

## **Assessing the Sectoral Dynamics of Non-performing Loans: Signs from Financial and Real Economy**

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**Abstract.** *The paper is an attempt at studying the mechanisms whereby the economic activity dynamics and money market conditions affect the developments in nonperforming loan ratio across the main activity sectors, namely agriculture, industry, commerce and constructions. The default rates are modeled both on the basis of a linear approach and via a logistic function, starting from the methodological solution of the reputed conditional risk model referred to as Credit Portfolio View. The robustness of the analytical framework is ensured by applying SUR estimation method for simultaneous systems of equations in combination with that of autoregressive vectors. The empirical analysis is based on unique set of quarterly data, which allows for assessing the quality of non-financial companies loan repayment. The relevant explanatory variables were used in various configurations and lags for constructing several macroeconomic credit risk models.*

**Keywords:** nonperforming loans; financial stability; macroeconomic credit risk models; real economy; monetary conditions.

**JEL Codes:** G01, G17, G21, G32, G33.

**REL Code:** 11B.

## 1. Introduction

Finding the determinants of reimbursing capacity of non-financial corporations starts from the empirical observation that bank credit default rates are higher during recessionary periods than during an economic upturn (Williamson, 1985, Kiyotaki, Moore, 1997, Marcucci Quagliariello, 2009). At the root of such discussions lay economic growth and interest rates, along with the exchange rate in the case of countries with a large share of foreign-currency denominated loans in the loan stock.

This paper follows the methodological line suggested by Wilson C. Thomas (1998), who went into more details as regards the theme of conditional credit risk models and proposed the reputed Credit Portfolio View model. Accordingly, the relation between credit risk and the macroeconomic landscape is best described by the logistic function and the lag is considered within the time frame delineated by the frequency of observations (one year).

Boss Michael (2002) applies the above-mentioned methodological solution in order to model the sectoral dependence of credit risk to the state of the Austrian economy both at the level of exposures to non-financial corporations and at the level of exposures to households. Empiric evidence shows that the macroeconomic factors generating default rates are, generally, the same for both types of counterparties, with the inflation rate and the short-term interest rate equally influencing the repayment ability of both non-financial corporations and households.

Virolainen Kimmo (2004) models the credit risk dynamics for Finland by using macroeconomic variables such as economic growth, inter-bank interest rate for a maturity of up to one year and the corporate indebtedness level. Unlike previous research works, the analysis of default rate sensitivity relating to the stock of loans extended to non-financial corporations vis-à-vis economic performance is broken down by sector, in six types of activity. At the same time, in measuring the coefficients of the equation system the author opts for the SUR method with a view to limiting the correlation between estimated regression errors resulting from the significant degree of correlation between the dependent variables.

Fiori, Roberta, Foglia Antonella and Iannotti Simonetta (2007) envisage analysing the extent to which the economic picture in Italy affects the developments in credit risk triggered by the exposures to non-financial corporations broken down by sector in eight categories. The methodology is based on Wilson's approach (1998) and the subsequent developments designed by Virolainen (2004), whereas the assessment of the operational form of the empiric relation between the logistically changed values of default rates by

sector and the macroeconomic environment is achieved via SUR method. The information on default rates at sectoral level is achieved by accessing the archives of the Central Credit Register in Italy. The preliminary testing of explanatory variables includes an enlarged set of macroeconomic indicators comprising 22 factors but, at the end of the multivariate filtering, only seven systemic factors were elicited, namely economic growth, the degree of financial intermediation, the short-term interest rate, the real EUR/USD exchange rate, the inter-bank interest rate spread, the inflation rate and the price of oil. Out of these indicators, within the individual specifications, the presence of the eight equations forming the estimated system is higher for the first four indicators.

As far as new EU Member States are concerned, analyses in this particular area are more difficult to identify. Jakubik and Schmieder (2008) give an overview of the macroeconomic factors weighing on credit risk in the Czech Republic, compared to Germany. The paper features different approaches to nonperforming loans generated by households and those by non-financial corporations, with empirical results showing some similarities between the two countries in terms of the set of exogenous variables. Both in the Czech Republic and Germany the annual GDP growth rate and the year-earlier financial indebtedness exert an influence on the default rate associated with corporate loans. In regard to households, one variable from either set of indicators for the labour market and the counterparties' financial burden are included in the function form of regressions estimated for the two countries. The major determinants identified in the paper are the year-earlier unemployment rate and the real interest rate recorded three quarters before in the case of the Czech Republic and the current disposable income and the year-earlier financial indebtedness in the case of Germany.

