



A MACRO STRESS TEST MODEL OF CREDIT RISK FOR THE TURKISH BANKING SECTOR



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ABSTRACT

Banking sector occupy an important position in the financial system. Consequently, in order to maintain financial stability in a country, financial system and major banks of the sector have importance. At this point, financial stability of the banks and the sector may be discussed. Sensitivity of the sector against the shocks may be measured and evaluated properly. A stress test is a technique to measure the vulnerability of a bank or the aggregate banking sector against a set of hypothetic scenarios or events. This paper proposes a model to conduct macro stress test of credit risk for the banking sector based on scenario analysis. In this study firstly a macroeconomic credit risk model based on Wilson's CreditPortfolioView for Turkish Banking Sector between the period 1999Q1-2012Q4 therefore 2013Q1-2014Q4 period is forecasted using historical simulation analysis. 3 historical scenarios are built for the macroeconomic credit risk model of banking sector. Then, responses of the sector's default rates against the macro-shocks are detected. Responses of the default rates are compared with the historical date and financial soundness of the sector are analyzed.

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Contribution/ Originality

This study is one of very few studies which have investigated the macro stress test model for credit risk on banking sector in Turkey.

1. INTRODUCTION

Financial stability is defined as the consistency and resistance of financial markets and institutions and payment systems against shocks. Financial system can work straightly and consistently, therefore economic resources can be distributed and managed efficiently according to the types of the risks.

Detection and forecasting of the risk determination factors is important in order to maintain financial stability. At this stage, factors of financial instability must be revealed. Once the factors of financial instability are detected, more effective measures can be taken.

Stress tests can be categorized as in three parts: sensitivity analysis, scenario analysis and statistical stress tests. Sensitivity analysis measures the effects of a certain risk factor on a financial institution. In this analysis source of

the shock is not defined and practice are less complicated. Source of the risk is determined in detail in scenario analysis, thus this method is more complicated as the movement of more than one factor is evaluated simultaneously (Committee of European Banking Supervision, 2009).

Stress testing is a risk management method used to test the stability of the banks and banking sector against various scenarios reflecting severe but potential market, interest, exchange rate, credit and liquidity risks.

Stress testing method puts a more dynamic analysis when compared with the history based methods. This method measures the possible impulses against various situations that are always likely.

In an environment surrounded by risks, unexpected conditions can be determined by stress tests by banks. Advantages of the stress tests are Banking International Settlements (2012):

- Forward looking evaluation of risks
- Eliminating the limitations caused by models and historical data,
- Supporting internal and external communication,
- Supporting capital and liquidity planning process,
- Determining risk tolerance of banks,
- Eliminating the level of risk under some circumstances and making emergency plans.

Strength of banks to financial crisis can be measured by default rates. Default can be defined as the failure possibility of the debtor. Default rate (default possibility) is the ratio of non-performing loans to total loans. Stress testing models enable to predict stronger and truer loan loss distributions than credit risk models based on aggregate data.

In this study, a macroeconomic credit risk model that relates credit risk with real economy and macroeconomic variables will be built in order to test financial strength of Turkish Banking Sector. A VAR model is estimated firstly to reveal the relationship between the macroeconomic variables. In the second place, macroeconomic credit risk satellite models are built for both banking sector. Finally, financial stability of the banks and the whole sector are tested using scenario analysis by Wilson (1997a;1997b) model.

2. LITERATURE REVIEW

Lately, macroeconomic models are widely used for credit risk stress testing applications. Macro stress testing method was introduced by Wilson (1997a;1997b) for the evaluation of financial systems fragility against macroeconomic shocks. After that, many researchers used the model for different countries. Besides Wilson approach, Merton (1974) approach is also developed in many studies. Merton approach models the effect of macroeconomic changes on stock exchange prices and then transformed these changes into default probabilities. Merton approach is further developed by many researchers.

Kalirai and Scheicher (2002) built a credit risk model for Australia using 9 selected variables between 1990 and 2001. A credit loss simulation and stress test are implemented for the Australian Banking System. They found acceptable levels of capital ratios when compared to current level of capital ratio rates.

Boss (2002) studied a model including the default rates of Australian economy between 1965 and 2001. A CPV (Credit Portfolio View) model is used to define the default rates by selected 8 macroeconomic variables which are chosen among 31 different variables. Credit loss simulation and stress test are emphasized in the model and it is concluded that Australian Banks have a higher risk carrying capacity than required ratios.

Virolainen (2004) built a macroeconomic credit risk model to determine the default rates of Finland corporate sector between 1986 and 2003. A significant relationship is found between the default rates and fundamental macroeconomic variables such as GDP, interest rates, corporate indebtedness. The estimated model aimed to reveal the effect of corporate credit conditions on some macroeconomic variables. In addition, this study included examples of

macro stress test modeling like analyzing the effect of negative macro economic shocks on banking sector credit risk. Findings show that corporate sector credit risks are quite limited in the current macroeconomic environment.

