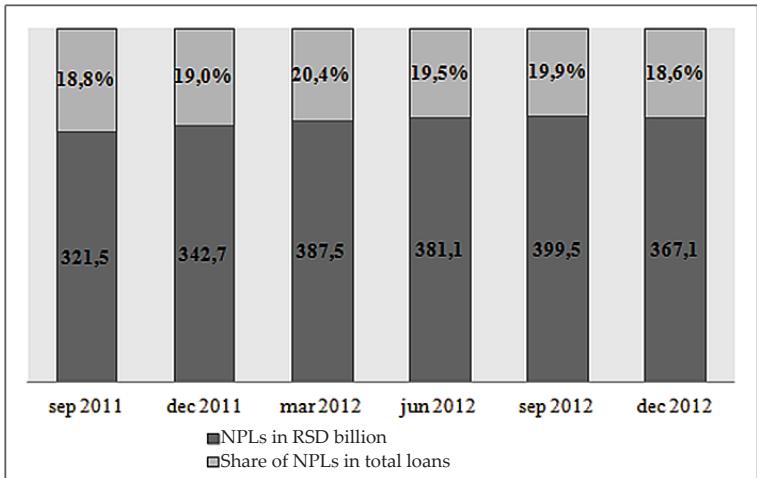
These results, though encouraging, must be taken into account within the context of the entire subject matter of stress testing. Namely, many other countries, implementing stress tests for many years now, have faced the problem of these tests' "rigidity", because they are believed to be insufficiently strict to be able to lead to unambiguous conclusions that would guide the banking sector in the right direction. And this is exactly what the idea of stress testing was based on in the first place - that, apart from examining resilience to unexpected events, they lead to certain conclusions and patterns in market behavior, which can be employed by banks' management to make rational decisions even in turbulent times.

Opposing the supporters of stress testing methods, the critics of this methodology most often advocate the Taleb's approach (after the economist Nassim Nicholas Taleb, author of the famous work *The Black Swan*), denying in its basis the applied risk management methods, and objecting to the model's predictive ability to foresee the occurrence of unexpected events. That the mentioned criticism in certain segments carries some weight has been confirmed by practical developments in the example of the banking sector of Serbia. Although during the global economic crisis the banking sector of Serbia demonstrated a high level of resilience to sudden events, the developments in the past two years have been particularly undermining the idyllic image.

In May 2012, the National Bank of Serbia revoked the operating license from Agrobanka due to operational irregularities, i.e. doe to a critical mismatch between the bank's capital and its overall risk exposure. In early April 2013, the similar fate befell the Development Bank of Vojvodina. In November 2013 and in late January 2014 another two state banks, Privredna banka Beograd and Univerzal banka, were closed, due to their operational losses and insufficient capitalization. In the mentioned cases of these four state banks, we can conclude that there was a lack of adequate response in the risk management segment, and that the belated reaction of the central monetary body generated bad publicity, thereby additionally jeopardizing the stability of the financial system of Serbia.

The crisis of the financial system has also had its reflections in the real sector of the economy, so that the inextricable connection between the real and the financial sector, and thereby the "health" of the financial sector, can be viewed through the position of non-performing loans (NPLs). Non-performing loans in Serbia have for a longer period of time exhibited a trend of growth, which makes it unambiguously clear that their amount is unsustainable in the long run.

Figure 2. NPLs in the Banking Sector of Serbia



Source: National Bank of Serbia

The high amount of non-performing loans, characteristic for Serbia and, in general, for developing countries, has been inherited from the preceding period - i.e. the crisis,

NPL kredita na način koji će omogućiti, ne samo „čišćenje“ bilansa banka i oslobađanje dela kapitala koji je neproduktivno angažovan, već i uspostavljanje efikasnih procedura i politika za upravljanje rizikom. Na taj način, banke bi obezbedile sebi daleko veći iznos kapitala, koji je deficitarna kategorija imajući u vidu regulatorne zahteve, a istovremeno bi se uspostavio znatno viši stepen discipline među finansijskim učesnicima i viši nivo poverenja u primenjene metode. Dakle, ono što nijedna metodologija, pa tako ni stres testovi sa najrigoroznijim pretpostavkama ne mogu predvideti, svakako stvara određenu dozu nepoverenja, koja može ponekad dobiti i potvrdu u praksi kroz pojedine nefunkcionalnosti i nesavršenosti bankarskog sistema. U takvom ambijentu, često se pokreće i pitanje svrsishodnosti i značaja primenjene tehnike stres testiranja.