Starting from the methodological approaches summarised previously, we envisage developing a system to predict nonperforming loan rates that will be able to identify at sectoral level the macroeconomic determinants of the repayment behaviour of debtors, legal entities, across the Romanian banking system.

The operational objective of our research paper is to build a set of econometrical models to answer to four interrelated questions: (i) Which are the components of the macroeconomic variables set that can signal in advance the developments of the companies nonperforming loans?; (ii) Which are the lags and the individual intensities of the macroeconomic relevant indicators when affecting the companies overdue loans rate? (iii) What is the hierarchy of the factors with impact on the dynamics of companies overdue loans?; (iv) What are the characteristics of the loans reinbursement behaviour in case of shocks on real economy or money market?

The paper is composed out of three sections and it concludes with the main findings and future research objectives. In the first section we described the methodological framework for assessing companies overdue loans, starting with the findings in the international literature. The second part comprises of both presentation of the data series that were used and the economic rational and statistical evidence which lead us in selecting the explanatory variables. In the third section we described main empirical findings derived by constructing and testing of the macroeconomic credit risk models.

## 2. Methodological framework

Methodological solutions used in identifying a symplified functional form of the macroeconomic models for assesing credit risk are based on multivariate regressions, estimaed independently or simultaneously (in systems of equations).

For capturing the general economic context that influence the repayment behavior of companies in different economic sectors, the sensitivity of rate of nonperforming loans to the developments of the Romanian economy is assesed individually on four major components of economic activity.

The methodology used in this research paper is based on the approach used by Virolainen (2004), which developed the conditional credit risk model proposed by Wilson (1998). Consequently, the conceptual model for the forecasting system of the nonperforming loans ratio is based on the hypothesis that the functional link between the endogeneous variable and the set of explanatory variables is captured by the logit function. The functional link is also investigated as a linear equation.

The methodological solution used in the research paper is based on the following systems of equations:

$$\left\{ \begin{array}{l} \ln\left(\frac{RCN_{AGR,t}}{1 - RCN_{AGR,t}}\right) = \sum_{i=1}^n \alpha_i \times y_{s,t} + \varepsilon_{AGR} \\ \ln\left(\frac{RCN_{IND,t}}{1 - RCN_{IND,t}}\right) = \sum_{j=1}^m \alpha_j \times y_{j,t} + \varepsilon_{IND} \\ \ln\left(\frac{RCN_{COM,t}}{1 - RCN_{COM,t}}\right) = \sum_{i=1}^n \alpha_i \times y_{s,t} + \varepsilon_{COM} \\ \ln\left(\frac{RCN_{CONS,t}}{1 - RCN_{CONS,t}}\right) = \sum_{j=1}^m \alpha_j \times y_{j,t} + \varepsilon_{CONS} \end{array} \right. , \text{ and} \quad (1)$$

$$\left\{ \begin{array}{l} \Delta RCN_{AGR,t} = \sum_{i=1}^n \alpha_i \times y_{s,t} + \varepsilon_{AGR} \\ \Delta RCN_{IND,t} = \sum_{j=1}^m \alpha_j \times y_{j,t} + \varepsilon_{IND} \\ \Delta RCN_{IND,t} = \sum_{i=1}^n \alpha_i \times y_{s,t} + \varepsilon_{COM} \\ \Delta RCN_{IND,t} = \sum_{j=1}^m \alpha_j \times y_{j,t} + \varepsilon_{CONS} \end{array} \right.$$

The individual impact of macroeconomic factors on the evolution of rates of default is analysed using first difference (with quarterly frequency) of the time series using SUR (Seemingly Unrelated Regression) econometric estimation technique. This econometric framework improves the efficiency of the estimation by adjusting the coefficients of both equations so that to reduce the errors correlation, as the significant correlation between the dependent variables of the system can generate a high errors' correlation. The framework for identifying the determinant factors is improved by using autoregressive vectors that can better identify the persistence and impact in time of the macroeconomic variables on the evolution of rates of nonperforming loans.