Drehmann (2005) introduced risk taking ratios of UK banks by stress tests. Default rates are modeled by various macroeconomic factors and market factors using Merton model systematic risk factors. Findings show that losses of the banks are not high to create a banking crisis even if the worse conditions are faced. It is also emphasized that systematic factors have non linear and unsymmetrical effects on credit risk.

Hoggarth *et al.* (2005) presented a different method using VAR model to measure the strength of English Banking System against contrary macroeconomic shocks. In this study, affects of some macroeconomic shocks on the aggregate loss of the banks. Ratio of non-performing loans to total loans is used to measure fragility of the banks.

Pesola (2005) made a regression analysis using panel data from Scandinavian Countries, Deutschland, Belgium, United Kingdom, Greece and Spain between 1980 and 2002 to determine macroeconomic factors affecting the credit loss rate of banking sector.

Wong *et al.* (2006) modeled a stress testing under the framework of credit loss and macroeconomic shocks using quarterly data of Hong Kong Banks between 1994-2006. Similar shocks to Asian Financial Crisis are used in the analysis. It is found that even in the worst scenario, banks continue to make profit and credit risk is at normal levels.

Jakubik and Schmieder (2008) built a comparing credit risk model of German Economics and Check Republic Economics. The study included the data of Check Republic between 1998-2006 and the data of German between 1994-2006. Analysis is made both at sectoral and individual level. As a conclusion it was found that a macroeconomic shock has more severe effect on Check Republic Economy twice more than German Economy.

Jakubik and Hermanek (2008) answered the question whether the developing loan volume would have negative impacts on banking sector stability in Chinese Economy. It was concluded that the banking sector is resistant against mentioned macro economic shocks.

Zeman and Jurca (2008) tested the affect of a depression in Slovakian economy on Slovakian Banking Sector using a VEC model including the data between 1995-2006. For this purpose, interest risk, credit risk and exchange rate risk are used as macroeconomic variables. As a consequence, it was stated that depression in Slovakian economy would not have negative effects on Slovakian Banking Sector.

Vazquez *et al.* (2011) built a credit risk model selecting the scenario analysis a baseline to test Brazilian banking Sector. Data is chosen at Bank level between the periods of 2001-2009. Results supported a credit risk quality moving with the conjuncture. Results also revealed a significant negative relationship between NPL and GDP. There are not many studies about stress testing in Turkey. Following part of the study summarize some major studies.

Küçüközmen and Yüksel (2006) used Turkish economy data between 1995 and 1999 to build a macroeconomic credit risk model and then used the model in the stress testing procedure. Macroeconomic variables are GDP, ISE100 Index, Euro/TL cross rate, USD/TL cross rate, interest rate, unemployment rate, current account balance, CPI, internal loan of the banking sector, industrial manufacturing index and money supply variables. Results show that changes in NPL can be explained by the mentioned macroeconomic variables. In the second part of the study, by the help of a Monte Carlo Simulation and stress tests, loss ratios can be compensated by profits and invested capital.

Altıntaş (2012) used a credit risk model for Turkish economy between 2003-2010. for this purpose, a VAR model was created to determine the macroeconomic variables and then Monte Carlo simulation method defined the non-performing loan ratio. It was conclude that

Turkish Banking sector is considerably sensitive to a real negative growth rate shock and exchange rate shocks. İskender (2012) tested the resistance e of Turkish Banking Sector against credit risk and other potential shocks. Results showed a high resistance of Turkish Banking Sector against those risks.

3. METHODOLOGY

3.1. Overview of the Methodology

Stress testing was first discussed in FSAP of IMF and World Bank in 1999. Previously, stress tests were only a part of FSAP but then these tests have been a useful tool for financial analysis studies for regulatory institutions such as IMF and World Bank and also for top management.

Stress testing is one of the tools that are used for evaluation of the total risk of banks. Regulatory institutions of the banking sector use stress testing to determine whether banking sector have adequate capital when some unexpected conjunctural movements happen. Stress tests are also named as scenario analysis thus uses hypothetical or historical scenarios to measure bank performances against various situations (Virolainen, 2004).

3.2. Data Set and Variables

In this study, variables that affect the credit risk are selected by the help of previous literature and conditions of Turkish economy. Ratio of non-performing loans to total loans is calculated to measure credit risk. Quarterly data between 1999-2012 is used in the study. Macroeconomic variables are seasonally adjusted GDP (GDP_SA), USD Exchange rate (USD), consumer price index (CPI), Stock Istanbul 100 Index (BIST100), 3-months interest rate (INT), Treasury Bonds Interest Rate (TINT) and seasonally adjusted unemployment rate (UNP_SA). Independent variable is non-performing loans of banking sector (NPLRE).