Značaj i perspektiva stres testiranja

Najjednostavniji odgovor na pitanje „zašto finansijske institucije sprovode stres testiranje?“ bio bi sadržan u regulatornim zahtevima predviđenim Bazelskim sporazumom iz 1996. godine. Ono što se u prvi mah činilo isključivo kao obaveza, vremenom je postalo predmet temeljnih analiza od strane menadžera i došlo se do zaključka o korisnosti primenjenog metoda stres testiranja. Naime, svi upravljački nivoi su uvideli da imaju značajne koristi od dobijenih rezultata na bazi stres testiranja, jer imaju uvid u ključne pokazatelje rizika, preko tehnike koja uzima u obzir neočekivane, šokantne tržišne događaje. Ključni aspekt jeste to što stres testiranje obezbeđuje informacije koje nisu dostupne menadžmentu ukoliko primenjuje neke standardne tehnike merenja rizika, poput Value-at-Risk tehnike.

Definisanje odgovarajućeg stres scenarija predstavlja i umetnost i nauku. Prema Bazelskim preporukama, kao kategorija scenarija se apostrofiraju istorijski scenariji, koji su zasnovani na istorijskim podacima o cenama i stopama, koje se tokom stresnog perioda primenjuju na tekuću tržišnu vrednost portfolija. Pored toga, postoje hipotetički scenariji, koji su se razvili kao rezultat regulatornih zahteva. Izvedena (hibridna) vrsta scenarija jeste matrični pristup, zasnovan

na istorijskom iskustvu i potom primeni stres testiranja na uzastopne nivoe promena u okviru datog raspona, vršeći revalorizaciju portfolija u svakoj fazi. Svaki od pomenutih stres testova ima svoje i dobre i loše strane.

Ništa nije sporno kada govorimo o istorijskim scenarijima, jer su se oni stvarno odigrali. Međutim, broj korisnih istorijskih scenarija je daleko manji, jer su oni po svojoj prirodi retki i pitanje je da li se mogu primeniti na konkretne instrumente u portfoliju banke. Kada se istorijski događaj uvede u stres testiranje, onda je potrebno odrediti početni i krajnji vremenski trenutak, tako da izbor vremenskog raspona ima veoma dramatičan uticaj na čitav proces stres testiranja. Koristan savet u ovoj problematici se odnosi na izbor datuma na bazi tržišnih stopa koje reprezentuju značajnu izloženost portfolija određenom neočekivanom događaju.

Nekoliko stotina različitih hipotetičkih scenarija je moguće izraditi u zavisnosti od kriterijuma koji su uzeti u obzir. Ta činjenica predstavlja prednost, ali istovremeno i lošu stranu, jer je zadatak određivanja jasnog i celovitog ekonomskog događaja vrlo komplikovan. Početni korak u definisanju hipotetičkog scenarija jeste identifikovanje potencijalno štetnih događaja u budućnosti i njihova manifestacija na ključne tržišne pokazatelje. Odluke se u takvim situacijama donose imajući u vidu širu sliku mogućih reprekusija na ostala tržišta naročito sa aspekta problema likvidnosti koji se može pojaviti kao krucijalan. Dobra strana matričnog pristupa je što smanjuje rizik da se velike izloženosti ne identifikuju i izmere u stres testu. Loša strana je što matrični pristup zahteva stvaranje velikog broja pod-scenarija, pa se može dovesti u pitanje izvršenje ovog tipa scenarija usled značajnih kalkulacionih zahteva koji su postavljeni.

