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Stress Testing of the Montenegrin Banking System with Aggregated and Bank-Specific Data[1]

Abstract: There are many different approaches to the process of stress testing and two of them will be investigated in this paper. The first one is a stress test performed on aggregated data i.e. the banking system as a whole. The variable of interest in both exercises is the Loan Loss Provision ratio (hereinafter: the LLP). The main goal of the thesis is to find an answer to the following question: what are the macroeconomic variables that influence LLP the most and how will LLP, as a variable of interest, behave in a situation when all these variables were to experience negative performance at the same time? The resilience of the banking system to such scenario will be tested through the capital adequacy ratio. In order to find out more about the management practices of banks, microlevel data on banks were also used in the analysis. The focus was to see which of the variables are able to explain the LLP ratio for each bank individually and how is this information helpful for possible improvements in the banking sector. The relations between these variables will be able to explain some of the banks' losses and some of the banks' practices regarding credit activities. The analysis there will provide for some recommendations for the banks but also for the Central Bank and its way to influence the practices in the banking sector.

Keywords: stress testing, loan loss provisions, estimation, credit risk

JEL classification: E50, E58, C12 C13, C32, C33

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Introduction

Real economy and financial sector are closely related. On one hand, financial stability, which is a necessary condition for a successful banking system, plays a crucial role in providing an efficient allocation of funds and in fostering economic growth. Similarly, macroeconomic environment affects the stability of the banking sector. The effect of macroeconomic changes on the banking sector will be addressed through the majority of the thesis while the opposite relation will also be examined in the last part, mainly through the impulse response functions.

The consequences of the most recent crisis are still being felt, specifically in Europe where the crisis had a profound influence through the sovereign debt crisis. In Montenegro, the effects of the crisis came with a delay. Even so, the crisis hit the Montenegrin economy hard and major changes in the entire economy were necessary. Recently, the institutions took some actions in order to ensure better coping with the crisis. The Central Bank of Montenegro limited the cap lending interest rate, while the Government increased Value Added Tax to increase the Government revenues. However, the banking system was in bad shape since after a credit boom which was present during 2008, the credit crunch took place in light of the crisis. Many banks received capital injections from their parent banks and this was crucial for such a small economy such as Montenegro.

When the events of pronounced negative performance and low probability are concerned, it is of crucial importance to be aware that they can happen at any given time. If this is the case, there are not so many extreme and surprising events that couldn't be handled. In order to be aware of possible negative shocks, the European Central Bank (hereinafter: the ECB) and other institutions have prescribed a set of regulatory frameworks and practices that each of the EU countries (but also the candidate and acceding ones) should perform on regular basis. One of these practices is stress testing. Banks are obliged to do it by themselves and the ECB performed EU-wide stress test several times. Central banks are also advised to perform stress tests regularly since they possess the majority of the necessary data. In Montenegro, stress tests have been done by the Central Bank on a quarterly basis for over three years.

1. Theoretical framework

In the aftermath of the recent global financial crises, it has become obvious what could be direct costs and possible indirect effects of such extreme negative economic performance. Even though direct costs are undoubtedly high, the indirect

ones may be more dramatic and longlasting. In order for people responsible for proper functioning of the financial system to be able to address the issues in the most suitable way, they must be aware of vulnerabilities of the financial system as a whole. Stress testing (or more precisely, macroeconomic stress testing) can help this cause since it is defined as a quantitative tool used by banking supervisors and central banks in order to assess the soundness of the financial systems in the event of extreme but plausible shocks.

Stress testing techniques are not as new as they may seem. They have been applied since the early 1990s. However, at the time, they were used only by large and internationally owned banks which, because of the nature of their risks, only thee few ones were able to understand the usefulness of stress tests. They were used as a complementary analysis of risk management models such as the value-at-risk technique. In contrast to the value-at-risk which gives information only about the level of negative performance, stress tests provided more useful information since they are able to actually explain these extreme events as opposed to merely identifying them. Since 1996, banks and investment firms have been required to perform some kind of stress tests as a part of the internal model related to the calculation of capital requirements. However, through many years these practices have become more and more frequent and now form a part of the obligatory regulatory tests (Quagliarello, 2009, p. 19).

1.1. The effect of the financial crisis on the financial system

As it was shown with the subprime mortgage crisis, the financial system is likely to be the one mostly affected by the crisis given that it is vulnerable and likely to cause contagion and consequently systemic crises. This is exactly why stress tests are usually performed in, or on financial institutions, mostly banks. Before actually performing stress, test it is important to detect the appropriate linkage between the shock related to the (macroeconomic) environment and the financial system. When this relation is established, some meaningful results are to be expected in the form of ability of the system to absorb shocks and resolve them (Quagliarello, 2009, p. 18).

Nowadays, stress tests are more used exactly for the purpose of assessing financial stability at the macroeconomic level. The International Monetary Fund (hereinafter: the IMF) and the World Bank have been using stress tests increasingly. For many authorities the practice of stress testing was introduced as a part of **Financial Sector Assessment Programs** (hereinafter: FSAPs) conducted by the IMF and World Bank. FSAP stress tests stimulated widespread research in-

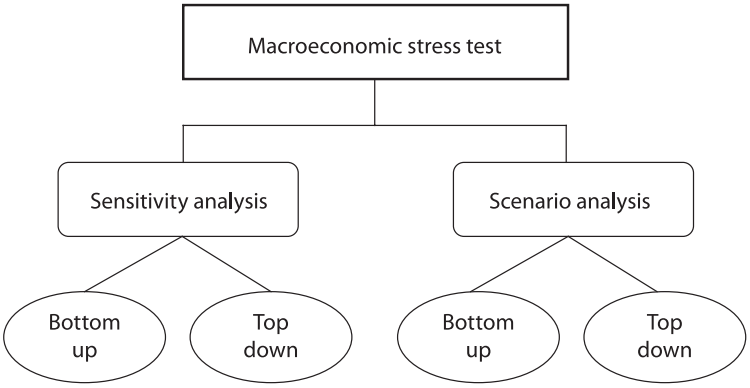
terest in developing new techniques whereas many additional studies are under way. Moreover, in some countries, econometric macroeconomic models have been developed in order to ease this kind of analysis. Basel II and III are forms of recommendations regarding banking laws and practices and contain, inter alia, recommendations for performing stress tests frequently. In euro area, almost every country has done stress tests regularly in order to check for the robustness of its financial system. According to Čihák (2004, p. 22), more often stress tests brought some benefits for the authorities such as more accurate and detailed data that can subsequently be analyzed even more regularly in the future.

1.2. Stress tests

There are different types of stress tests and consequently various definitions. According to the IMF and from the macroeconomic point of view, stress testing is defined as a key element of the macro prudential analysis that can help in monitoring and anticipating potential vulnerabilities in the financial system. Macroeconomic stress test (the one which will be the first performed and analyzed in the paper) is defined as a way of measuring the risk exposure of a relevant set of institutions to stress events. However, stress test is not a single exercise. It actually comprises of various techniques with a goal to identify a range of extreme but plausible events and the response of the banking sector. Hence, the main outcome of the portfolio is an estimate of a change in the value of a portfolio, where portfolio can be considered as, for instance, the balance sheet or income statement of a particular bank or even more frequently used – the **capital adequacy ratio**. Still, it is useful to be aware of the fact that they are not always accurate and in many ways they rely on the judgment of the researcher. Stress test cannot, therefore, be considered a precise tool; it is more of an art, where all of the three ingredients such as quantitative techniques, human judgment and several discretionary assumptions have to be taken into account (Quagliarello, 2009, p. 23).