Table-1. Data Sets

Variables	Definition	Explanation
NPLR	Non Performing Loans	The Ratio of Non Performing Loans to Total Loans
INT	Interest Rate	3 months time deposit interest rate
TINT	Treasury Interest Rate	Tresuary Bonds Interest Rate
CPI	Consumer Price Index	Consumer Price Index
BIST100	Borsa Istanbul 100 Index	Change Rate Of Stock Istanbul 100 Index
USD	USD Exchange rate	Change of USD Exchange rate
GDP_SA	Gross Domestic Product	Seasonally adjusted Real GDP
UNP_SA	Unemployment Rate	Seasonally adjusted unemployment rate

Source: Compiled by the author. Non performing loans data is taken from the web site of <https://www.tbb.org.tr/tr>. int, tint, cpi data is taken from the web site of Turkish Undersecretariat of Treasury <https://www.hazine.gov.tr/tr-TR/Istatistik-Sunum-Sayfasi?mid=249&cid=26&nm=41>, Bist 100, Usd, GDP and UNP data are taken from the web site of Central Bank <http://evds.tcmb.gov.tr/>.

Time series of the macroeconomic variables can be seen in Figure 1. When we investigate the figure, we can see that only GDP and UNP series show seasonality trend.

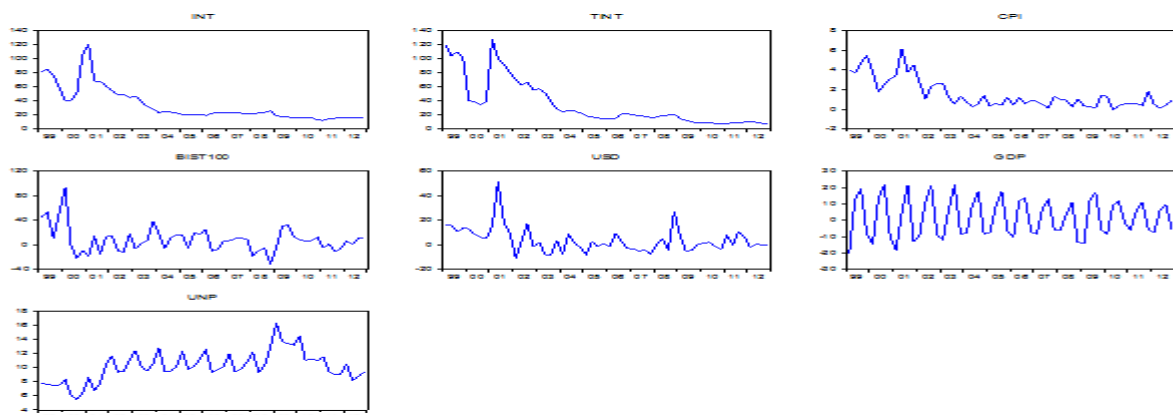


Figure-1. Time Series of the macroeconomic variables

Source: Author.

Series with a seasonality trend should be seasonally adjusted initially. Otherwise, heteroscedasticity and spurious regression problems can be seen in the time series (Altıntaş, 2012).

For this reason, GDP and UNP series are seasonally adjusted and two new series GDP_SA and UNP_SA are created. These seasonally adjusted series will be used in the following parts of the study. Deterministic properties of the series are shown in Table 2. We should examine skewness and kurtosis value of the Jarque-Bera statistic of the series to determine whether they are normally distributed.

Table-2. Deterministic properties of the series

	INT	TINT	CPI	BIST100	USD	GDP_SA	UNP_SA
Mean	33.94	34.839	1.526196	8.107197	3.738321	1.632803	10.16473
Median	23.02	19.8365	0.972	6.825135	1.527	2.115927	10.39746
Max.	120.26	127.617	6.174	93.05326	51.089	5.522274	14.83827
Min.	12.16	7.248	-0.107	-31.18536	-11.037	-4.57397	6.160609
Std. Dev.	24.31608	33.12175	1.500318	20.80095	10.21752	2.422074	1.908385
Kurtosis	1.705508	1.405009	1.337207	1.432835	2.000216	-0.78187	-0.0038
Skewness	5.464269	3.789399	3.937182	6.804957	9.640964	3.098076	3.438596
Jarque-Bera	41.31786	19.87849	18.73852	52.94278	140.247	5.728139	0.44899
Prob.	0.000000	0.000048	0.000085	0.000000	0.000000	0.057036	0.798920
Obs	56	56	56	56	56	56	56

Source: Author

According to the values of the table 1, we can say that only GDP_SA and UNP_SA series are normally distributed. Firstly, correlation matrix of the variables will be built and over-related variables will be eliminated to minimize an autocorrelation problem in the model.

