

**Academy of Economic Studies  
Doctoral School of Finance and Banking**

# **Macroeconomic Determinants of Credit Risk**

**Non-Performing Loans Approach in Central and Eastern Europe**

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# Contents

- Introduction
- Paper's Objectives
- Literature review
- Methodology
- Data analysis
- Results
- Conclusion
- References

# Introduction

- Recent financial crisis outlined the importance of managing correctly credit risk in relation with macroeconomic context.
- Banks' non-performing loans (NPL) serve as an important indicator of financial imbalances.
- A high share of problem loans indicates that borrowers are having problems servicing their debt and this may lead to higher losses for banking sector.
- After one decade in which borrowing had grown constantly, banks' loan portfolio had deteriorated and had become an issue of substantial importance for both financial institutions and regulatory authorities.
- The rapid growth in loan portfolio was due to the deregulation of financial markets, the reduced transactional costs and the rapid economic growth, transposed in the evolution of credit supply.

# Motivation and Objectives

The motivation of this paper is to improve the understanding of credit risk determinants, focusing mostly on macroeconomic key factors.

Our objectives are:

- To determine what variables contribute to the evolution of non-performing loans rate in the five countries from Central and Eastern Europe
- To determine to what extent there is a persistence of non-performing loans over time
- To establish whether there is any significant specific determinant of non-performing loans for each country

# Literature Review

Stress testing to analyzes the linkage between non-performing loans and macroeconomic conditions

- **Wilson (1998)** link macroeconomic factors with corporate default rates considering CreditPortfolioView, a credit risk model developed by McKinsey&Co.
- **Boss (2002)** in stress testing Austrian credit portfolio confirm the influence of inflation and short term interest rate on the debt paying capacity.
- **Jakubik and Schmieder (2008)** find both in Czech Republic and Germany that GDP growth rate and credit to GDP rate have an influence on the default rate of corporate loans and labor market and indebtedness affect household non-performing loans.

Anti-cyclical behavior of the non-performing loans

- **Berge and Boye (2007)** on Norway, confirm that house prices, real interest rates and unemployment make a significant contribution to the rise of non-performing loans
- NPL is considered a proxy for the onset of banking crisis by **Reinhart and Rogoff (2010)**
- **Vogiazas and Nikolaïdou (2011)** find for Romanian banking system that construction, investment expenditure, inflation, unemployment, external debt to GDP and M<sub>2</sub> influence credit risk
- According to **Louzis, Vouldis and Metaxas (2010)**, Greek banking sector is affected by GDP, unemployment, interest rates, and public debt, performance and efficiency
- **Nkusu (2011)** demonstrate that asset price, unemployment rate and economic growth affect non-performing loans rate

# Methodology

OLS Panel regression:

$$y_{it} = \alpha + X'_{it}\beta + u_{it} \quad i = 1, \dots, N; t = 1, \dots, T$$

- i – cross sectional dimension
- t – time dimension
- $\alpha$  – scalar
- $\beta$  – vector of coefficients
- $X$  – vector of explicative variables

$$u_{it} = \mu_i + v_{it}$$

- $\mu$  represents the unobservable and time invariant fixed effects in the cross section dimension and  $v$  represents the reminder disturbance

# Methodology

Dynamic panel specification:

$$y_{it} = \delta y_{i,t-1} + X'_{it} \beta + u_{it} \quad i = 1, \dots, N; \quad t = 1, \dots, T$$

GMM estimation – Arrelano and Bond (1991)

$$y_{it} - y_{it-1} = \delta(y_{i,t-1} - y_{it-2}) + (X_{it} - X_{it}) \beta + (v_{it} - v_{it-1})$$