As shown in Figure 1, when the choice of the negative impact (one factor or more) is done, stress test of the whole system can be done in two ways. The first option is called bottom-up approach and is done in a way that authorities define the macroeconomic shock and let the institutions evaluate the impact on their balance sheet. Then all the results are aggregated in order for researcher to be able to inspect the overall impact on the system as a whole. The other approach is called top-down and it is done in the opposite way, namely the authorities themselves apply the shock either to the aggregated banking system portfolio or on the bank-by-bank data.

Figure 1: Types of stress tests



Source: M. Quagliarello, Stress testing the banking system, 2009, p. 23.

As it can be supposed, bottom up approaches are more detailed and done according to the specificities of the particular institution. Hence, this is one of their advantages. However, this advantage immediately becomes a disadvantage of this approach since the comparability of these results is very limited, if possible at all. On the other hand, in the top down approach the data that the central institution has are not as rich and detailed as those of each institution individually, but are therefore very easy to compare and to interpret their results. There is a clear distinction between those which are highly understandable and those more complex and realistic ones (Quagliarello, 2009, p. 25).

1.2.1. Ingredients of the stress tests

When it comes to the ingredients of the stress tests and the definition of its parameters it is important to determine what the primary goal of the stress test is. Also, in order to perform stress tests in a meaningful and useful manner, it is important to explore the economy and financial system of a country or institutions in which a stress test is performed. Even though the best way is to include all relevant **financial intermediaries**, banks are mostly the ones which are subject to the tests. However, if a stress test is done in those countries where non-bank intermediaries are more important and account for a significant or bigger portion of the financial system, they should also be included. Still, in most cases, banks are the ones included in the exercise as these are usually the most important part of the financial system through which the majority of the payment system is done and through which the contagion is likely to happen.

1.2.2. Identifying the proper risks

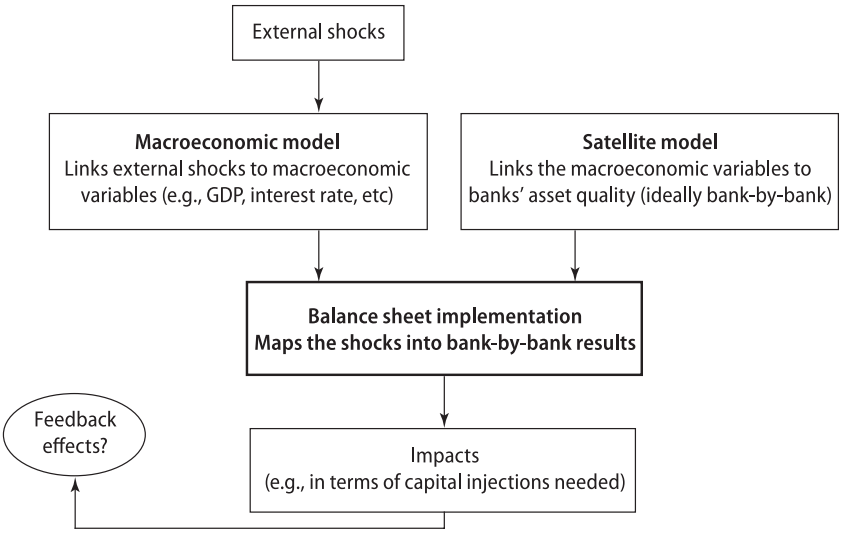
The next important step in this procedure is to identify the **proper risks** of a specific institution on which the stress test is done. Along with the selection of intermediaries, this step is of huge importance, since this is how the tailoring according to a given country or bank can be done, precisely by analyzing its weaknesses and possible cause-effect relations. This way the whole process becomes more realistic and effective and the results become more useful. Making the right decisions regarding the choice of risk types is also of huge importance. Furthermore, what has to be done is **shock calibration** i.e. defining the events which will trigger the shock and the level to which these shocks are to be materialized in the form of specific stress scenario. In this step, it is important to be aware of the fact that these events should be extreme but still plausible. However, they should always be strong enough to produce turbulence (or a stress). There are several ways in which the shock is to be determined; among them are historical events, worst-case scenarios, threshold approach etc. Once the estimation of results is done, another factor that should be considered is **feedback effects**. The fact is that the shock can usually cause other processes to affect the model and other variables of interest and these should also be analyzed in order to form a complete picture of the stress performed. Feedback effects can provide insight into the reaction of macroeconomy to an increase in financial fragility and it is usually done through the Vector Auto Regression. In the case of the stress tests by Hoggarth et al. (2005, pp. 3-7) UK banks' aggregate write-offs, particularly the ones related to the corporate portfolio, are found to be sensitive to an adverse macroeconomic scenario, while household write-offs are found to be more sensitive to changes in income gearing (Quagliarello, 2009, p. 28).

1.2.3. Stress testing as a multi-step process

The stress test has several steps and all are extremely important for the quality and credibility of the results. The steps and models mentioned in Foglia (2009, p. 11) are used in the empirical part of the thesis regarding the stress test performed on the aggregate data. They are also presented graphically in Figure 2. First, the macroeconomic model is to be considered as a coherent stress test scenario. Next, given that this kind of macroeconometric model doesn't include the financial sector variables, there is a necessity to include the so-called satellite model which is used to map macroeconomic variables to some financial variables. Further, there is a need to map the values provided this way to some measures of bank assets quality or potential losses. This type of stress testing by formulating macroeconometric model whose variables have been forecasted into stressed values

and then linking this stressed model to the satellite model (the one containing variables related to the financial sector) has already been used many times.

Figure 2: Stress testing - a multi-step process



Source: M. Čihák, Introduction to applied stress testing, 2007, p. 8.

For example, the Dutch central bank has done a similar analysis by performing stress tests using deviations of the macro variable from the baseline scenario (i.e. output of the macroeconomic model) as input in the credit-risk model. The French Banking Commission and the Bank of France performed similar form of stress tests where the outputs of the macro model (stressed GDP, short-term and long-term interest rates) done with the new version of the macro-econometric forecasting model are the input of the credit-risk model (Foglia, 2009, p. 30).

1.2.4. The design of the macroeconomic stress scenario

The macroeconometric model can usually be done in three ways: as a structural econometric model, the vector autoregressive method (hereinafter: VAR), and a pure statistical approach. Many of these macroeconomic models are done in parallel with existing econometric model used by central banks and other authorities for forecasting and policy analysis in order to get the level of key macroeconomic variables under assumed stressed conditions. The VAR model is flexible and has

a simple way of producing a set of mutually consistent shocks although they don't incorporate the economic structure like in the macro modeling approach. These models were also used in many stress tests performed by central banks such as: the Bank of England, the Bank of Japan, the Bank of Spain and the European Central bank (Foglia, 2009, p. 14).

Both the structural and VAR approaches need a way to map econometric variables into indicators that can then be further used to estimate the implications of the stress on banks (balance sheet, losses, capital adequacy ratio or something else). In this kind of model, loan performance measures are used to link these two models, usually the non-performing loans (hereinafter: NPL) ratio. The assumption behind this practice is that loan quality is sensitive to economic cycles. Unlike macroeconometric model, the credit risk satellite model can be estimated on the individual banks' data and even on the individual borrowers' data. For example, Čihák (2007, p. 49) differentiates between two groups of satellite models: one is based on loan performance data and the other is based on micro-level data like default risk of the household and corporate sectors.

1.3. Stress testing in the EU

One of the responsibilities of the European Banking Authority (hereinafter: the EBA) is to ensure the proper functioning and integrity of financial markets as well as the stability of the financial system in the EU. It is a part of the European System of Financial Supervision whose primary goal is to rebuild trust in the financial sector.