Correlation matrix of the variables shows a high correlation between the interest variables that are 3-months interest rate (INT), Treasury bonds interest rate and consumer price index. One or two of these variables should be eliminated from the model in order to prevent autocorrelation problem.

Different possible models will be tested using different variations including INT, TINT and CPI variables.

3.3. Time Series Analysis

Time series analysis enables us to get better models explaining an economic variable with its own past values and past and current error terms rather than traditional statistical methods. This method estimates future values of a variable using past values of that variable having significant effects in the past. It can make predictions even the structure of the time series and variables is not clear (Griffiths *et al.*, 1993).

A process is stationary if the mean and variance of the variable do not change over time and covariance between two periods depends on the distance between the two periods.

If a stochastic process is not stationary, estimates of the process would be valid for only estimated time. A general evaluation of the process cannot be made. But, a time series process should some predictions about the future values or general trends of the variables (Bozkurt, 2007). For this reason, stationary of the series must be tested in order to proceed the analysis. In this study, stationary of the variables are tested by unit root test. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are chosen for that purpose.

Table-3. Results of the unit root tests

	ADF		PP	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
INT	-2.290547 (0.1786)	-2.970437 (0.1497)	-2.112352 (0.2408)	-2.780258 (0.2106)
TINT	-4.272012 (0.0015)	-3.997629 (0.0158)	-2.729747 (0.0755)	-3.573595 (0.0415)
CPI	-2.293147 (0.1778)	-3.777394 (0.0253)	-2.506920 (0.1194)	-3.724915 (0.0288)
BIST100	-5.198861 (0.0001)	-5.255259 (0.0004)	-5.106008 (0.0001)	-5.166879 (0.0005)
USD	-5.023504 (0.0001)	-5.383419 (0.0002)	-4.970142 (0.0001)	-5.286290 (0.0003)
GDP_SA	-5.910451 (0.0000)	-5.927852 (0.0000)	-5.935969 (0.0000)	-5.946113 (0.0000)
UNP_SA	-1.792652 (0.3802)	-1.890255 (0.6458)	-2.292551 (0.1780)	-1.895503 (0.6434)
First Differences				
INT	-6.207987 (0.0000)	-6.205235 (0.0000)	-7.321957 (0.0000)	-9.124885 (0.0000)
TINT	-2.714770 (0.0794)	-3.906322 (0.0200)	-8.565682 (0.0000)	-8.975929 (0.0000)
CPI	-9.444724 (0.0000)	-2.630722 (0.2692)	-19.22649 (0.0000)	-29.20625 (0.0001)
BIST100	-8.877316 (0.0000)	-8.809813 (0.0000)	-17.24038 (0.0000)	-27.36821 (0.0001)
USD	-6.989312 (0.0000)	-6.951826 (0.0000)	-22.07791 (0.0001)	-24.67302 (0.0001)
GDP_SA	-10.58231 (0.0000)	-5.925475 (0.0000)	-22.29836 (0.0001)	-22.25106 (0.0001)
UNP_SA	-5.728611 (0.0000)	-5.634879 (0.0001)	-5.788810 (0.0000)	-5.678685 (0.0001)

Source: Author

Results of the unit root tests are shown in Table 3. Tests are performed with constant and with constant and trend. Significance values are considered 1 %. Result of the test shows that BIST100, USD and GDP_SA are level stationary. INT, TINT, CPI and UNP_SA are stationary at first level. Further parts of the study, variable INT will be used as DINT, variable TINT will be translated to DTINT, variable CPI will be translated to DCPI and variable UNP_SA will be translated to DUNP_SA.

3.4. The Model

3.4.1. The Macroeconomic Model

There are various methods of time series analysis in order to determine the relationship between macroeconomic variables. Traditional time series methods are not used in the study because variables are not classified as dependent and independent variables. For this reason, VAR (Vector Autoregressive) will be estimated in this section.

Financial variables continuously interact with each other. Thus, choosing a variable as dependent variables and some other variables as independent variable which are considered to affect that variables may not an effective method at most of the time. Because, so-called dependent variable may also has some impacts on independent variable as a result of a complex system. It is hard to decide which the dependent variable is and which the independent variables are in financial systems (Bozkurt, 2007). An unrestricted VAR model may help to eliminate

this difficulty showing the dynamic relationships between all the chosen variables and enabling to make future predictions (Brooks, 2008).