The relevance of the determinant factors was computed based on individual contribution to the adjusted R squared for systems of equations estimated using the SUR method and on variance decomposition for a 24 month time horizon in case of VAR models

### 3. Data

The dynamics of the overdue companies loans was illustrated as an overdue loans value weight. A loan is considered overdue if the debt service is higher than 90 days.

The data used for the empirical analysis cover quarterly information during the period of Q3 2004 – Q1 2010. The beginning of the estimation period is determined by the availability of data for the dependent variables - companies default ratios for the following sectors: agriculture, industry, services and constructions. The independent variables were grouped into two subgroups: a) real economy; and b) monetary conditions (Table 1).

Table 1

<b>List of candidate variables</b>		
	<b>Determinants</b>	<b>Expected sign of impact on the dependent variables</b>
<i>Real economy</i>		
1	Seasonally adjusted value added expressed both in constant and current prices for the above mentioned economic sectors	-
2	Gross income	-
3	Energy price index	+
4	Fuel price index	+
5	Quaterly FDI flow	-
6	Quaterly export value flow	-
<i>Monetary conditions</i>		
1	Interest rate for RON loans	+
2	Interest rate for euro loans	+
3	1M and 3M EURIBOR rate	+
4	Volume of mortgage loans	-
5	EURRON exchange rate	+

These data were drawn up from the reports of the Statistics National Institute and those of the National Bank of Romania.

The variables of the labor market and value added were seasonally adjusted based on the Tramo Seats methodology in order to eliminate the impact of the seasonal factors on this market, especially of the public sector. Moreover, as all the data series were considered non-stationary and integrated of order one, based on their economic significance and statistical tests (ADF și Phillips-Perron), their stationalisation was ensured through first-diferentiation. Moreover, except nonperforming loans rates and interest rates, all the variables were considered in the econometrical analysis in natural logarithms.

#### 4. Empirical analysis

For selecting the models' specifications, the starting point was the estimation of equations systems. Given the complexity of the analysis, the selection procedure for the determinant factors consisted in employing a reasonable number of models that used a large diversity of exogenous variables.

Models' specifications, including number of lags, was chosen so that to insure functional stability of the mechanism both form the economical and econometrical point of view, taking into account specific statistics as adjusted R squared, informational criteria, tests for regression errors.

Empirical results lead to the selection of four (relatively) distinct specifications based on combining of two methodologies for regressions estimation (linear and logistic) and two measures of added value (in current and constant prices) and the lags and the individual intensities of the macroeconomic relevant indicators when affecting the companies overdue loans rate were estimated both with SUR systems of equations and with VAR models (Table 2).

Table 2

## Systems of equations specifications for the dynamics of the default rates

Factors Models	Agriculture				Industry				Services				Constructions			
	VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R
	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit
<b>Real economy</b>																
Value added of the sector	-0.03 (3)**	-0.39 (2)**	-0.03 (3)**	0.00 -	-0.05 (3)**	-1.00 (3)**	-0.06 (2)***	-1.58 (2)***	-0.13 (3)***	-2.60 (2)***	-0.17 (3)***	-3.79 (2)***	-0.03 (3)**		-0.08 (4)***	
Gross income	-0.23 (3)***	-3.69 (3)***	-0.20 (3)***	-3.77 (3)***										-2.47 (2)***		-2.33 (2)**
Fuel prices	0.07 (1)*	-0.12 (1)***	0.06 (1)*	1.13 (1)***												
FDI	-0.008 (4)***	-0.123 (4)***	-0.009 (4)***	-0.136 (4)***		-0.030 (6)***	-0.002 (6)*	-0.036 (8)***	-0.003 (2)***		-0.003 (2)***					
Export					-0.03 (6)***	-0.32 (6)*	-0.03 (4)***	-0.57 (4)***								
<b>Monetary conditions</b>																
RON interest rate	0.50 (2)***	8.27 (2)***	0.47 (2)***	7.25 (2)***	0.11 (2)***	2.90 (2)***	0.06 (2)*	2.62 (2)***	0.19 (1)***	2.52 (1)**	0.16 (1)***	2.40 (1)**				
EUR interest margin					0.48 (4)***	12.52 (4)***	0.74 (4)***	19.27 (4)***					1.02 (5)***	17.59 (1)*		
EURRON exchange rate										1.05 (5)**		0.96 (5)**	0.05 (6)***	1.49 (5)*	0.04 (6)**	2.46 (5)***
Mortgage loans													-0.02 (2)***	-1.02 (2)**	-0.03 (2)***	-0.73 (2)***
Constant	0.060	0.909	0.063	0.989	0.004	0.074	0.002	0.056	0.027	0.119	0.025	0.078	0.008	0.311	0.010	0.264
Adjusted R squared	70.4%	68.0%	70.9%	64.8%	54.2%	58.1%	59.4%	67.7%	76.8%	63.0%	76.6%	68.3%	84.8%	53.6%	77.5%	68.3%
Durbin Watson	2.12	1.58	1.84	1.36	1.37	1.38	1.28	1.89	1.84	1.40	2.02	1.70	2.10	1.59	1.76	1.70