Regarding this goal, the EBA has a responsibility to monitor and recognize market developments but also to identify trends, potential risks and vulnerabilities. One of its most important tools with which it aims at reaching this goal is a **EU-wide stress test exercise**. This exercise is done in cooperation with the European Systemic Risk Board (hereinafter: the ESRB). The resilience of the financial system is being tested against an adverse macroeconomic scenario. These stress tests are performed in bottom-up manner using methodologies, scenario and assumptions developed through the work with the European Central Bank and the European Commission (the EBA, 2011a, p. 2).

The 2011 EU-wide stress tests contains an unprecedented level of transparency regarding banks' exposures and capital positions, so that investors, analysts and other market participants can develop a proper and informed view of the resilience of the EU banking sector. Also, the results of stress tests for all individual

banks are published on the EBA's website. Other important requirements are also available such as: database of structure, database of results, summary report, the necessary tools etc. This majority of the available data and methodology can motivate other practitioners to perform stress tests as well. If they decide to do so, they have appropriate information and methodology available and are able to provide some new relevant insights into this topic (the EBA, 2011b, p. 3).

2. Empirical analysis based on aggregated data

In the empirical part of the paper, two stress test models are estimated. The first one is presented in this chapter and it is based on aggregate data of the whole banking sector. The results are analyzed through a change in the CAR. The second model presented in the fourth chapter is based on bank-specific data for 10 Montenegrin banks. In both chapters, first the methodology in use will be explained and followed by the estimation results.

Primary goal of this exercise is to see how resilient is the Montenegrin banking system and availability of the application of the stress testing process in Montenegro. Aggregate data of the whole banking sector and its variables of interest are all available on the website of the Central Bank of Montenegro. This chapter is organized in the following way: first, the construction of the macroeconomic model will be presented. This model is transformed into a necessary adverse scenario through the forecasting technique. The values of this forecast are then further used as input for the satellite model where the variable of interest (in this case, loan loss provision) is matched to these stressed macroeconomic conditions. The results of the stress tests are communicated in the form of the stressed LLP ratio but also in the form of stressed CAR.

Since LLP was used as a measure of loan quality and as the dependent variable in both models, some insights regarding loan loss provisioning practices are provided after which the methodology and the results will be explained.

2.1. The link between LLP and bank failure

Ng and Roychowdhury (2010, pp. 2-20) tried to detect the link between banks' loan loss reserve decisions in 2007 (i.e. in the period before the crisis) and the risk of the failure of banks during 2008-2009 economic crises. Their aim is to question the soundness of recent regulator proposals and their effectiveness. Specifically, the authors wanted to verify the fact that regulatory capital guideline can gener-

ate dysfunctional outcomes. They believe that this is so because under current guidelines banks are allowed to add their loan loss reserves to Tier 3 regulatory capital, up to a maximum of 1.25% of a bank's gross risk-weighted assets. Given that regulatory capital adequacy is a key metric in judging a bank's solvency, banks can be motivated to account more loan loss reserves and seemingly provide a better quality of capital or higher regulatory capital. This illusion of better financial health can then lead to avoiding taking prudent actions like restricting risky lending, improving collection efficiency etc. Consequently, increases in loan loss reserves can be a sign of more severe cash flow losses in the future. Banks with similar practices are more likely to fail and this statement is known as the „troubled bank" hypothesis (Dechow, 1994). Other literature proves the opposite. Namely, banks can report large loan loss provisions and so increase their loan loss reserves exactly during the time when they are financially strong and can expect better performance in the future. This hypothesis is known as the „signal of strength" hypothesis.

However, Ng and Roychowdhury (2010, p. 1) suppose that there is much more complex relationship between loan loss reserves and banks' failure. After examining several components, the authors conclude that bank failure is positively associated with loan loss provisions while it is negatively correlated with loan charge-offs. They discover even more severe conclusions such as the one saying that loan loss reserve increases are not only associated with greater failure risk, but that they also contribute to more severe bank failures.

2.2. Loan loss provisioning practices

Determining an appropriate level of the reserves for loan losses depends on the appropriate balance between the protection of the safety and soundness of the bank on one side and emphasizing the transparency of financial statements on the other side. Highly important fact is that loan loss provisions have a significant effect on earnings and regulatory capital. There is a possibility that managers will use their discretionary right and try to smooth their income with loan loss provisions. In order to prevent this Financial Accounting Standards Board (hereinafter: FASB) has established guidelines stating that banks may increase their loan loss reserves only when it becomes highly probable that a loss is imminent and if the amount of loss can be estimated. However, despite this potential misuse of loan loss reserves, prudential considerations suggest that higher reserves enable the bank to absorb greater unexpected losses. Therefore, more forward-looking approach to loan loss provisions is desirable given the fact that in the times of high economic growth there is more risk-taking in lending and more potentially

bad loans which will be revealed after the growth stops. These accounting guidelines could make loan loss reserves more pro-cyclical (or forward-looking) since demanding higher reserve is much more realistic when the economic situation is stable (Balla, Rose, & Romero, 2012, p. 2).

According to Angklomkliew, George and Packer (2009, p. 69), loan loss provisions have been backward looking and highly procyclical. In response to the latest crisis, it has become usual to perform more forward-looking practice which would provide banks entering the crisis and characterized with credit deterioration to have higher level of reserves. In that way, they can be more prepared for negative consequences of the economic downturn. This is evident when looking at the provision practices in Asia during the period following the Asian financial crisis. Because there were great loans remaining from the crisis, most jurisdictions adopted prudent policies with higher provisions during times of economic and credit growth. It is, however, important to know that the provisioning practice is only as good as the methodology used to estimate losses in a given portfolio. If the latter is not good, this can distort the bank's balance sheet and overestimate the capital adequacy ratio.

Leaven and Majnoni (2002, p. 1) were interested to see what the most usual loan loss provisioning practices are and what role they can play in the overall minimum capital regulatory framework. They found out that in many cases banks delayed provisioning for bad loans until it was too late, i.e. when the crisis has already started. Additionally, they found out that different patterns of loan loss provisioning are present in different geographical areas. They also differ among the group of industrialized countries as well as among the emerging economies. Further, they find that larger and timelier provisions are associated with more economically developed economies.

2.3. Methodology and data

In the first part of the stress test, the macroeconomic model is estimated and forecasted in order to obtain the adverse macroeconomic scenario. Five variables that proved relevant and provide explanatory power for the situation in the Montenegrin economy are included in the model. Afterwards, this macroeconomic scenario is linked to the loan performance variable. The only variable associated with loan performance that was available was LLP.

2.4. Adverse macroeconomic scenario

In order to construct a shock which will further be mapped to the banking sector, the scenario analysis was performed, i.e. various macroeconomic variables exhibit negative forecasted levels and together form a stressed scenario. These five variables simultaneously perform a shock on the Montenegrin economy.

Generally, the most commonly used macroeconomic variables in stress tests are: GDP growth, unemployment and a short term interest rate, but also export growth, domestic consumption, a stock exchange index, and the interest rate spread or a long term interest rate. In this stress test, as a proxy of the GDP growth i.e. the overall growth of the economy, the only variable available was industrial production. Given that it is already heavily used in research analysis IP was chosen to enter the model. However, since Montenegro relies heavily on tourism, the assumption was that without inclusion of tourism in the macroeconomic scenario, the overall economic growth would not be estimated as well as it should be. With the inclusion of variable related to tourism, two variables of great influence on the general economic activity are included in the model. These two variables account for the major part of the percentage change in GDP. Unemployment, as a necessary variable of interest in constructing any type of macroeconomic analysis, is also included in this analysis. As far as the cost of lending is concerned, the weighted average lending interest rate is used. Another variable included is the Consumer Price Index (hereinafter: the CPI). Since data on the CPI are provided as the change relative to the value of the same month last year this variable becomes a measure of inflation. The idea is that with these five variables all the important changes in the Montenegrin economy are taken into account.

