Case – study Concerning the Effects of the Macroeconomic Variables on the Loan Portfolios Quality of the Romanian Banking Sector Using the VAR Model and Least Squares Method

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Abstract: *The purpose of this article is to analyze the effects of Romania's macroeconomic variables of the loan portfolio quality of the banking sector. Specifically, the study seeks to emphasize the interdependent macroeconomic elements that influence the evolution of credit portfolio quality for commercial banks. To achieve these correlations we use both the VAR model and the method of least squares. Monetary and structural influences are highlighted by using cumulative impulse – answer functions. The results show that monetary factors have contributed greatly to the intensity of financial crises. Beyond these results, it can be concluded that the interest rate and real exchange rate play an important role in sizing the loan portfolio quality at the banking system level.*

Keywords: interest rate, economic growth, exchange rate, credit risk rate.

JEL Classification: E32, G14.

1. Introduction

Along time, the bank crisis affected many countries and led to the bankruptcy or restructuring of many credit institutions. The solvability of a credit institution resides in the quality of the loan portfolio, the risk exposure being thus a key indicator of the financial vulnerability of a bank.

This subchapter focuses on the quantification of the effects of Romania’s macroeconomic performances on the quality of the loan portfolio from the bank sector. To be more specific, the study tries to discover those independent macroeconomic elements (such as the interest rate, the increase of the GDP, the exchange rate) which influence the evolution of the quality of the loan portfolio for the commercial banks. In order to achieve these correlations we will use the VAR model and the least squares method.

2. Research and Methodology

Therefore, we will apply the VAR model and the impulse-response analysis in order to set the causality relations between the economic variables and the loan quality variables. Plus, similarly to the model proposed by Baboucek and Jancar (2005), the scenario analysis and the stress test can also be applied, in order to examine their impact on the quality of the loan portfolios of the banks in Romania. The stress tests are performed within some exceptional events, but plausible both with hypothetic and also historical character in order to evaluate the vulnerability of loan portfolios to negative factors at macroeconomic level. The idea of these simulations is to offer a future oriented evaluation of the bank sector on credit risk exposure level for the purpose of maintaining a financial stability.

The VAR model uses a linear equations system to catch the dynamic of the feedback relations between two or more endogenous variables. VAR treats all the variables as symmetric, without supposing that a variable is independent and dependent. All the endogenous variables are affected by the present and past achievements of those variables. The structural form of the model is as follows (Tracey Marlon, 2008):

$$\begin{bmatrix} 1 & b_{12} & ... & b_{1n} \\ b_{21} & 1 & ... & b_{2n} \\ ... & ... & ... & ... \\ b_{n1} & b_{n2} & ... & 1 \end{bmatrix} \begin{bmatrix} y_{1t} \\ y_{2t} \\ ... \\ y_{nt} \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ ... \\ a_n \end{bmatrix} + \begin{bmatrix} \Gamma_{11}(L) & \Gamma_{12}(L) & ... & \Gamma_{1n}(L) \\ \Gamma_{21}(L) & \Gamma_{22}(L) & ... & \Gamma_{2n}(L) \\ ... & ... & ... & ... \\ \Gamma_{n1}(L) & \Gamma_{n2}(L) & ... & \Gamma_{nn}(L) \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \\ ... \\ y_{nt-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ ... \\ \varepsilon_{nt} \end{bmatrix} \quad (1)$$

or in a more compact form:

$$\mathrm{B}\, y_t = \mathrm{A} + \Gamma(L)\, y_{t-1} + \varepsilon_t \quad (2)$$

where B is a matrix $n \times n$ of the coefficients of n endogenous variables in the y_t vector. A represents the constant vector $n \times 1$, $\Gamma(L)$ is the matrix $n \times n$ of the polynomial spreads which catches the spreads of the endogenous variables, and ε_t is the vector $n \times 1$, $\varepsilon_t \sim N(0, \Omega)$. The model from equation [2] can be adjusted in order to include exogenous variables as:

$$\mathrm{B}\, y_t = \mathrm{A} + \Gamma(L)\, y_{t-1} + \Pi\, x_t + \varepsilon_t \quad (3)$$

In this case, Π is a matrix $n \times p$ of the coefficients and x_t is the vector $p \times 1$ for the exogenous variables such as the weather and/or an accidental variable. Therefore, the VAR model avoids this problem of endogeneity, estimating the model through a simplified form, in accordance to the predetermined and the residual variables. Multiplying the equation [3] by B^{-1} a form reduced VAR results:

$$y_t = C_0 + C_1(L) y_{t-1} + C_2 x_t + e_t \quad (4)$$

Where: $C_0 = B^{-1}A$, $C_1(L) = B^{-1}\Gamma(L)$
$C_2 = B^{-1}\Pi$ şi $e_t = B^{-1}\varepsilon_t$.