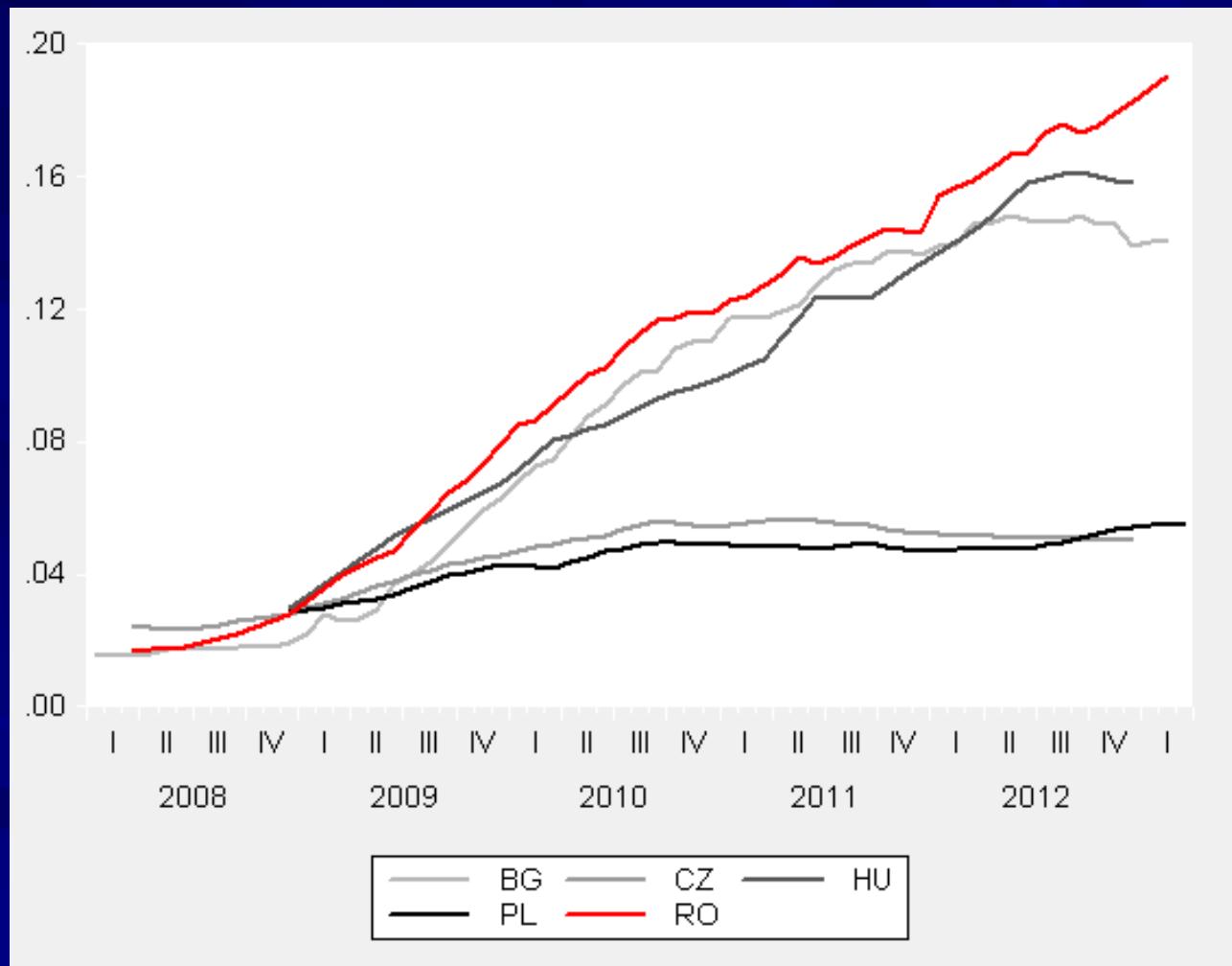
Instruments:  $E [z_i \varepsilon_i] = 0$ ,  $\varepsilon_{it} = (v_{it} - v_{it-1})$

# Data Analysis

- Sample: monthly data between 2008M01 and 2013M03
- Cross section: Bulgaria, Czech Republic, Hungary, Poland, Romania
- International Monetary Fund approach for calculating NPL rate
- Exlicative variables: GDP growth, Gross capital formation growth, Unemployment rate, Monetary policy rate, 6-month interest rate, 6-month EURIBOR
- Logarithmic transformation of variables, except form GDP growth and gross capital formation growth.
- Stationary series by first differencing and stationary panel stacked series