2.5. Variables

The variables used throughout the whole model along with the detailed description of the data and the assumptions of correlation are the following:

- **Loan loss provisions** (in the analysis denoted as LLP): monthly data are used for all variables on the aggregate level of the whole banking sector. The variable is in the form of the ratio i.e. the percentage of total loans. The length of the series is 81 observations, from M9 2006 until M11 2012 and it is the same for all variables. It is used in the satellite model as the only endogenous variable.

- **Industrial production** (in the analysis denoted as IP): monthly data are used in the form of index change on the yearly basis. This variable along with the following one is used as a proxy for economic performance of Montenegro. The variable is assumed to be negatively correlated with loan loss provisions ratio meaning that the lower GDP, the higher LLP ratio (the banks need to make more provisions in order to account for the increasing non-performing loans).
- **Tourism** (denoted as TOUR): measured with number of tourist overnights in Montenegro. Negative correlation is assumed since tourism in the model is seen as the proxy for the major part of the Montenegrin economic activity.
- **Unemployment rate** (denoted as UNR): The positive correlation is assumed indicating that more people out of work indicate more non-performing loans and therefore more loan loss provisions.
- **Consumer Price Index** (denoted as CPI): This variable is assumed to be positively correlated with loan loss provision since more costly items would imply that loans are more likely to become non-performing causing higher loan loss provisions.
- **Weighted average lending interest rate** (denoted as IR): Positive correlation is assumed since the higher the interest rate the higher cost of loans which leads to lower level of high quality loans. Then LLP ratio needs to be increased in order to account for the low quality loans now in use.

2.6. Macroeconomic model

In order to perform multivariate shock scenario or adverse macroeconomic scenario, vector autoregressive model (VAR) is used in the following form:

$$macro_t = A_1 macro_{t-1} + ... + A_p\, macro_{t-p} + CD_t + u_t, \quad (1)$$

where $macro_t$ = (IP, TOUR, UNR, CPI, IR)' is a vector of endogenous macroeconomic variables. D_t is the deterministic part of the equation which may be comprised of the constant, linear trend, seasonal dummies, and impulse dummies if necessary and u_t is unobservable zero mean white noise. A and C are parameter matrices. The model is estimated with vector autoregressive model up to the 11th month of 2012. When the model is properly estimated and the correlations between the macroeconomic variables are established, they are used in the forecast of the macro model. The coefficients surpassing the significance of the threshold of 2.00 are presented in the model. This forecast is done recursively as:

$$macro_{t+1|t} = A_1 macro_t + ... + A_p macro_{t+1-p} + CD_{t+1} \quad (2)$$

$$macro_{t+1|t} = A_1 (a_1 macro_{t-1} + ... + a_p macro_{t-p} + cd_t + e_t) + ... + A_p macro_{t+1-p} + CD_{t+1} \quad (3)$$

$$macro_{t+2|t} = A_1 macro_{t+1|t} + ... + A_p macro_{t+2-p} + CD_{t+2} \quad (4)$$

These forecasts are done for 12 months ahead, which means that one year forecasted stressed values will enter the model with LLP ratio i.e. the satellite model. In order to satisfy the condition of the extreme but plausible events 95 % confidence interval is used but either lower or upper bound, depending on the type of the variable (as said, for GDP the lower bound is the stressed forecasted value while for the interest rate it is the upper bound).

Assuming that the disturbance factor u_t is normally distributed, confidence interval in the case of one variable, e.g. IP, for one period ahead forecast can be written as:

$$\left[IP_{t+1|t} - C_{1-\frac{\gamma}{2}}\sigma_{IP}, IP_{t+1|t} + C_{1-\frac{\gamma}{2}}\sigma_{IP}\right] \quad (5)$$

where $C_{1-\frac{\gamma}{2}}$ is the $\left(1 - \frac{\gamma}{2}\right)100$ percentage point of the standard normal distribution and σ_{IP} is the standard deviation of IP. Since the IP is assumed to be negatively correlated with LLP, values of the lower bound of 95% confidence interval are used in further analysis, specifically in the satellite model.

2.7. Satellite model

The output we got from the forecast of the macroeconomic model is an input for the model linking the LLP ratio (our variable of interest) with the economic situation in Montenegro. This is done with autoregressive distributed lag model (ARDL) where values of macroeconomic forecast enter the equation as exogenous variables and LLP ratio is the endogenous dependent autoregressive variable. The equation is the following:

$$LLP_t = A_1 LLP_{t-1} + ... + A_p LLP_{t-p} + B_0 macro_t + ... + B_q macro_q + CD_t + u_t \quad (6)$$

where $macro_t$ is the vector of exogenous macroeconomic variables, D_t is the deterministic part of the equation which may be comprised of a constant, linear trend, seasonal dummies and impulse dummies and u_t is the unobservable zero mean white noise process. As in the previous model, the significance threshold is set at 2.00. The already obtained values of the coefficients of adverse macroeconomic

scenarios are added to the satellite model to forecast future LLP ratios under these scenarios.

2.8. Model adequacy

The Dickey Fuller statistics tests the null hypothesis of the presence of the unit root. When values of the DF statistics are smaller than critical values, the null hypothesis of the presence of unit root is rejected. KPSS test the null hypothesis of stationarity so when the statistics is higher than the critical value the null hypothesis of stationarity is not rejected and thus the data are stationary. There was no specific necessary transformation of the time series since the unit root presence was rejected, in most of the cases, with both tests.

Stationarity of the variables is confirmed with both tests for all the variables except for LLP.

Futher, the only variable that is transformed is Tourism which measures the number of tourist overnights in Montenegro on a monthly basis. Since this variable showed one negative forecasted value which logically does not make sense, it is transformed with first difference. This way, what we observe is the monthly change in the number of nights tourists have spent in Montenegro.

2.9. The estimation results

The VAR macroeconomic model was estimated with 6 lags. Since the data are on monthly basis, this lag order is the expected one. The variables included are: tourism_d1 (first difference of tourism), industrial production, unemployment, CPI and interest rate. Since the model exhibited non-normality additional impulse dummy were introduced, for the data of third month of 2010 where the residuals exhibited more than 3 standard deviation differences. Another deterministic part of the equation is broken trend included in order to account for the decreasing trend of interest rate. After including this deterministic part, the forecasts of this variable become more realistic i.e. they are not biased toward smaller values. Along with the trend and intercept, seasonal dummies are also included in the model because of the variable Tourism which is extremely seasonal.

2.9.1. The macroeconomic forecast

When the model is estimated and checked for auto-correlation or non-normality, the forecast is done on 95% confidence interval. Extreme but plausible forecast values are presented in the table below where for each variables either upper or lower value of the CI is accordingly chosen.