As e_t is a function of ε_t, it is made of uncorrelated residual values which will be correlated during the equations.

3. Empirical Results

The study considers the period during 2000 – 2011 and one used the quarterly data provided by the European Central Bank and the National Bank of Romania. These data are represented in table no. 1. The endogenous variables used for the ***VAR model*** are: the credit risk rate (RRC), interest rate (INT), the GDP growth rate (G) and the real exchange rate (REER). The exogenous variable is considered constant. To assure accurate results, the logarithms of the data introduced in the Eviews statistic program have been previously found, except for the G variable.

In scenario no. 1 one presents the results of the estimates concretised in the responses of the credit risk rate to the GDP increase rate shocks, of the real exchange rate and of the interest rate on our country level. From scenario no. 1 and graphic no. 1 results the fact that, in the case of credit institutions, the improvement of the loan portfolio quality of a bank is due to a depreciation of the real exchange rate, while a high interest rate leads to the increase of the non-reimbursement probability risk. At the same time, the increase of the GDP only increases the incomes of the population and implicitly to minimize the credit risk.

Table 1. The variable used in the model (only annual values)

	RRC	INT	G	REER
2000	3.83	35	2.4	95.55
2001	2.54	35	5.7	94.12
2002	1.1	27.7	5.1	77.05
2003	3.37	19.03	5.2	78.13
2004	2.85	19.925	8.5	74.67
2005	2.61	8.625	4.2	100
2006	2.81	8.6175	7.9	107.16
2007	3.99	7.3275	6.3	128.47
2008	6.52	9.8125	7.3	138.76
2009	15.29	9.095	-7.9	120.69
2010	20.82	6.5	-1.3	128.67
2011	23.28	6.25	2.5	130.31

Source: European Central Bank and National Bank of Romania

Scenario no. 1. Estimation of the VAR model for Romania

Vector Autoregression Estimates

Date: 03/20/13 Time: 03:40

Sample (adjusted): 2000Q3 2011Q4

Included observations: 46 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	LRRC	LINT	G	LREER
LRRC(-1)	1.452757 (0.16276) [8.92550]	0.037035 (0.09989) [0.37076]	-2.139400 (1.83030) [-1.16888]	-0.050623 (0.03740) [-1.35351]
LRRC(-2)	-0.549281 (0.16011) [-3.43067]	-0.054274 (0.09826) [-0.55237]	1.492734 (1.80044) [0.82910]	0.046842 (0.03679) [1.27321]
LINT(-1)	-0.123321 (0.43545) [-0.28320]	1.350712 (0.26723) [5.05448]	4.735979 (4.89665) [0.96719]	0.165779 (0.10006) [1.65679]
LINT(-2)	0.013063 (0.44143) [0.02959]	-0.344356 (0.27090) [-1.27115]	-5.642006 (4.96392) [-1.13660]	-0.203549 (0.10143) [-2.00670]
G(-1)	-0.000453 (0.01904) [-0.02382]	0.004876 (0.01168) [0.41727]	1.094165 (0.21410) [5.11054]	-0.007274 (0.00437) [-1.66257]
G(-2)	-0.004630 (0.01615) [-0.28676]	-0.004435 (0.00991) [-0.44761]	-0.405405 (0.18156) [-2.23290]	0.004755 (0.00371) [1.28154]
LREER(-1)	-0.754544 (0.94079) [-0.80203]	0.137292 (0.57735) [0.23780]	10.72132 (10.5792) [1.01343]	1.707168 (0.21618) [7.89699]
LREER(-2)	0.836047 (1.00496) [0.83192]	0.059982 (0.61674) [0.09726]	-14.29626 (11.3009) [-1.26505]	-0.847704 (0.23093) [-3.67088]
C	0.095930 (1.09925) [0.08727]	-0.932528 (0.67460) [-1.38235]	21.28729 (12.3611) [1.72211]	0.774475 (0.25259) [3.06612]