# Data analysis

## Evolution of Non-Performing Loans Rate



# Data Analysis

## Correlation Matrix

	DLNPL	DLFX	DLIPOL	DLIRATE6M	DLEURIBOR6M	DGDPGR	DGCFGR	DLUNEMP
DLNPL	1							
DLFX	0.0300	1						
DLIPOL	-0.2072	-0.0212	1					
DLIRATE6M	-0.1474	-0.0048	0.4116	1				
DLEURIBOR6M	-0.2184	-0.0476	0.1595	0.28712	1			
DGDPGR	-0.0694	-0.0561	-0.0177	-0.06538	0.0420	1		
DGCFGR	-0.0445	-0.1043	-0.0066	-0.11701	0.0230	0.1465	1	
DLUNEMP	0.4330	0.0677	-0.2519	-0.15685	-0.3033	0.0077	0.0078	1

BG HU RO	DLNPL	DLFX	DLIRATE6M	DLEURIBOR6M	DLIPOL	DGDPGR	DGCFGR	DLUNEMP
DLNPL	1							
DLFX	0.0237	1						
DLIRATE6M	-0.1661	-0.0072	1					
DLEURIBOR6M	-0.2496	-0.0609	0.1313	1				
DLIPOL	-0.2926	-0.0287	0.1438	0.0669	1			
DGDPGR	-0.1132	-0.0579	-0.0617	0.0948	-0.0072	1		
DGCFGR	-0.0638	-0.1063	-0.1401	0.0497	0.0174	0.1552	1	
DLUNEMP	0.5206	0.0840	-0.1600	-0.2839	-0.3658	-0.0400	-0.0038	1

CZ PL	DLNPL	DLFX	DLIRATE6M	DLEURIBOR6M	DLIPOL	DGDPGR	DGCFGR	DLUNEMP
DLNPL	1							
DLFX	-0.1411	1						
DLIRATE6M	-0.2583	-0.1489	1					
DLEURIBOR6M	-0.2435	0.0179	0.5088	1				
DLIPOL	-0.0989	-0.1753	0.7097	0.2755	1			
DGDPGR	0.3123	-0.0157	-0.1172	-0.1785	-0.0686	1		
DGCFGR	0.2031	-0.1321	-0.1024	-0.1147	-0.1247	0.0028	1	
DLUNEMP	0.2743	-0.0697	-0.1603	-0.3360	-0.1118	0.2385	0.0904	1

# Results – Global Approach

Significance level: \*significant at 1 percent; \*\* significant at 5 percent; \*\*\*significant at 10 percent. t-statistics and p-value for Sargan test are reported in parenthesis

Equation	OLS Fixed Effects				GMM
	(11)	(12)	(13)	(14)	(15)
DLNPL(-1)		0.403* (6.9515)		0.6510* (9.8569)	0.4085* (3.9414)
DLUNEMP	0.6389* (5.9553)	0.2714** (2.4094)	0.382* (2.6946)		
DLUNEMP(-1)				0.0937*** (1.1863)	0.2860* (3.0035)
DLEURIBOR6M(-5)	-0.0859* (-3.6682)	-0.0675* (-3.0916)	-0.0738* (-3.0258)	-0.0296* (-2.2947)	
DGDPGR(-1)	-1.5957** (-2.287)	-1.2203*** (-1.9043)			
DLIRATE6M					-0.0485** (-2.4116)
DLIPOL					-0.0113*** (-1.8346)
Constant	0.0192* (8.4833)	0.0109* (4.5948)	0.0208* (9.9111)	0.0063* (3.7713)	
No obs	242	237	248	243	233
R-squared	0.3262	0.4256	0.3479	0.6724	
R-squared adj	0.3061	0.4055	0.3316	0.6626	
Global variable dummies	no	no	no	no	yes
Redundant fixed effects F-test	9.1939*	3.1718**	16.0921*	2.3133***	
Sargan test					214.1402 (0.1884)

# Results – Global Approach

- Negative relation between lagged GDP growth and non-performing loans rate
- Unemployment rate and non-performing loans rate are positive correlated
- Significant lagged unemployment rate variable
- 6-month EURIBOR, 6-month interest rate and policy interest rate significant for non-performing loans rate development – inverse correlation
- Lagged non-performing loans ratio significant in each estimated model - autocorrelation of the non-performing loans rate

# Results – Global Approach

- Significant cross-section fixed effects
- Positive fixed effects in Bulgaria, Hungary and Romania
- Negative fixed effects in Czech Republic and Poland

Fixed Effects	Eq 11	Eq 12	Eq 13	Eq 14
BG	0.0062	0.0060	0.0083	0.0046
CZ	-0.0148	-0.0088	-0.0156	-0.0052
HU	0.0086	0.0038	0.0086	0.0018
PL	-0.0148	-0.0085	-0.0145	-0.0044
RO	0.0135	0.0066	0.0115	0.0025