**Note:** (x) represents the impact interval expressed in number of quarters.

Results of the statistical tests show that the set of models comply with demands of a good econometrics performance. The response time frame of the rates of default to a shock on macroeconomic and monetary variables was set based on the lag of the independent variables in the regression equations.

Structural investigation of the determinants set was followed by detailed investigation of the autoregressive profile, which emphasize the importance of the second round effects. The autoregressive profile analyzed by using vector-autoregression (VAR) models. These models evaluate the persistence of effects of shocks on different macroeconomic and monetary variables on the dynamics of defaults.

Based on the results of the impulse-response functions of default rates to macroeconomic and financial variables identified in the SUR systems of equations estimations procedure, 16 alternative VAR models were estimated. Thus each VAR model specification was consistent with final specification of each equations in the estimated systems of equations, while the number of lags for each VAR was selected so that to insure its stability and in the same time to be consistent with economic theory and statistically relevant (Adjusted R-squared, Informational criteria).

According to analysis of the roots of characteristic polynomial, all the four VAR specifications fulfill the stability condition. Moreover, according to the residuals correlogram, there is no autocorrelation of the errors. For generating the impulse-response functions, the time horizon taken into account was 8 quarters and the interpretation of the results was based on the cumulated impulse-response functions of the two rates of defaults to a shock on variables in the system.

Results of the cumulated impulse-response functions, for a tiome horizon of two years are presented in Table 3.



Table 3

<b>Impulse-response functions for the VAR models</b>	
<b>Agriculture</b>	<i>(1) a shock on gross income has an impact on the rate of defaults that lasts four quarters.</i>
<b>Industry</b>	<i>(1) a shock on the RON loans interest rate has a statistically significant impact on default rate after one quarter; (2) a shock on FDI has an impact on default rate starting from the first quarter and lasts four quarters.</i>
<b>Services</b>	<i>(1) the impact of a shock on value added in services is statistically significant after first quarter and lasts 3 quarters; (2) a shock on FDI has an impact on default rate starting from the fourth quarter; (3) a shock on RON loans interest rates has an impact on default rate starting with the fourth quarter and has a high percintency.</i>
<b>Constructions</b>	<i>(1) the impact of a shock on EUR loans interest rate margin is statistically significant after one quarter; (2) the impact of a shock on EURRON exchange rate is statistically significant after three quarters; (3) the impact of a shock on mortgage loans has an impact on default rate starting with the fourth quarter and has a high percintency.</i>

The econometric was deepened by variance decomposition for both simultaneous equations and VAR models, in order to emphasize how much of the variance of rates of default is explained by the variance of each determinant macroeconomic or financial (Table 4).

Factorial decompositions shows that the monetary variables are more important than those of the real economy in explaining the dynamics of the rate of defaults for construction sector, while for agriculture sector the findings are opposite. For industry and services sectors, the models seems not to show a clear conclusion on this regard.

The loan reimbursement capacity of the companies from the agriculture sector is determined mainly by the dynamics of the gross income, foreign direct investments and interest rate for RON denominated loans. For industry, the determinants factors are the financing cost, expressed by the interest rate for RON denominated loans and the interest rate margin for EUR denominated loans and added value measured in constant prices. Factorial decomposition for the services and commerce sector shows the importance of the real economy variables, as value added and FDI. Among the monetary factors the contribution of RON loans interest rate is especially noticed, exchange rate having only a minor impact. But the exchange rate is especially important, along with the risk premium for EUR denominated loans and the evolution of mortgage loans, in explaining the dynamics of rate of default in the construction sector.