R-squared	0.976638	0.979806	0.877156	0.977768
Adj. R-squared	0.971586	0.975439	0.850595	0.972961
Sum sq. resids	0.927446	0.349291	117.2772	0.048970
S.E. equation	0.158323	0.097161	1.780352	0.036380
F-statistic	193.3440	224.4005	33.02425	203.4074
Log likelihood	24.51997	46.98014	-86.79684	92.16794
Akaike AIC	-0.674781	-1.651311	4.165080	-3.615997
Schwarz SC	-0.317004	-1.293533	4.522858	-3.258220
Mean dependent	1.573769	2.530689	3.944022	4.646810
S.D. dependent	0.939249	0.619974	4.605988	0.221244

Determinant resid covariance (dof adj.)	1.30E-07
Determinant resid covariance	5.44E-08
Log likelihood	123.6441
Akaike information criterion	-3.810612
Schwarz criterion	-2.379501

Estimation Proc:
===============================
LS 1 2 LRRC LINT G LREER @ C
VAR Model:
===============================
LRRC = C(1,1)*LRRC(-1) + C(1,2)*LRRC(-2) + C(1,3)*LINT(-1) + C(1,4)*LINT(-2) + C(1,5)*G(-1) + C(1,6)*G(-2) + C(1,7)*LREER(-1) + C(1,8)*LREER(-2) + C(1,9)
VAR Model - Substituted Coefficients:
===============================
LRRC = 1.452757433*LRRC(-1) - 0.5492805802*LRRC(-2) - 0.1233207335*LINT(-1) + 0.01306262589*LINT(-2) - 0.0004534614336*G(-1) - 0.004629980509*G(-2) - 0.7545439414*LREER(-1) + 0.8360465674*LREER(-2) + 0.09592981381

Source: own calculations in Eviews program

We present in the annex no.1 the response functions of the risk credit indicator to the GDP shocks, the interest rate and the real exchange rate. Thus, a positive response is associated to an increase of the incomes of the population and thus implicitly to a decrease of the credit risk. On the other hand, a negative shock of the real exchange rate is associated to a decrease in the loan portfolio quality, because the debtor purchase power increases. At the same time, a positive shock of the interest rate also has a negative impact on the loan portfolio quality because thus the rates to pay for the debtors increase and thus the non-reimbursement risk increases.

In the case where we use ***the least squares method***, we obtain the following results:

Scenario no. 2. Estimation of the Least Squares Method for Romania

Dependent Variable: LRRC
Method: Least Squares
Date: 03/20/13 Time: 03:47
Sample: 2000Q1 2011Q4
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
G	-0.090279	0.017011	-5.307092	**0.0000**
LINT	-0.322741	0.173772	-1.857270	**0.0700**
LREER	1.723590	0.523872	3.290096	**0.0020**
C	-5.259882	2.791466	-1.884272	**0.0661**

R-squared	0.722640	Mean dependent var	1.566207
Adjusted R-squared	0.703729	S.D. dependent var	0.919781
S.E. of regression	0.500644	Akaike info criterion	1.533811
Sum squared resid	11.02834	Schwarz criterion	1.689744
Log likelihood	-32.81147	F-statistic	38.21292
Durbin-Watson stat	1.703652	Prob(F-statistic)	0.000000

The estimated regression equation is:

$$LRRC = -0.09*G - 0.32*LINT + 1.72*LREER - 5.25 \quad (5)$$

From the above equation results that there is a high intensity negative correlation between the GDP increase rate and the credit risk which reflects the fact that at a decrease by a percent of the GDP increase rate, the credit risk rate will increase by 0.09%. On the other hand, there is a negative correlation between the monetary policy credit risk rate and the credit risk rate, namely at a decrease by a percent of the interest rate, the credit risk rate will increase by 0.32%. However, in the case of the effective real exchange rate, there is a positive correlation with the credit risk rate, so that at an increase by a percent of the actual real exchange rate, the credit risk rate increases by 1.72%. By analysing the p-value registered values one can say that only in the case of the GDP increase rate and of the actual real exchange rate the obtained results are significant because the obtained values are much smaller than the 0.05% significance threshold. In the case of the monetary policy interest rate, the p-value is placed over the minimum significance threshold, and therefore it results that one accepts the null hypothesis and we cannot achieve any correlation between the interest rate and the credit risk rate. In other words, in the case of the method of the smallest squares, the monetary policy interest rate would exercise no significant influence on the credit risk rate. The value of R^2 shows that approximately 72% of the credit risk rate variation is explained by the variation of the variation of the GDP increase rate, of the actual real exchange rate and of the monetary policy interest rate.