Uspešno stres testiranje, iz perspektive upravljanja rizicima, bi trebalo da obuhvati sve tri prethodno izložene metode, kako bi se napravio balans između pozitivnih i negativnih strana svakog od izloženih metoda. Razvoj scenarija mora biti dinamičan, prilagođen trenutnim promenama na tržištu i promenama u portfoliju, uz neizostavnu reviziju predloženih scenarija u određenim vremenskim periodima (npr. na kvartalnom nivou). Rezultati stres

indicating that the economic growth and economic recovery are a necessary, but insufficient precondition for the financial system's stability. Moreover, the problem of NPLs needs to be solved in a way that would not only enable banks to "clear" their balance sheets and free up a segment of capital which has been engaged non-productively, but also to establish efficient risk management procedures and policies. Thereby, banks would ensure for themselves way higher amounts of capital, which has been undersupplied bearing in mind regulatory requirements, and at the same time a considerably higher level of discipline would be established among the financial participants, accompanied by more confidence in the applied methods. In other words, what no methodology, not even stress tests with the most rigorous assumptions, can predict undoubtedly causes a certain level of distrust, which can sometimes be confirmed in practice through malfunctioning and imperfection of the banking system. In such an environment it is often questioned how purposeful and significant, if at all, the applied stress testing technique is.

Significance and Prospects of Stress Testing

The simplest answer to the question "Why do financial institutions conduct stress testing?" is to be found in the regulatory requirements prescribed by the 1996 Basle Accord. What at first looked solely like a commitment, over time became a subject of thorough analyses conducted by managers, following the conclusion about the usefulness of the applied stress testing method. Namely, all levels of management realized that they have substantial benefits from the results obtained from stress testing, granting them insight into the key risk indicators, by means of a technique taking into account unexpected, extreme market events. The crucial aspect is that stress testing provides information otherwise unavailable to management if it applies some standard risk measurement techniques, like Value-at-Risk.

Defining the appropriate stress scenario is both art and science. According to the Basle recommendations, the highlighted category of scenarios is historical scenarios, based on

historical data on prices and rates, which are then, during a stressful period, to be applied on the portfolio's current market value. Moreover, there are hypothetical scenarios, having developed as a result of regulatory requirements. A derived (hybrid) type of scenarios is the matrix approach, based on historical experience and subsequent implementation of stress testing on consecutive levels of changes within the given framework, with the revaluation of the portfolio in each stage. Each of the above stress tests has its advantages and disadvantages.

There is nothing arguable about historical scenarios, because they actually took place. However, the number of usable historical scenarios is much lower, given that they are, by their nature, rare, and that it remains questionable whether they can be applied to concrete instruments in the bank's portfolio. When a historical event is brought into stress testing, it is necessary to determine its commencement and ending dates, hence the selection of the time frame dramatically impacts the entire stress testing process. A useful tip in this respect refers to the selection of dates based on market rates representing a considerable exposure of the portfolio to a certain unexpected event.

It is possible to create several thousand different hypothetical scenarios, depending on the criteria taken into account. This fact is an advantage, but at the same time a drawback, because the task of determining a clear and comprehensive economic event is rather complicated. The initial step in defining a hypothetical scenario is to identify potentially harmful events in the future, and their manifestation on key market indicators. In such situations, decisions are made bearing in mind the wider image of potential repercussions on other markets, especially from the aspect of liquidity problems, which may be crucial. The good side of the matrix approach is that it reduces the risk of large exposures not being identified and measured with the stress testing. The bad side of the matrix approach is that it requires the creation of a large number of sub-scenarios, which may bring into question the execution of this type of scenario due to considerable calculation requirements.

Successful stress testing, from the risk

testiranja imaju dvojak uticaj na upravljanje rizicima: prvo, kao izvor informacija, i drugo, kao kontrolni mehanizam koji se koristi u procesu upravljanja rizicima. Kao izvor informacija, stres testovi imaju poseban značaj naročito u kriznim periodima, jer upravo stres testiranje omogućava sagledavanje preuzetog rizika, identifikovanje glavnih faktora koji dovode do stresnih situacija kao i doprinos tih faktora stresnom događaju i otkrivanje skrivenih izvora rizika. Raspolaganje ovakvim informacijama omogućava menadžmentu da pravovremeno donese odluke koje će uticati na smanjenje izloženosti riziku bilo kroz hedžing transakcije ili smanjenje u sopstvenoj trgovačkoj poziciji. Sa druge strane, rezultati stres testiranja mogu biti u funkciji kontrole rizika u okviru postojeće strukture limita i kao deo obračuna internog tržišnog rizika za potrebe alokacije kapitala. Stres testovi svojim rezultatima utiču na buduću alokaciju resursa i ponašanje prilikom preuzimanja rizičnih situacija.