Table 4

## Factorial decomposition

Factors	Models	Agriculture				Industry				Services				Constructions			
		VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R	VA No	VA No	VA R	VA R
	Met.	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit	Linear	Logit
Real economy																	
Sector value added	SE	4.4%	3.0%	4.9%	0.0%	17.2%	12.1%	14.4%	17.7%	39.8%	29.0%	38.6%	35.3%	2.8%	0.0%	24.5%	0.0%
	VAR	14.8%	28.3%	3.7%	8.6%	17.0%	20.4%	19.3%	11.8%	4.2%	13.2%	21.5%	12.2%	29.6%	33.8%	17.5%	44.9%
Gross income	SE	35.4%	39.0%	31.9%	39.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.6%	0.0%	25.3%
	VAR	45.3%	32.1%	46.0%	34.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fuel prices	SE	2.4%	3.0%	1.9%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	VAR	1.6%	3.7%	1.4%	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FDI	SE	51.4%	41.0%	51.9%	33.8%	0.0%	2.1%	14.4%	7.7%	15.8%	0.0%	17.6%	0.0%	0.0%	0.0%	0.0%	0.0%
	VAR	5.3%	13.0%	5.7%	13.3%	6.1%	1.7%	1.3%	2.5%	18.5%	4.1%	7.3%	0.7%	0.0%	0.0%	0.0%	0.0%
Export	SE	0.0%	0.0%	0.0%	0.0%	20.2%	6.1%	11.4%	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	VAR	0.0%	0.0%	0.0%	0.0%	12.1%	8.9%	0.9%	28.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Monetary conditions																	
Interest rate for RON loans	SE	51.4%	47.0%	52.9%	44.8%	16.2%	26.1%	3.4%	10.7%	18.8%	5.0%	14.6%	3.3%	0.0%	0.0%	0.0%	0.0%
	VAR	11.4%	13.5%	20.7%	35.3%	11.0%	19.9%	8.6%	18.1%	33.9%	55.8%	40.3%	67.3%	0.0%	0.0%	0.0%	0.0%
EU loans interest margin	SE	0.0%	0.0%	0.0%	0.0%	9.2%	20.1%	36.4%	46.7%	0.0%	0.0%	0.0%	0.0%	14.8%	5.6%	0.0%	0.0%
	VAR	0.0%	0.0%	0.0%	0.0%	5.2%	9.9%	5.4%	8.8%	0.0%	0.0%	0.0%	0.0%	27.5%	29.9%	30.3%	14.2%
EURRON exchange rate	SE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.0%	0.0%	5.3%	6.8%	0.4%	5.5%	29.3%
	VAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.6%	5.9%	9.5%	7.4%
Mortgage loans	SE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.8%	4.6%	23.5%	35.3%
	VAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.4%	10.6%	11.0%	24.4%
Real economy factors																	
	Average	80.3%	81.5%	73.7%	66.3%	36.3%	25.7%	30.8%	37.4%	39.1%	23.2%	42.5%	24.1%	16.2%	21.2%	21.0%	35.1%
Monetary conditions factors																	
	Average	31.4%	30.2%	36.8%	40.1%	20.8%	38.0%	26.9%	42.2%	26.3%	34.0%	27.4%	38.0%	46.4%	28.5%	39.9%	55.3%

Among the real economy variables it is worth mentioning especially the gross income; the added value for the construction sector having only a minor impact. The results are not surprising taking into account the likely modest representation in the official data of the actual level of new created value in this sector than the other sectors of the economy.

## **5. Conclusions**

Econometric results shows that the dynamics of the real economy is the main driver of the evolution of the rates of default for nonfinancial companies; the financial pressure induced by the monetary conditions, except for the constructions sector, being a secondary factor.

The impact time frames are generally low, the maximum effects being registered until the first year. Exception is the FDI and exports volume, which negatively impact the rate of default in industry after six quarters and also the exchange rate that have impact on rates of default in services and constructions sectors after five or six quarters.

Factorial decomposition confirms the assumption of a strong link between the dynamics of the mortgage loans and the dynamics of rate of default in constructions sector.

The linear models seems to be the preferred solution except for the industry sector and the way to express the added value seems not to be of great importance for agriculture and services sectors, but for industry the real value (in constant prices) is relevant and for constructions the nominal value (current prices) is more important.

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