Table 1: Adverse macroeconomic scenario

Time	Industrial production	Tourism_d1	Unemployment	CPI	Interest rate
2012 M12	-18.801	-747.5	0.156	7.093	9.7342
2013 M1	-24.739	-42261.8	0.159	8.060	9.6225
2013 M2	-28.453	-51489.6	0.160	9.773	9.7241
2013 M3	-22.226	-9769.5	0.161	9.127	9.8497
2013 M4	-25.471	-20600.5	0.157	9.266	9.9242
2013 M5	-48.182	-1833.7	0.152	9.862	9.8253
2013 M6	-43.562	2979.9	0.146	10.426	9.8568
2013 M7	-24.259	148895.1	0.140	10.772	9.9674
2013 M8	-30.468	37554.2	0.140	10.702	9.9648
2013 M9	-32.902	-285499.1	0.142	10.678	9.9440
2013 M10	-29.979	-185144.1	0.147	11.156	9.9355
2013 M11	-23.408	-61615.3	0.149	11.117	9.9566

As it can be seen, the model predicts a decline in IP of 48% which is to be expected since the fluctuation of the IP index is large over the sample period. However, this is the lower bound of CI. Regarding tourism, the largest change in the number of tourist nights spent in Montenegro is in the 7th month of 2013 when the season is at its peak. Unemployment, which has been experiencing a declining trend since 2006 doesn't increase as much since the highest rate is in March of 2013 and is 16.05%, only 1% change. CPI increases up to the 11.12% change, which is higher than in the values experienced so far.Interest rate, since it doesn't experience too much fluctuations recently, increases only for 0,5 percentage points and this negatively affects potential loans. Seasonality is present in the forecasted fluctuations of the variables, especially in tourism and industrial production where there are many factors influencing this kind of economic performance. Those factors are numerous and usual, for example extremely bad weather conditions in winter or extremely good (or bad) tourist season during the summer. Moreover, these factors can then influence other ones (CPI, interest rate and unemployment) which then exhibit seasonality themselves.

2.9.2. Satellite model

Satellite model is estimated in the next step. It has LLP as the only one endogenous variable. The intercept, seasonal dummies and trend were all included in the model. This model is estimated with 5 exogenous lags and 10 endogenous lags which was the suggestion of all three information criteria: Akaike, Hannan-Quinn and Schwartz.

Broken trend and impulse dummies were again included to account for the same deviation. However, the model doesn't exhibit autocorrelation and non-normality. Non-normality was tested also by plotting the standardized residuals. Some of the specification tests used in estimation of the model are presented in the table below.

Table 2: Specification tests of the model

Test	P-value
LM test for autocorrelation with 2 lags	0.8608
Jacque-Bera test for non-normality of the residuals	
U1	0.9347

When the model is correctly specified, the estimation of the model can be done. The significant coefficients of this model are presented in the table below.

LLP is expected to be negatively correlated with tourism and industrial production and, despite the small values of the coefficients in the first three lags, it is indeed negatively correlated. However, unemployment exhibits both positive and negative coefficients, all significant at 1% significance level. As far as the CPI is concerned, there are more lags in which there is positive correlation then negative and the assumption was that with the increase in CPI there will be an increase in the LLP ratio also. Interest rate is supposed to be positively correlated and indeed in the last two lags it is positively correlated which may imply that there has to pass some time in order for borrowers to start backing up from loans. Additionally, banks are able to identify the negative selection happening only with a lag.

Table 3: The restricted satellite model with LLP as the endogenous and macroeconomic variables as the exogenous variables

Lag	LLP	Industrial production	Tourism	Unemployment	CPI	Interest rate
T		-0.0001***			-0.002***	0.013**
t-1	0.916***					-0.015***
t-2	-0.234***	0.002***	-0.0001***	-0.438***	0.001***	-0.045***
t-3			-0.0002***	0.605***		-0.012**
t-4	0.209***			-0.622***	-0.001***	0.012***
t-5				0.326***	0.002***	
t-6						
t-7						
t-8						
t-9						
t-10	0.317***					

Note: * indicates 10% significance level,
** 5% significance level and
*** 1% significance level.

These correlations were then used to perform a forecast of LLP ratio under stressed values of macroeconomic conditions presented in Table 4. However, these values of LLP were forecasted for 1 year ahead since LLP depends up to five lags on macroeconomic variables. This way, LLP variable is affected by macroeconomic stress with at least a half year window. The forecasted values of LLP with lower and higher bound of CI are presented in the table below as well as in the Figure 3.

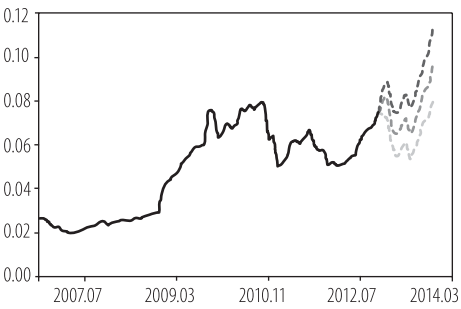
This is 95% CI and we can see that the change in LLP ratio in the 11th month of 2012 (the actual level before the forecast) and the last forecasted value in 11th month of 2013 is around 2.3%. Since the actual level of LLP ratio was 7.45 % the forecasted has increased to 9.84% which is a significant change since the fluctuations in LLP are not usually as large. It is the assumption of the model that negative i.e. adverse macroeconomic scenario implemented in this VAR model resulted in the worse loan quality. The measure of loan quality is, in this case, LLP ratio. Banks are supposed to put aside more provisions for loan losses when the economy is performing negatively.

Table 4: LLP forecast with 95% upper and lower confidence interval

Time	Forecast	Lower bound	Higher bound	+/-
2012 M12	0.0802	0.0740	0.0864	0.0062
2013 M1	0.0810	0.0725	0.0894	0.0084
2013 M2	0.0677	0.0584	0.0771	0.0094
2013 M3	0.0643	0.0545	0.0741	0.0098
2013 M4	0.0687	0.0583	0.0792	0.0105
2013 M5	0.0729	0.0620	0.0839	0.0109
2013 M6	0.0646	0.0532	0.0760	0.0114
2013 M7	0.0708	0.0589	0.0827	0.0119
2013 M8	0.0777	0.0652	0.0903	0.0126
2013 M9	0.0850	0.0716	0.0984	0.0134
2013 M10	0.0869	0.0720	0.1018	0.0149
2013 M11	0.0984	0.0814	0.1153	0.0169

As it can be seen, these forecasts predict an increase in the LLP ratio of almost 3 percentage points which is a lot since the average of the LLP ratio throughout the sample period was around 4.5% and the highest value reached was in 2009 when they peaked at 10%. Therefore, the forecasted value of almost 10% is quite high for Montenegrin banking system and it represents significant level of stress which is necessary exactly what is needed for this kind of exercise.

Figure 3. LLP forecast with upper and lower bound of 95% confidence interval



2.9.3. Capitalization

One of the usual ways of checking how stressed is a particular variable of interest is to calculate the capital adequacy ratio.

Table 5: CAR during the 2011 and 2012

Time	Risk-weighted assets	Total capital	CAR (in percentages)
31.03.2011.	2131709	302605	14.20
30.06.2011.	2120724	305101	14.39
30.09.2011.	2038323	290938	14.27
31.12.2011.	2028697	305229	15.05
31.03.2012.	1990431	303540	15.25
30.06.2012.	2058936	291567	14.16
30.09.2012.	2017925	270086	13.38
31.12.2012.	1972771	288686	14.63

Source: Centralna banka Crne Gore – monetarna statistika, 2013.

After taking notice of the level of CAR before the stress (which was around 14%), the computation of the capital adequacy ratio for Montenegrin banking sector, already affected by macroeconomic shock, can be performed. However, in order to check for the amount of stress, the next necessary step is to calculate the capital loss.