Aktuelna faza u razvoju bankarskog sektora Srbije nalaže da banke sprovedu stres testiranje u okviru procesa interne procene adekvatnosti kapitala (u daljem tekstu, skraćeno ICAAP). Odgovornost za sprovođenje stres testova imaju organi upravljanja u bankama. Banka kreira i sprovodi stres testiranje imajući u vidu uticaj neočekivanih događaja na rizični profil banke, kao i na dobit i kapital. Testiranje obuhvata veći broj metodologija, čija složenost varira: od jednostavnih do kompleksnih testova, sa ciljem procene uticaja makroekonomskih poremećaja na kapital i finansijski rezultat banke i na interne kapitalne zahteve. Stres test obuhvata različite vrste materijalno značajnih rizika i sprovodi se na različitim nivoima agregiranja, počev od nivoa pojedinačnih rizika do nivoa ukupnog portfelja banke.

Ukoliko banka ima nizak obim poslovanja onda ona može sprovoditi i jednostavnije tj. manje složene postupke stres testiranja, koje često nazivamo analizom osetljivosti. Analiza osetljivosti uključuje promenu ulaznih podataka ili parametara bez povezivanja tih promena s odnosnim događajima ili rezultatima u stvarnom svetu. Analiza osetljivosti treba takođe da uključi hipotetičke, ekstremne vrednosti kako bi se osiguralo obuhvatanje široke palete mogućih događaja.

Analiza scenarija razmatra uticaj nepovoljnih makroekonomskih kretanja i događaja na ključne parametre rizika i primenjuju je banke sa većim obimom poslovanja i složenosti. Vrlo bitno je da su scenariji orijentisani unapred, odnosno gledaju u budućnost (engl. forward looking scenarios), te da obuhvataju ekstremne, ali dovoljno moguće ishode. Scenariji nužno moraju biti i sveobuhvatni tj. uključivati sve materijalno značajne rizike banke.

Scenario i s njim povezani makroekonomski parametri se prevode u tzv. „stresirane parametre“ koji se zatim primenjuju kako bi se simulirala rizična izloženost banke. Kako bi se postigao navedeni cilj treba se koristiti kako kvantitativnim (bazirane na induktivnoj logici koja određene promene makroekonomskih varijabli, putem uspostavljanja matematičko-statističkih relacija zasnovanih na istorijskim podacima, prevodi u relevantne parametre portfolija banke), tako i kvalitativnim tehnikama (koje su bazirane na ekspertskim procenama stručnjaka banke, primarno stručnjaka iz oblasti upravljanje rizicima).

U okviru tržišnih rizika, stres test metodologija zasnovana je na kalkulaciji izloženosti bankarske knjige kamatnom riziku koristeći definisane pretpostavke raspoređivanja pozicija po vremenskim intervalima kao i pretpostavke o procenjenom modifikovanom trajanju. Interno definisane pretpostavljene promene u krivi prinosa množe se sa procenjenim modifikovanim trajanjem u cilju dobijanja pondera koji se primenjuju na netirane pozicije po vremenskim zonama.