# Results – Re-estimation Approach

Significance level: \*significant at 1 percent; \*\* significant at 5 percent; \*\*\*significant at 10 percent. t-statistics and p-value for Sargan test are reported in parenthesis

	BG, HU, RO OLS Estimation					CZ, PL GMM
	1	2	3	4	5	
<b>DLNPL(-1)</b>		0.3658*		0.3658**	0.5723*	
		(4.8185)		(2.4649)	(9.0616)	
<b>DLUNEMP</b>	0.9622*	0.5757*		0.5757*		
	(6.5102)	(3.4794)		(3.1544)		
<b>DLUNEMP(-1)</b>			0.8579*			
			(4.7553)			
<b>DLEURIBOR6M(-5)</b>	-0.0564***					
	(-1.7560)					
<b>DLIRATE6M</b>					-0.0421*	
					(-6.8651)	
<b>DGDPGR</b>			-1.4524***		0.9166***	
			(-1.8815)		(1.7135)	
<b>Constant</b>	0.0258*	0.0175*	0.0306*	0.0175		
	(7.5244)	(4.6191)	(8.9574)	(3.3638)		
<b>No obs</b>	152	149	146	149	89	
<b>R-squared</b>	0.2569	0.3084	0.1887	0.3084		
<b>R-squared adj</b>	0.2469	0.2989	0.1775	0.2989		
<b>Global variable dummies</b>	no	no	no	no	yes	
<b>Hausman Test</b>	2.4325	0.5603	0.00	0.00		
<b>Sargan Test</b>					52.3131	
					(0.2112)	

# Results – Re-estimation Approach

## Panel estimation for Bulgaria, Hungary and Romania

- Significant unemployment rate with higher coefficients than in global approach
- Significance of the lagged unemployment rate
- Negative correlation between GDP growth and non-performing loans rate - similar coefficients as global approach
- Lower coefficients of 6-month EURIBOR than in case of modelling all five countries
- Reduced coefficients of lagged NPL

## Panel estimation for Czech Republic and Poland

- Significant lagged NPL - higher coefficients in contrast with first estimation
- 6-month interest rate significant with similar value of coefficient as in the global approach
- Unemployment rate was not significant, as for the first approach

# Results – Robustness checks

- Significant fixed effects - Likelihood Ratio Test
- Hausman test for random effects models - random effects more appropriate than fixed effects in the first model for Bulgaria, Hungary and Romania
- Small sample restrictions - although the p-value of the test was indicating significance, Hausman test not relevant
- Sargan test for over-identifying restrictions - instruments are correctly specified

Redundant Fixed Effects Tests Equation: EQ_FE Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	9.193998	(4,234)	0.0000
Cross-section Chi-square	35.324926	4	0.0000

Redundant Fixed Effects Tests Equation: EQ_FE_LAG Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	3.171877	(4,228)	0.0146
Cross-section Chi-square	12.834453	4	0.0121

Redundant Fixed Effects Tests Equation: EQ_FE_CSW_WHITE Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.313364	(4,235)	0.0583

Redundant Fixed Effects Tests Equation: EQ_FE_WOLAG_CSW_WHITE Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	16.092195	(4,241)	0.0000

# Conclusion

- Economic growth acts as a source of wealth and improves visibly the capacity of the borrowers in servicing their debt as GDP growth was found significant in our study for the evolution of non-performing loans rate
- The repayment source is fundamental for loan quality, unemployment rate having a substantial impact on non-performing loans rate level
- Prolonged effect of macroeconomic variables on non-performing loans, lagged variables being significant
- Non-performing loans are persistent to an important extent, with significant lagged NPL rate
- The evolution of non-performing loans has different particularities among countries - there were evidence of significant fixed effects

# Conclusion

- In Bulgaria, Hungary and Romania labor force have higher impact on non-performing loans level, than have for the all five countries
- Money market interest rate has lower impact on non-performing loans rate in the three countries
- There is a lower persistence of non-performing loans across time in the three countries group
- For Czech Republic and Poland the persistence of non-performing loans was higher than for the entire group of five countries
- Unemployment and interest rate influence non-performing loans rate similarly as in the global approach

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