The calculation of the new and stressed CAR can be seen in Table 6 where the first step is to check the level of total loans of the banking sector in the last month of the actual data in time series. When this is done, the calculation of capital loss is performed in the following way. The difference in the LLP ratio before and after the stress is, by assumption, transformed into capital loss through loan losses. The capital and risk weighted assets are also, because of the data constraints, kept the same as in the actual data, the one as of November 2012. This way the difference in the level of LLP is transformed into loss of capital and capital (which remains the same) is decreased by this amount. After the calculation of the new level of capital, the stressed CAR can be calculated. All calculated data in these steps are presented in Table 6.

Table 6: The computation of the stressed CAR

Total loans	2,341,978.00
Difference in LLP ratio before and after stress (in percentages)	2.40
Loss of capital	56,207.47
Total capital	288,686.00
Risk weighted assets	1,972,771.00
Total capital after the stress	232,478.53
CAR after the stress (in percentages)	11.78

As it can be seen, the CAR has decreased for more than 2 percentages. However, countries in the region of Montenegro are known to have high capital adequacy ratio so it is not odd that even after the stress CAR is above the regulatory minimum which is 10% in the case of Montenegro.

The conclusion is that the overall banking system is resilient to the negative economic performance according to its capital adequacy ratio. However, it is important to point out that other explanatory variables can be taken into account like: house price, stock exchange index etc. Further, other types of stress tests such as testing the trade book or liquidity stress test can provide a broader overview of the banking and financial system. However, because of the data constraints stress test was performed only on credit risk and the explanations are all addressed only to this type of risk.

3. Empirical analysis based on bank-specific data

Unlike the previous stress test which was performed on the aggregated data i.e. on the banking sector as a whole, in this exercise the bank-specific data us used. The model is estimated through panel VAR while the response of LLP to the shocks in other variables is analyzed through impulse response functions. The main goal is to provide more insight into the determinants of LLP in Montenegrin banking system. Hopefully, the banking system would benefit from different kind of information provided by testing several hypotheses. The model aims at answering the following question: How to explain the banking sector on a basis of the information about certain variables from micro level bank-specific data? In order to control for the macroeconomic situation or generally the economy the idea is to include macroeconomic variable such as industrial production which will be the same for all the banks and would only change in time.

3.1. Hypotheses of the model

In the analysis done by the Bank of Greece (Louzis, Vouldis, & Metaxas, 2010, p. 35) dynamic panel data methods are used in order to examine the determinants of non-performing loans. It is assumed that the period of economic growth or expansion of the economy was characterized by a low number of non-performing loans while during the recession and economic downturn there are more low-quality loans and consequently more NPL. In this paper several bank-specific variables were used according to a proper assumption assigned to each one of them. These are summarized in the table below.

Table 7: Definition of bank-specific variables

Variable	Definition	Hypothesis tested
Return on Assets*	$ROA_{it} = \frac{Profits_{it}}{Total\ assets_{it}}$	„Bad management II“ (-)
Return on Equity*	$ROE_{it} = \frac{Profits_{it}}{Total\ equity_{it}}$	„Bad management II“ (-)
Solvency ratio	$SOLR_{it} = \frac{Owned\ capital_{it}}{Total\ assets_{it}}$	“Moral hazard” (-)
Loans to Deposit ratio*	$LtD_{it} = \frac{Loans_{it}}{Deposits_{it}}$	“Moral hazard” (+)
Inefficiency	$INEF_{it} = \frac{Operating\ expenses_{it}}{Operating\ income_{it}}$	“Bad management” (+) “Skimping” (-)
Credit growth	$GLOANS^{h}_{it} = \frac{Loans^{t}_{it} - Loans^{h}_{it-1}}{Loans^{h}_{it-1}}$	“Procyclical credit policy” (+)
Market power	$MPOW^{h}_{it} = \frac{Loans^{h}_{it}}{\sum_{i=1}^{9} Loans^{h}_{it}}$	“Size” (-)
Size	$SIZE_{it} = \frac{Total\ assets_{it}}{\sum_{i=1}^{9} Total\ assets_{it}}$	“Size” (-)

Note: * indicates variables used in the exercise performed by the author i.e. in Montenegrin panel VAR.

Source: D. Louzis, A. Vouldis, & V. Metaxas, *Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios*, 2010, p. 31.

All variables regarding the hypothesis presented in the table were included in the model but the results were not satisfying i.e. some proved not to provide enough explanatory power while some were not able to improve the model. This empirical analysis for Montenegro is based on the assumption that there is a correlation between the NPLs and LLPs which was already proved in many researches. The proper term considering LLP over NPL is coverage ratio. The aim is, therefore, to prove that Montenegrin banking system can be explained with macroeconomic and certain bank-specific variables. As already said, some of the variables (those in the table marked with *) are used in the estimation of panel VAR for Montenegrin banking system. The same method of computation along with the hypotheses described in Table 7 is used in PVAR model. The model, therefore, consists of the following variables: LLP, ROA ROE, LtD, IP.

The "bad management" hypothesis implies that low cost efficiency is positively associated with increases in future non-performing loans. Since the future loan losses are supposed to be backed up with provisions of loans the both of the bank-specific variables are used with the same assumption of the coefficient sign. "Moral hazard" hypothesis implies that low capitalization of banks leads to an increase in non-performing loans. Banks' managers can also increase the riskiness of their portfolio by increasing the loan to deposit ratio (more loans not backed up with deposits) and this leads to more non-performing loans. Similar logic holds for the LLP ratio regarding this hypothesis. "Skimping" hypothesis is related to the fact that banks which devote less effort to ensure higher loan quality are more likely to seem more cost-efficient but there will be increased number of NPLs in the long run. Finally, the "size" hypothesis suggests that the size of the banks is negatively correlated with non-performing loans (Louzis et al. 2010, p. 13).

3.2. Panel VAR

Dataset used in the model contains strongly balanced panel data on quarterly basis. The time series is in a range from the 1st quarter of 2007 until the 3rd quarter of 2012. The last quarter of 2012 was not included since the data were only partly available. 10 out 11 Montenegrin banks are included in the model.

The appropriate model for estimation when using micro-level data and bank specific variables is panel data Vector Autoregressive model or panel VAR (hereinafter: PVAR). PVAR is estimated by using the package provided by Inessa Love. This package was first used and presented in Love & Zicchino (2002). This approach allows us to benefit from both the advantages of VAR approach and panel data techniques. For example, VAR can address endogeneity in the model by allowing endogenous interaction between the variables. The usual form of this model is the following:

$$Y_{it} = a_0 + \sum_{l=1}^{m} Y_{it-1} + f_i + e_t \qquad (7)$$

where a_0 is a constant term, Y_{it} is a vector of bank-specific variables for bank i at time t, and e_t is the disturbance factor (Holtz-Eakin, Newey, & Rosen, 1988, p. 1373). Still, some bank-specific heterogeneity is likely to affect this process. In order to allow for this heterogeneity, fixed effects (f_i)are included in the model. Those unobserved effects can be a propensity of an individual bank towards particular relation to one of the variables. In order to eliminate fixed effects, mean difference approach is usually used. It has been proved that this way produces biased

estimates when lagged dependent variables are included in the model. Therefore, in this panel VAR another transformation has been used, namely Helmert transformation of the parameters as Love and Zicchino (2002, p. 10) suggest in their paper regarding panel VAR. Variables are transformed with forward mean differencing which in Hayakawa (2009, p. 7) was suggested to perform better with GMM estimator than the first difference transformation. This kind of transformation preserves homoscedasticity and does not cause serial correlation.