Kod operativnih rizika, scenario analizom se procenjuju efekti istovremene promene većeg broja faktora rizika na kapital i finansijski rezultat banke u jasno utvrđenim (stresnim) okolnostima. Izbor scenarija se vrši uzimajući u obzir profil istorijskih gubitaka banke, profil budućih izloženosti banke, zabrinutost menadžmenta banke za određene oblasti, uticaj socio-ekonomskog i političko-ekonomskog okruženja. Fokus je na utvrđivanju potencijalnih tipičnih izloženosti, kao i najgorih mogućih (ekstremnih) uticaja tokom narednih nekoliko godina, za svaki izabrani scenario, uz uključivanje reputacionih posledica. Rezultat scenario analize ukazuje na potencijalnu izloženost regulatornog kapitala

management perspective, should include all three above presented methods, in order to strike a balance between the positive and negative sides of each of these methods. The scenario development has to be dynamic, adjusted to the current market changes and the portfolio changes, with the inevitable revision of the proposed scenarios in certain time periods (for instance, on the quarterly basis). The stress testing results have a twofold impact on risk management: firstly, as a source of information, and secondly, as a control mechanism used in the risk management process. As a source of information, stress tests are particularly significant in times of crisis, because it is stress testing that enables the consideration of taken risks, identification of the main factors causing stressful situations, contribution of these factors to the stress event and detection of hidden sources of risk. Having such information at their disposal enables the management to pass timely decisions that facilitate the reduction of risk exposures either through hedging transactions or through their lowered trading positions. On the other hand, stress testing results can be in the function of risk control within the existing structure of limits, and as part of the calculation of internal market risk for the purpose of capital allocation. Stress tests, through their results, impact the future allocation of resources and the behavior when it comes to facing risky situations.

The current stage in the development of the banking sector of Serbia obliges banks to conduct stress testing within the internal capital adequacy assessment process (hereafter to be referred as ICAAP). The responsibility for conducting stress tests rests on the management bodies in banks. The bank creates and conducts stress testing bearing in mind the impact of unexpected events on its risk profile, and on its profit and capital. The testing includes a large number of methodologies, with varying complexity ranging from simple to complex tests, with the aim of assessing the impact of macroeconomic disturbances on the bank's capital and financial result, and on its internal capital requirements. Stress testing encompasses various types of materially significant risks and is conducted on various aggregation levels, starting from the individual risk level to the

level of the bank's entire portfolio.

If a bank has a low volume of business, it can also conduct simpler, i.e. less complex stress testing procedures, which are often called sensitivity analyses. A sensitivity analysis includes the changes of input data or parameters without linking such changes to relevant real-life events or results. A sensitivity analysis should also include hypothetical, extreme values in order to ensure that a wide array of plausible events has been encompassed. A scenario analysis examines the impact of unfavorable macroeconomic trends and events on key risk parameters, and is implemented by banks with bigger volume of business and complexity. What is very important is for the scenarios to be forward looking, and to encompass exceptional, but sufficiently plausible outcomes. Moreover, the scenarios have to be comprehensive, including all materially significant bank risks.

The scenario and macroeconomic parameters related to it are translated into the so-called "stressed parameters" which are then implemented as to simulate the bank's risk exposure. In order to achieve the set goal, one should resort to both quantitative (based on inductive logic which, through the establishment of mathematical and statistical relations based on historical data, translates certain changes in macroeconomic variables into the relevant parameters of the bank's portfolio) and qualitative techniques (based on expert assessments of the banks' professionals, mostly professionals in the field of risk management).

When it comes to market risks, the stress testing methodology is based on the calculation of banking book's exposure to interest rate risk, by using the defined assumptions of distributing positions according to time intervals, and the assumptions of the assessed modified duration. Internally defined, assumed changes in the yield curve are multiplied by the assessed modified duration in order to get weights to be applied on net positions per time zones.

As for operational risks, the scenario analysis assesses the effects of simultaneous change of a large number of risk factors on the bank's capital and financial result, under the clearly defined (stressful) circumstances. The scenarios are selected taking into account the bank's profile of historical losses, the

banke neželjenim posledicama proisteklim iz operativnog rizika i kao takav se uzima u obzir pri proceni i održavanju internog kapitala na odgovarajućem nivou.