VAR models have many advantages when compared with the univariate time series models or simultaneous structural models. First of all, it makes us possible to build models without determining dependent and independent variables. In additions, variables can be dependent to more than one lagged value of its own lagged values or lagged white noise error terms values. Moreover, VAR models are mostly preferred than the traditional methods (Maddala, 1992).

Lagged level for the model is determined as 3 by evaluating the results of Schwarz Information Criteria, Akaike Information Criteria and Sequential modified LR test statistic, Final prediction error test statistics, Hannan-Quinn information criterion. After estimating the VAR model, we should make some good to fit tests. Normality, autocorrelation, heteroscedasticity and AR Root tests are analyzed for the model. Results of these tests will help us to decide whether to continue the study with the model or to estimate a better model. But when the lagged value increased, degree of freedom becomes ineffective causing more problems for the model (Gujarati, 1999).

Under this framework, a VAR (3) model is estimated. Results of the model are in the appendix 1. This estimated model will be used in the credit risk model. For this reason, this model will not be evaluated. Only correlation coefficients of the variables will be demonstrated.

The VAR(3) model has valid values of normality assumption, autocorrelation assumption, homosecdasticity assumption and stability of AR Roots. As a consequence, we can say that the VAR (3) model is valid model for our further analysis. Next part of the study, an OLS model will be estimated to show the relationship between non-performing loans and the macroeconomic variables.

3.4.2. Satellite Model

The relationship between the non-performing loans index like in the CPV (CreditPortfolioView) model of Wilson and the selected macroeconomic variables will be tested by a linear regression model. Dependent variables that present credit risk are NPLRE (non-performing loan index) series created by logistic transformation of NPLR series. NPLRE is formulated as follows:

$$NPLR_t = \frac{1}{1 + e^{-NPLRE_t}} \quad (1)$$

$$NPLRE_t = \ln \left[\frac{NPLR_t}{1 - NPLR_t} \right] \quad (2)$$

In the equations 1 and 2, $NPLR_t$ represents the ratio of non-performing loans (loss ratio) and $NPLRE_t$ represents non-performing loans index. Although non-performing loan index is in the same direction with Virolainen (2004) it is parallel with Boss (2002); Küçüközmen and Yüksel (2006); Vukelic (2011).

Low value of index series at time t shows low level of non-performing loans ($NPLR_t$) and also economy. $NPLRE_t$ represents the total economic outlook and can be defined as a linear function of external macroeconomic variables. Thus;

$$NPLRE_t = c + \beta X_{1t} + \beta X_{2t} + \dots + v_{nt} \quad (3)$$

In equation 3, c represents constant term, β represents regression coefficients of the macroeconomic variables at time t, v represents independent identically distributed error terms. Independent variables are the variables that are derived from VAR model. Linear regression model is estimated by ordinary least square (OLS) method. Estimated model will be used as the banking sector credit risk satellite model.

The regression model will be the basis of estimates of NPLRE series future values.

Time series analysis is completed in the previous section in detail. In this section, time series analysis of the index series will be completed. Before OLS estimation, stationary test will be applied for index series. Results of this test are summarized in Table 4.

Table-4. Unit Root Test Of Index (NPLRE) Variable

	ADF		PP	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
NPLRE	-1.233623 (0.6536)	-1.734481 (0.7223)	-1.377564 (0.5867)	-1.875216 (0.6538)
NPLRE (First Difference)	-6.109113 (0.0000)	-6.067386 (0.0000)	-6.110868 (0.0000)	-6.063327 (0.0000)

Source: Author.

When we analysis the results, we can conclude that NPLRE series is not stationary at level but becomes stationary when we take the first difference. In the next sections, differenced NPLRE series will be used in the model indicated as DNPLRE. Estimates of the model are given in Table 5. After eliminating variables with significant coefficients and t values, the final OLS model is as follows.

Table-5. Credit Risk Satellite Model

Variable	Level	Coefficient	Standart Error	T Statistics	Probability
C		-0.047045	0.024388	-1.929034	0.06020
GDP_SA(-1)	-1	0.012971	0.007793	1.664447	0.10310
DUNP_SA	0	0.10801	0.031809	3.395531	0.00150
BIST100(-1)	-1	-0.001687	0.000934	-1.806639	0.07770
DINT(-3)	-3	0.002878	0.000989	2.910718	0.00560
DCPI(-2)	-2	-0.081036	0.022423	-3.614026	0.00080
DTINT(-3)	-3	0.005662	0.001465	3.866308	0.00040
USD(-2)	-2	0.012046	0.001951	6.174583	0.00000
R Square	0.784896				
Adjusted R Square	0.750675				

Source: Author.

Table 5 is analyzed according to the confidents and significance levels of the variables. Significance level of the model is 75 %. All the variables except for GDP are significant at 5 % significance level.