3.3. Estimated model

The 5 lag panel VAR was estimated with explained vector Y_{it} and with IP variable as the one to control for the macroeconomic environment. The panel VAR is estimated with GMM method and the variables are transformed with Helmert transformation before the estimation was done. Six equations were formulated but the only one that will be presented is the one where LLP is the dependent variable since the goal is to see the response of LLP to the shock in other variables. In some cases the response of the other variable to the shock in LLP will also be analyzed in order to be aware of the possible implications of the feedback effects.

As it can be seen from the table the coefficients of the 4 (out of 5) variables are significant. As it was assumed, LLP depends on its endogenous lags and these coefficients are significant in 3 lags. Coefficients related to ROA don't show significance in this model, even though they have a negative sign in the first and last lag. LtD ratio, as a variable implying possible moral hazard in the management of the banks, is positively negatively correlated. The highest order significance is in the 4^{th} and 5^{th} lag where there is first positive correlation and then negative sign. ROE, as a variable assumed to be negatively correlated with LLP, in three out of 5 lags experienced negative correlation.

However, only in the third lag the coefficient was negative and significant at 10% level. IP is also expected to be negatively correlated since the increase in IP may imply less problematic loans. It is indeed negatively correlated in the third lag where the coefficient is significant at 10% significance level.

In order to see which variables provide the most explanatory power to LLP for 10 periods ahead, variance decomposition is analyzed. LLP is mostly explained by its own lagged dependent values while ROE also accounts for major explained part, namely 22.28%. Industrial production as well as LtD ratio provides around 1.5 % of explanatory information. ROA provides the least relevant information according to variance decomposition but also according to the significance level

of the coefficients. However, when we look at the percentages which tell us how much these variables are explained by LLP, we can see that ROA is explained by LLP with 14.43% which can indicate interesting analysis of a feedback effect of the shock in LLP. ROE is explained by LLP with only 5.67%. LtD ratio is explained with 5.98% by LLP which is more than the percent of explanation provided by LtD to LLP. Nevertheless, IP still doesn't provide too much explanatory power to the LLP.

3.4. The results

The impulse response functions were estimated for all variables while for those which were provided significant explanatory power by shock in LLP also feedback effects were analyzed. First, the size of the shock in LLP is presented in order to see how it depends on its own lagged values and to be aware of the size of shock which will be used in feedback effect analysis.

When the shock is done to the LLP, it increases for over than 1% which represents a large fluctuation in LLP during only 6 quarters. However, after the initial shock this ratio starts to decrease and up to the 6th quarter it is decreased to 0.4% above the level it had before the shock was introduced.

Further in the analysis, the responses of LLP to the shocks in other variables will be presented as well as some of the feedback effects.

When the negative shock on one standard deviation in ROA is induced, the response of LLP is very small and can be seen in Figure 5. At the very first moment the LLP is decreased for 0.06

Figure 4: Response of LLP to LLP shock

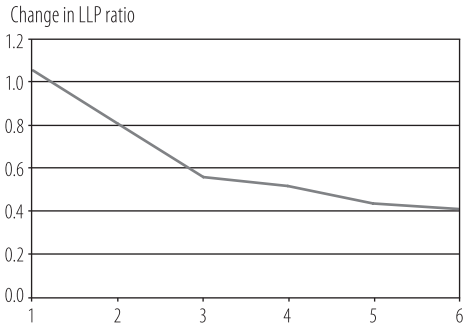
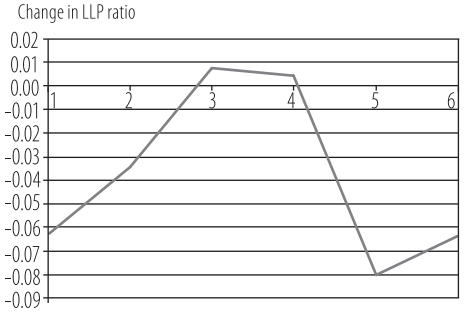


Figure 5: Response of LLP to a negative ROA shock



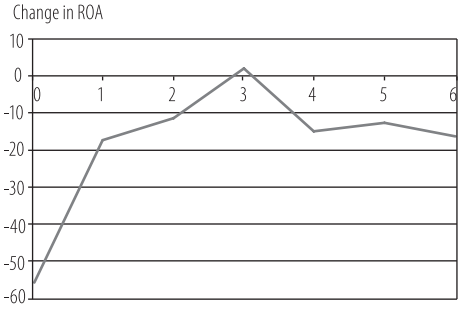
p.p. while it starts to increase up to the third quarter. After that, it starts to decrease again and it does so up to the Q5 when it will reach 0.08 p.p. decrease compared to the level before the shock.

After this quarter it starts to increase again with returning gradually to the initial level. The small deviations in LLP ratio due to shock in ROA is possibly due to the small explanatory power ROA has on LLP. Also, this variable doesn't provide as much useful information since the coefficients weren't also significant up to these 6 quarters.

As it can be seen, the response of ROA is consistent with the bad management hypothesis, since when the ROA decreases LLP increases. However, having in mind the fact that the fluctuations in LLP are not as much sizeable as in NPLs this size of response may not be so strange. Possibility is also the fact that Montenegrin banks have too different management practices so that no relevant conclusion can be made regarding the response of the management to a decrease in ROA.

As said, it would be interesting to have a look at the feedback effect, i.e. at the response of ROA to the shock in LLP. The shock is, in this case, positive indicating the increase in LLP ratio and the goal is to see how this affects ROA, if at all.

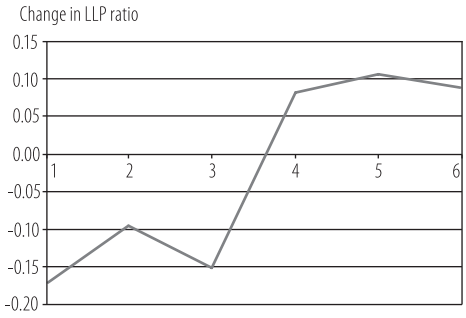
Figure 6. Feedback effect on ROA



What we find out is that ROA is affected in the very first moment when the shock is applied which is consistent with the ordering provided by Cholesky decomposition. Namely, the LLP ratio is supposed to influence other variables contemporaneously and with a lag while other variables are supposed to influence LLP only with a lag. Return on asset has immediately decreased for over 50% and in the next 3 quarters it is increasing toward the initial level. After reaching the initial level, it starts to decrease again and up to the Q6 it has decreased for around 15%. However, the explanatory power that ROA provides to LLP and viceverca is not so sizeable.

The figure 7 shows a response of LLP to a positive shock in LtD ratio. In the first quarter the LLP ratio is decreased while it starts to increase along third and four quarter reaching a level of 0.1 % above the initial level. When the banks give out more loans which are not backed up with deposits the LLP decrease. This delayed effect can be due to the fact that other variables are supposed to affect LLP only with a lag. So, after the initial delay, the LLP starts to increase.

Figure 7. Response of LLP to a positive LtD shock



Feedback effect may also be interesting to explore in this case also as it can be seen in the Figure 8. The initial increase in LLP ratio increases the LtD ratio up to the 10% above the level it had before the shock happened. This proves the hypothesis that LLP is connected with NPL in a way that a similar response is happening regarding the bad management hypothesis. Since the increase in the LLP ratio implies the worse state of the economy, LtD ratio has still increased for 10% and the obvious conclusion can be that this is the underlying problem of the Montenegrin banking system.