Specifični testovi otpornosti na stres imaju za cilj, u sklopu odabranih scenarija, procenu uticaja kombinacije promena različitih ulaznih varijabli i parametara na određenu komponentu bančinog troška rizika - kao što su: očekivani gubitak, kapitalni zahtevi vezani za regulatorni i interni kapital. Zajednički uticaji svih obavljenih ispitivanja otpornosti na stres se prvo razmatraju na nivou ICAAP radne grupe, zajedno sa ostalim učesnicima u procesu stres testiranja, a zatim na nivou Izvršnog odbora banke.

Zaključak

Svaka finansijska kriza, pa i ova poslednja - globalna ekonomska kriza, po mnogim poslenicima ekonomske struke i najdublja i sa dalekosežnim posledicama posvetske ekonomije, pokušava da nađe odgovore na pitanja koja su izbila u prvi plan tek sa eskalacijom same krize. Među brojnim pitanjima, jedno od najčešćih se odnosi na utvrđivanje uzroka ranjivosti finansijskog sistema i moguće prevencije u budućnosti od sličnih događaja. Samim tim čine se pokušaji da se neizvesnost i rizik kvantifikuju ukoliko je to moguće, a sam stepen rezistentnosti finansijskog sistema na neočekivane događaje u budućnosti poveća. U tom cilju jedna od najčešće pominjanih i korišćenih tehnika jeste tehnika stres testiranja. Iako su inicijalno primenjivani na nivou portfolija banke kako bi se utvrdio stepen volatilnosti u vrednosti portfolija banke na bazi značajnih promena faktora rizika, sadašnji pristup stres testiranju je mnogo širi i kompleksniji pa se danas o stres testovima najčešće govori u kontekstu metodologije kojom se meri osetljivosti grupe finansijskih institucija ili čak celokupnog finansijskog sistema na neočekivane (šokantne) događaje.

Okosnicu finansijskih sistema širom sveta čine banke, pa je sprovođenje stres testiranja u bankama suštinski „lakmus papir“ za ocenu ranjivosti globalnih finansijskih sistema. Kreiranje a zatim i sprovođenje stres testiranja nije nimalo jednostavan zadatak, naprotiv - mora biti prilagođen specifičnostima svakog finansijskog sistema pojedinačno i iz tog

razloga je teško uporediti stres testove u različitim sistemima, ali svakako doprinose formiranju jedne celovite slike o svim mogućim scenarijima i analizama koje ukazuju na stabilnost finansijskog sistema. Finansijske insitucije, kao deo prihvaćenih obaveza u okviru Bazelske regulative, sprovode regularne stres testove, tako da je u 21. veku stres testiranje postalo integralni deo svih politika i procedura u bankama, naročito prisutno u segmentu upravljanja rizicima. Na osnovu dobijenih rezultata Izvršni odbor banke je u situaciji da sagleda sve faktore rizike, sve moguće scenarije i krajnje efekte po kapital i dobit banke. Na taj način, putem stres test metodologije i njenih rezultata menadžment banaka raspolaže vrednim instrumentom u procesu donošenja strateških odluka.

Naravno da i stres testiranje sa svoje strane pokazuje mnoge nedostatke i zato jeste predmet mnogih kritika. Najčešće se ovoj tehnici kao nedostatak može pripisati tendencija da se, putem scenarija i analiza, predvide posledice u slučaju nastanka neočekivanog (ekstremnog) događaja, kao događaja koji se po svojim pojedinim karakteristikama nikada nije pojavio u tom obliku do posmatranog trenutka. Sama ta činjenica i pretpostavka sve ekonometriste i ekonomiste čini „slepim“, jer iako se trudimo da učimo iz grešaka u prošlosti i istorijskih događaja, moramo se zapitati u kojoj meri nam učenje iz prošlosti može pomoći da predvidimo buduće događaje. Drugim rečima, da li zaista skup neočekivanih prošlih događaja može biti relevantna osnova za predikciju budućih događaja koji po svojim posledicama mogu prevazići sve dosadašnje krize? Polazeći od pomenutog stava, možemo zaključiti da stres testiranje jeste korisna i opšteprihvaćena metodologija u finansijskim sistemima širom sveta, ali je istovremeno i metodologija koja sve nas poslenike ekonomske struke upozorava i opominje da neizvesnost i rizik nije moguće uvek i egzaktno kvantifikovati, te su učinjene pretpostavke modela vrlo verovatno zasnovane na našim ubeđenjima da želimo da predvidimo samo ono što dovoljno znamo, pa makar i na bazi istorijskih podataka koje tretiramo kao reprezentativnu seriju podataka za projektovanje budućih događaja.