When we look at the coefficients, we can see that there is a negative relationship between inflation rate and default rate. Relationship is positive for all the other variables. An increase in stock exchange index and inflation rate will decrease default rates, and an increase in nominal interest rates, treasury bonds interest rate, Exchange rates and unemployment rates will cause an increase in default rates.

Error terms of the model have no autocorrelation, normality or heteroscedasticity problem. Error terms do not violate any assumptions of the OLS.

3.5.Scenario Analysis

In this section, historical data of the macroeconomic variables most influent on banking sector will be chosen and given a shock. These macroeconomic variables are interest rates and USD exchange rates that are chosen according to the Financial Stability Reports of the Central Bank of Turkey. Estimate period is two years.

Base and adverse scenarios are created based upon data of 2001. Base scenario indicates the most probable situation in the light of information derived from macroeconomic variables. Adverse scenario indicates the financial situation at the extreme levels in the periods of a crisis.

Historical data between 1999Q1-2012Q4 is considered to determine the extent of the shocks. At the same time, credit risk satellite model is used to evaluate the period and sign of the shock. Properties of the shocks periods are summarized in Table 6.

Table-6. Stres Test Scenarios

Type of Shock	The Period of Shock-Ratio-Direction	The time of the Shock
Treasury Bonds Interest Rate's Shock	Increase the value of 2012Q2 Period to the value of 2001Q1 period	2001 Q1
Exchange Rate Shock	Increase the value of 2012Q3 Period to the value of 2001Q2 period	2001 Q2
Simultaneous Shock	Use interestrate and exchangerate shock at thesame time	2001 Q1 and 2001 Q2

Source: Author.

There are 3 scenarios in Table 6. Firstly, graphs of the macroeconomic variables to be used in the model are examined in detail. In the first scenario, we can see that interest rates are at peak in the first quarter of 2001. Possible increase in the non-performing loan rates will be estimated if such a rise like 2001 is to happen again. In the second scenario, a similar rise is seen in the second quarter of 2001 when we look at the graph of exchange rate. Trend of non-performing loans for the period 2013Q1 and 2014Q4 is investigated if such an event happens again. In the third scenario, the effect of a simultaneous shock given to both interest rates and exchange rates is considered.

3.5.1. Interest Rate Shock (Scenario 1)

Level of the interest rate shock is determined according to the past values of the interest rates. Theoretically, a significant increase in the interest rates is expected to affect the non-performing loans even if lagged time. An unexpected and sudden increase in interest rates, negatively affects non-performing loan level. When we look at the past values of interest rates, there is a 55 % increase in 2000Q4 and 120 % increase in 2001Q1. Stress test scenario is built under the assumption that the rise of interest rates in 2001Q1 is to happen at 2013Q1. Under the framework of this scenario, values of base scenario and actual rates are given in Table 6.

SCENARIO 1

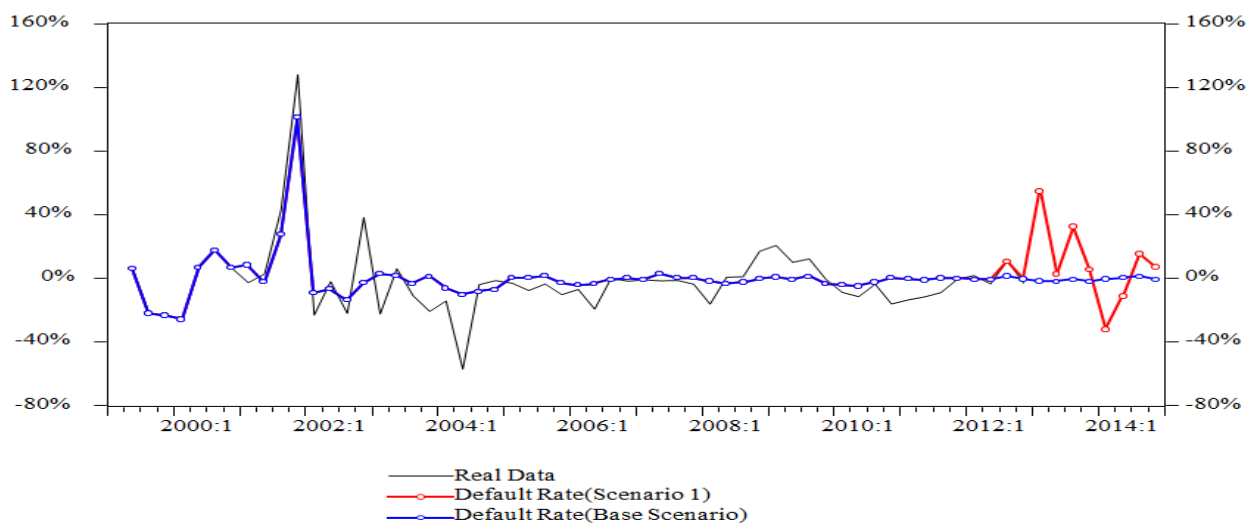


Figure-2. Graph of First Scenario

Source: Author.