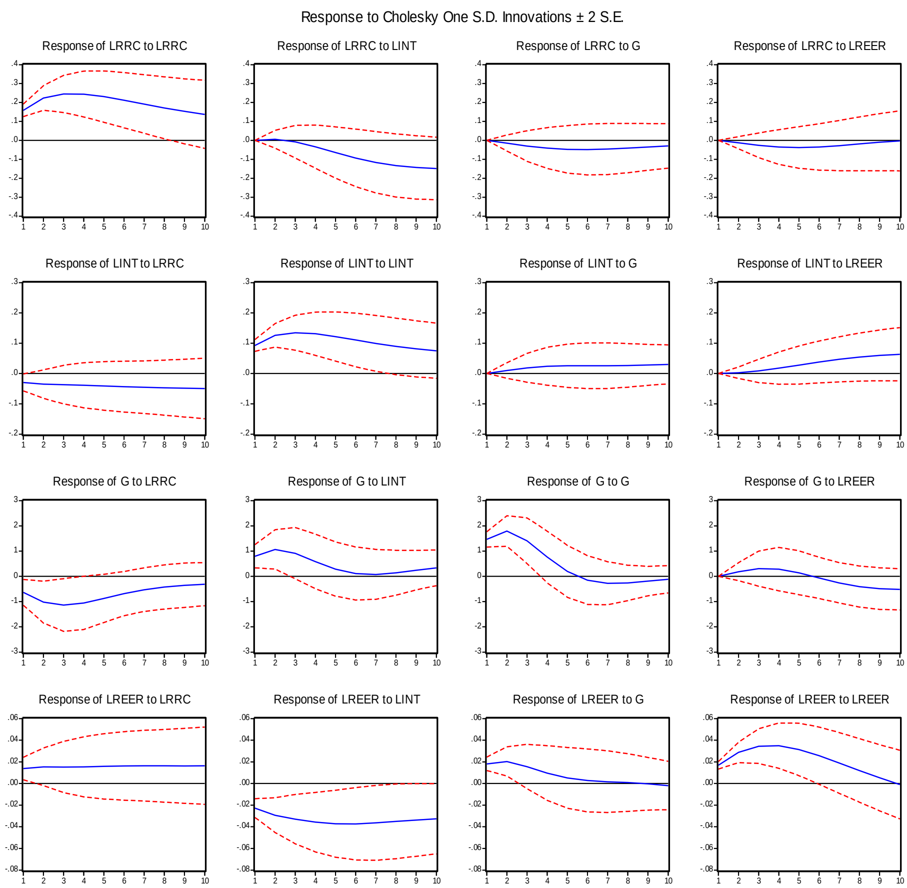
Therefore we have obtained results in the case of both used method which denotes that the estimated model is correct and the obtained results are significant.

4. Conclusions

This article points out thus the impact of some moderate and external macroeconomic shocks on the quality of the loan portfolios of banks. The VAR methodology offers us useful results for research. Thus, the monetary and structural influences are pointed out through the cumulative use of the impulse-response functions. The monetary factors have greatly contributed to the intensity of the financial crises. Beyond these results, it is obvious that the interest rate and the real exchange rate play an important role in the dimensioning of the loan portfolio at the banking system level.

Therefore, the monetary authorities must be careful when they use the exchange rate as monetary policy instrument considering the fact that the impact on the exposure to the credit risk is not homogenous at the level of all credit institutions. The increase of the interest rate and a high inflation represent early warning systems of the deterioration of the loan portfolio quality. In conclusion, the govern representatives and the banks must efficiently administrate the risk in favourable economic conditions.

Annex no. 1. The responses of the credit risk rate to the shocks to the GDP increase rate, the interest rate and the real exchange rate shocks



Source: own calculations in Eviews program

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