bank's profile of future exposures, the bank management's concern for certain fields, the impact of the socio-economic and political-economic environment. The focus is placed on determining potential typical exposures and the worst possible (extreme) impacts over the several years to come, for each of the selected scenarios, including reputational consequences. The result of the scenario analysis indicates the potential exposure of the bank's regulatory capital to unwanted circumstances arising from operational risks, and, as such, it is taken into consideration when assessing and maintaining internal capital at the appropriate level.

Specific stress resilience tests have the objective to assess, within the selected scenarios, the impact of the combined changes of various input variables and parameters on a certain component of the bank's risk related cost - such as: expected loss, capital requirements related to regulatory and internal capital. The joint impacts of all conducted examinations of stress resilience are first considered at the ICAAP working group level, together with other participants in the stress testing process, and then at the level of the bank's Executive Board.

Conclusion

Each financial crisis, including the latest global economic crisis - according to many practitioners of the economic profession, the deepest one with far-reaching consequences for global economies - is trying to find the answers to the issues which rose to the centre of attention with the escalation of the crisis itself. Among the numerous questions, one of the most frequent ones refers to determining the cause of the financial system's vulnerability, and defining potential preventive actions in the future in order to avoid similar events. To this end, there have been attempts to quantify, if possible, uncertainty and risk, and to increase the level of the financial system's resilience to unexpected events in the future. One of the techniques most frequently mentioned and used for this purpose is the stress testing technique. Although stress tests were initially implemented at the bank's portfolio level to determine the volatility in the bank's portfolio values based on substantial

changes of risk factors, today's approach to stress testing is much wider and more complex, hence today we most often talk about stress tests in the context of methodology for measuring the sensitivity of a group of financial institutions or even of the entire financial system to exceptional events (shocks).

Banks are the core of financial systems worldwide, which is why the implementation of stress testing in banks serves as the essential indicator in the process of assessing vulnerability of the global financial systems. Creation and then the implementation of stress tests is not at all a simple task, on the contrary - it has to be adjusted to the specificities of each financial system individually, which makes it difficult to compare stress tests in different systems. Nevertheless, this certainly contributes to the formation of a complete picture including all possible scenarios and analyses, indicating the versatility of risk factors and their impact on the financial system's stability. Financial institutions, as part of the accepted obligations imposed by the Basle regulations, conduct regular stress tests, so that in the 21st century stress testing has become an integral part of all bank policies and procedures, especially present in the risk management segment. Based on the obtained results, the bank's Executive Board is in the position to view all risk factors, all possible scenarios and ultimate effects on the bank's capital and profit. This way, thanks to stress testing methodology and its results, the bank's management can avail itself of a valuable instrument in the process of strategic decision-making.

Naturally, stress testing on its part also shows many drawbacks, which has made it the subject of abundant criticism. What can most often be ascribed to this technique as its weakness is the tendency to predict, through scenarios and analyses, the consequences in case of an exceptional (extreme) event, as the event which has, with its specific characteristics, never occurred in that form until the observed moment. This very fact and assumption is what "blinds" all econometricians and economists alike, because even though we are trying to learn from our past mistakes and historical events, we have to wonder to which extent learning from the past can actually help us

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predict the future events. In other words, can a set of unexpected past events serve as the relevant basis for the prediction of future events whose consequences can potentially surpass all the crises so far? Starting from the above standpoint, we can conclude that stress testing is a useful and generally accepted methodology in the financial systems worldwide, but at the same time the methodology which warns all of

us, practitioners of the economic profession, that uncertainty and risks are not always possible to quantify in exact terms, and that the derived assumptions of this model are, in all likelihood, based on our convictions that we want to predict only what we are sufficiently familiar with, even if only on the basis of historical data treated as a representative series of data for projecting future events.