When we look at Figure 2, we can see that a 120% shock rise in interest rates have no significant effect on non-performing loan rate at the first stage. But, this shock begins to have influence at 3 periods later and causes high levels of non-performing loans on 2013Q1. An interest rate shock on 2012Q2 has a fluctuating effect on non-performing rates. Non-performing loan ratio is about 2 % before the shock, under the scenario 1 this ratio rises to 6 % on 2013Q4. This ratio tends to decrease on 2014Q1 but increase once more on 2014Q4. While in the baseline scenario, non-performing loan ratio is about 1 % on 2014Q4 but rises to 7 % after the shock. These movements indicate the sensitivity of non-performing loans to interest rates.

3.5.2. Exchange Rate Shock (Scenario 2)

An unexpected increase in the exchange rates tends to have a negative effect on non-performing loan ratio. But, approximately 30.4 of the cash credits are foreign currency issuer in Turkish Banking Sector, for this reason non-performing loans ratio may not increase at first (Altıntaş, 2012).

An instantaneous shock raises non-performing loan ratio by 35 % at first, but this level decreases in time and reaches its initial point on the last quarter of 2014. Estimated non-performing loan ratio is 0.2 % in the base scenario, while it rises to 0.8 % after the shock. Even it seems to rise as percentage; the impacts are very limited when it is compared to the impacts of other variables. This shows that the sensibility of non-performing loans to exchange rates is limited.

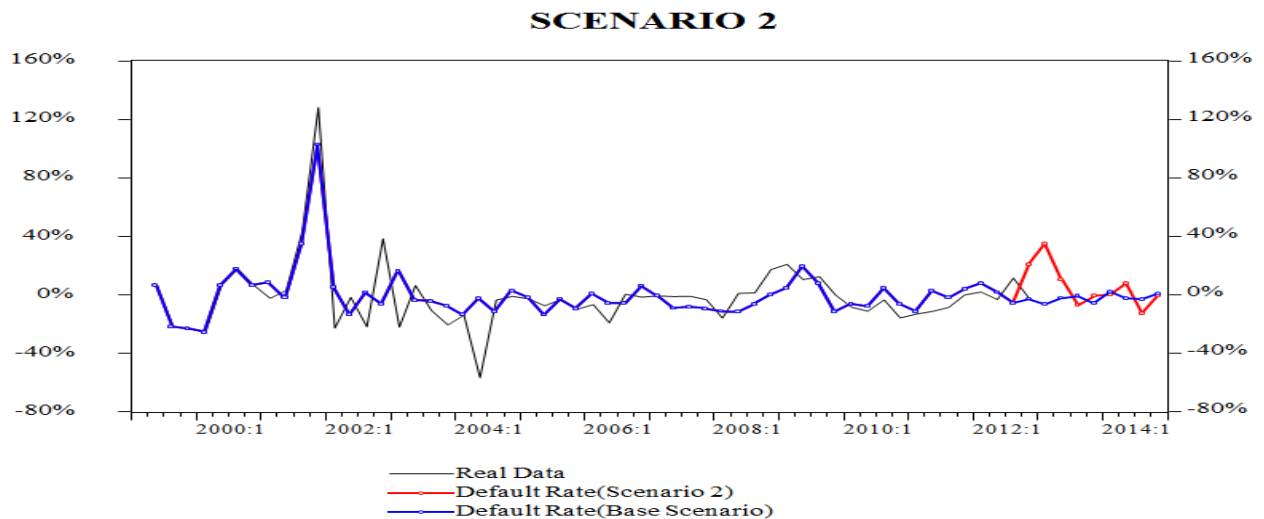


Figure-3. Graph of Second Scenario

Source: Author.

3.5.3. Interest Rate and Exchange Rate Simultaneous Shock (Scenario 3)

Interest rates and exchange rates have a simultaneous shock for the third scenario. It is expected to reveal more impact with this scenario.

Results of the third scenario can be seen in Table 6. As a result of the shock, non-performing loan ratio rises rapidly. But this impact passes by time especially on 2014Q4. This scenario reveals more effects than the second scenario. On 2014Q4, non-performing loan ratio is 1%, but it rises to 13 % on the assumption of scenario 3 impacts of a simultaneous shock is more than the other scenarios as expected.