Figure 8. Feedback effect of LLP to LtD ratio

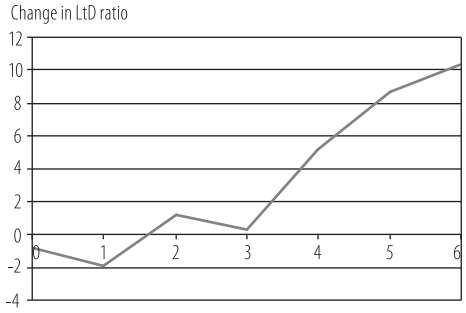


Figure 9. Response of LLP to a negative ROE shock

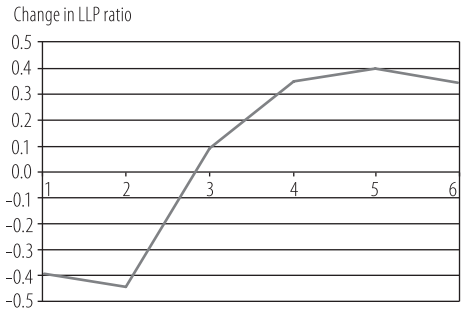
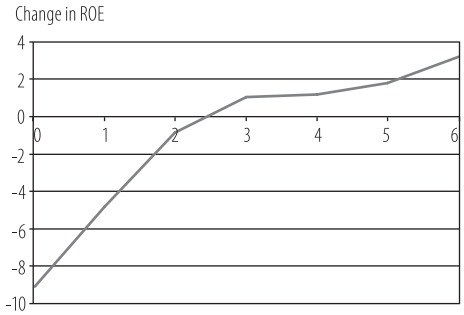


Figure 10. Feedback effect of ROE to LLP shock



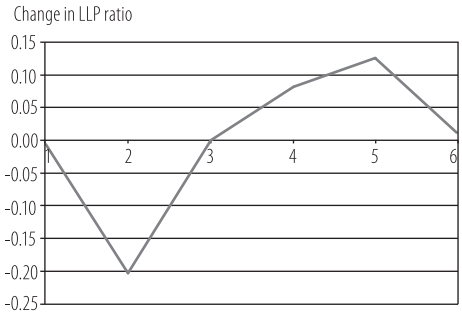
The next impulse response that will be analyzed is the response of LLP to a negative shock in ROE. Since the ROE was mostly negatively correlated with LLP, the response that is seen in the graph is expected. After initial decrease which can be due to delayed effect of the shock, the ROE increases for total of 0.8 p.p. i.e. almost 1% or 0.4% above the level it had before the shock was introduced.

An increase in LLP of almost 1% in a half year's time is large and it implies that the bad management hypothesis tested was confirmed with this variable. When the return on equity is decreased, loan loss provisions increase in order to account for the bad loan decisions made by the management.

The response of the ROE to the shock in LLP is also analyzed since the variance-decomposition implied that LLP accounted for a significant part of the explanatory power in ROE. In Figure 10 can be seen immediate response of ROE in a decrease of around 9%. Then ROE starts to increase in the same time as the LLP starts to decrease. This is also consistent with bad management hypothesis where in case of an increase in the LLP ratio, the ROE decreases significantly.

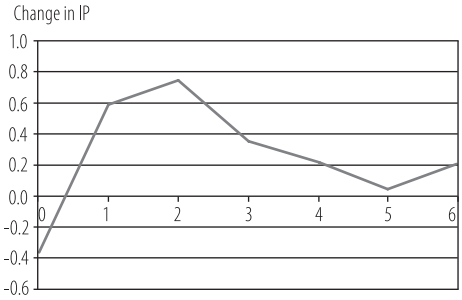
Last but not least, the response of LLP to a negative shock in IP will be analyzed. After an initial decrease which can be due to some other effects the delayed shock starts to affect the LLP ratio during the second quarter. The increase in LLP is, in total amount, equal to 0.3 %. After 5th quarter the effect is to decrease i.e. gradually return to the initial level. However, the negative effect of the decrease of industrial production is present in the LLP ratio after the third quarter.

Figure 11. Response of LLP to a negative IP shock



This kind of response is to be expected since industrial production is an economic variable which needs time to be transmitted to the banking system. However, the variance-decomposition didn't show too much of the explanatory power provided neither from LLP to IP, neither the opposite. The feedback effect is, still, interesting to be analyzed since it can be considered as a kind of response of the economy to the shock in banking sector. After the positive shock in LLP, the IP has decreased initially for 0.4%.

Figure 12. Feedback effect of IP to LLP shock



This initial decrease is consistent with the assumption of contemporaneous effect of LLP to other variables. After the initial decrease, IP starts to increase up to the Q2 and returning back in Q5 to the initial level it had before the shock. The total change in IP is equal to 1.2%.

4. Conclusion

The main goal of the thesis is twofold: one to test the resilience of the whole banking system and the other was to establish the bank-specific determinants of the loan loss provisions. Within a first stress test, the banking system of Montenegro proved to be resilient to the stress performed by a scenario of decreasing industrial production and tourism (overnights) and increasing lending interest rate, unemployment and CPI. The capital adequacy ratio proved to be above the regulatory minimum even after the stress was introduced in the model. However, it is important to keep in mind that this was the credit risk stress test and no other risks were included in the analysis. The main reason for this was data limitation.

The other stress test was done by estimating panel VAR and analyzing impulse responses. This was done with bank-specific data and the problem of data constraints was encountered again. For example, the only variable available with regard to loan quality on each bank separately was loan loss provisions. In the analysis, this variable is used in the form of the ratio of total loans and it represents the loan quality. Two main hypotheses were tested: „the bad management" hypothesis and "moral hazard" hypothesis as well as the influence of the economic situation to the loan quality and banking management practices. The bad management hypothesis was tested through two variables: return on assets and return on equity. This hypothesis was confirmed with the second variable indicating that the smaller return on equity stimulates higher loan loss provision ratio. This implies the fact that the bad management in banks is tried to be covered by approving more risky loans, and consequently increasing LLP ratio. In this way, the bad position of the bank regarding return on equity is trying to be improved by higher credit activity. Because of the motive for this credit activity, the loans are not prudently revised and more non-performing loans are present consequently increasing loan loss provisions. The response of LLP to the shock in loan to deposit ratio confirmed moral hazard hypothesis. By the increase in loan to deposit ratio the LLP ratio has also increased indicating that the loans that are not backed up with deposits are also the riskiest ones since they indicate the increase in LLP. The main finding is the fact that loan loss provisioning practices are not forward-looking but precisely the opposite. When the situation regarding the profit or credit activity is bad, there are attempts to improve it by increasing the level of loans even though this increase implies more risky loans in the bank's portfolio.

Finally, the banking system should be more forward-looking in a way to increase the loan loss provisions while the economy is in good shape, so that when there is an economic downturn the banks are somewhat secure with the provision they

left aside for loan losses. The Central bank of Montenegro should, as the supervisor authority, motivate banks to practice good and sensible decisions regarding their portfolio management. The data regarding the stress tests should be more available for researches. Consequently, more stress testing exercises could be done and the better implications for the banking system could be made. In addition, if the data were more available and better organized, more different risk types could be assessed and consequently broader conclusion regarding the resilience of the financial sector could be established.

Stress tests have, undoubtedly, become regularly used as a macroprudential analysis and crisis management tool. These practices have improved over the years and have now become a crucial component of the methodology used by banking supervisors and central banks for assessing financial stability. Hopefully, more practitioners will start performing this exercise on the Montenegrin banking system. Consequently, more information regarding deficiencies of the financial system will be available and this kind of information can then be used as an input to the new and more reliable stress tests. Possible threats regarding the financial system could be determined more accurately and there would be higher probability that the financial stability is preserved. Nevertheless, it is extremely important to bear in mind that the stress tests, as useful and informative as they can be, are of the greatest value when followed by concrete and appropriate actions, first by the central authority and then by each bank separately.

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