SCENARIO 3

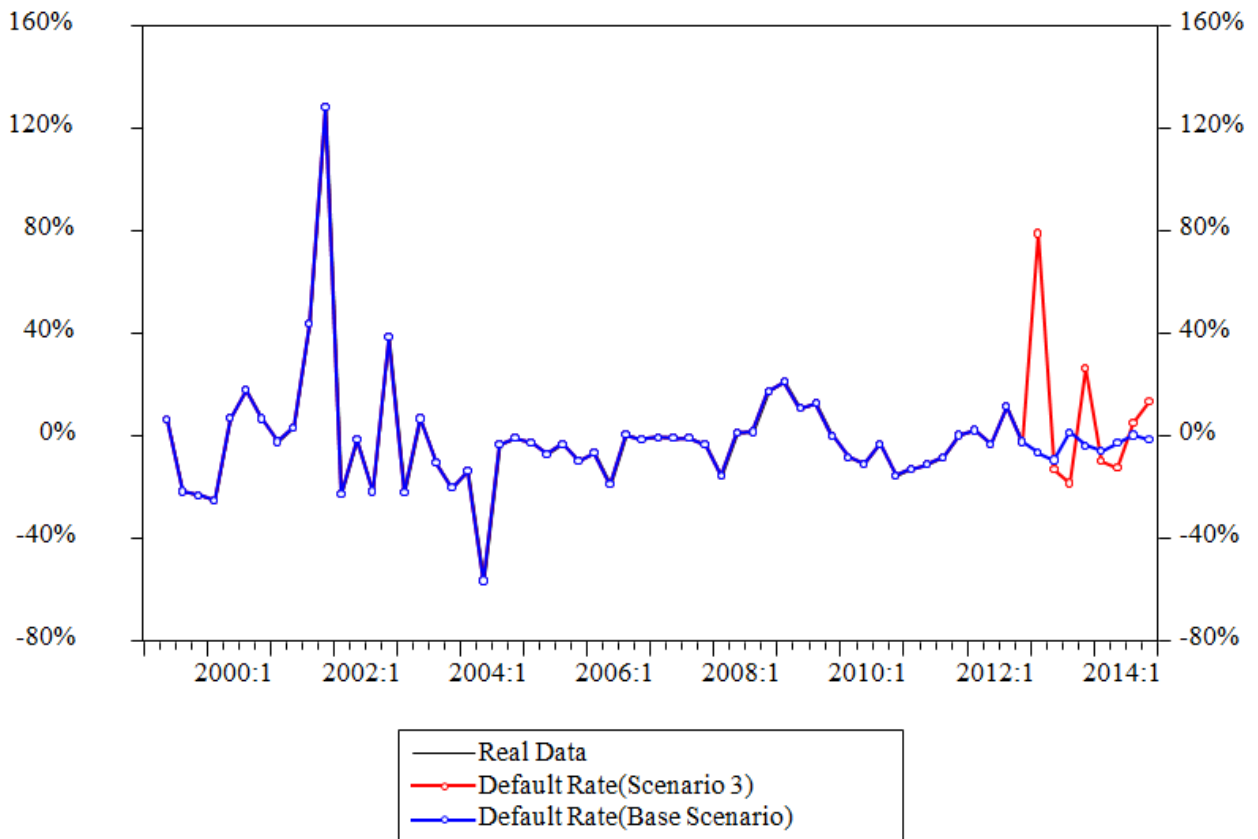


Figure-4. Graph of Third Scenario

Source: Author.

4. RESULTS AND FINAL CONSIDERATIONS

Strength of the financial sector has an important role for the financial stability of both developing and developed countries and also for the stability of the global markets. Because of this important role, banking sector should be disciplined, transparency, and proper to scientific criteria.

Stress testing is a method used to test the stability of the banks against various scenarios reflecting severe but potential market, interest, exchange rate, credit and liquidity risks.

In this study, stability of the Turkish Banking Sector is tested against financial crisis is tested by building a credit risk model under 3 different assumptions and a satellite model. Firstly, a macroeconomic VAR model is estimated to determine the relationship between the macro variables. Then credit risk satellite models are created in order to reveal the relationship between macroeconomic variables and non-performing loan ratio.

Using these model scenario analysis framework is set and the behavior of non-performing loan ratio against some unexpected situations are analyzed. Between the periods of 1999Q1-2012Q4, historically observed peak levels are used as shocks. As a result of sectoral analysis, we can conclude that the banking sector is highly resistant to the shocks similar to 2001 crisis. Even the non-performing loan ratio is 128 % in 2001 crisis; this ratio is only 13 % under the assumption of a crisis for the last quarter of 2014. When we evaluate the scenarios collectively, we can conclude that Turkish Banking Sector has a strong financial structure and effective management for the reason that the sector has low and decreasing levels of impact under shocks.

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