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Credit Risk Determinants: Evidence from the Bulgarian Banking System

Petros Golitsis[1], Athanasios P. Fassas[2] and Anna Lyutakova[3]

Abstract

The present study examines a wide set of credit risk determinants for the Bulgarian banking system. Using both monthly and quarterly data and employing two methodologies, Vector Autoregressive and Autoregressive Distributed Lag models, we test ninety-one possible determinants of the banks' credit risk, as measured by non-performing loans, loan loss provisions and problematic loans. Our empirical findings show that both bank-specific and institutional, in addition to macroeconomic, factors have a significant impact on the credit risk of the banking system in the country.

JEL classification numbers: C10, C32, C51, G01, G20, O52
Keywords: credit risk; non-performing loans; loan loss provisions; Bulgarian banking system.

1 Introduction

The great recession was marked by a surge in non-performing loans (NPLs) in both developing and developed countries. Investigating the driving factors of NPLs, a proxy for ex-post credit risk, is a topic that concerns regulatory authorities, financial market participants and corporations. The particular study attempts to shed light upon the credit risk determinants of the Bulgarian banking system.

Bulgarian banks have experienced a period of unprecedented stability after the currency board agreement in 1997. The debt created from the severe 1997 economic and banking crisis has been written off, inflation has been contained, while the existence of bank capital and liquidity buffers cushioned the spillover effects of the global financial crisis in 2008. Nonetheless, Bulgarian banks persistently experienced one of the highest non-performing loan levels in European Union. In 2014, Corporate Commercial Bank

[1] International Faculty of the University of Sheffield, City College, UK
[2] University of Thessaly, Greece
[3] VUZF University, Bulgaria

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(KTB) – the country's fourth largest bank – went bankrupt due to over-90% sub-standard corporate loans.

The present study extents existing literature in several ways. All previous studies of the Bulgarian banking system lack lower-than-general aggregate models, such as borrower or loan-purpose levels. Lower than general-level aggregate models stem from observed differences between loans to companies and to individuals/households, and within households, in terms of size, maturity, purpose, collateral, default rates, business-cycle effects, transmission channels , and crisis susceptibility (Jiménez and Saurina, 2004; Hilbers et al, 2005; Louzis et al., 2012). For example, corporations have double indebtedness and NPL levels compared to households in Bulgaria. Among the mixed-aggregation approaches, few scholars combine the general, borrower, and loan-purpose levels (Hoggarth et al., 2005; Vazquez et al., 2012), as this paper does. In addition, our empirical analysis employs monthly and quarterly macro-data and uses two methodologies, that is the Vector Autoregressive (VAR) and ARDL models, in order to identify the determinants of non-performing loans in the Bulgarian banking sector. The sample covers the period from January 2001 to December 2015. The period under investigation includes both the growth phase (EU pre-accession) as well as the downturn, following the great recession and the Greek debt crisis.

The paper proceeds as follows: the next section sketches indicative literature and domestic conditions justifying the dataset choice. The third section overviews the empirical data and methodology, while the fourth one outlines and interprets the test results. The fifth section summarizes the research conclusions.

2 Literature Review

The global financial crisis has led to an increased interest in examining the drivers of non-performing loans; for a comprehensive review see Ghosh (2015) and Konstantakis et al. (2016). The respective empirical attempts can be broadly categorized into cross-country analyses, using panel data models, and country-specific case studies, using several methodologies.

The Bulgarian banking system has been relatively well-studied under both strands; in particular, Kavkler and Festić (2010), Vogiazas and Nikolaidou (2011), Nikolaidou and Vogiazas (2014), Vogiazas (2015) and Karoglou et al. (2018) apply a country-specific, macroeconomic analysis, while Festić et al. (2009; 2011), Festić and Kavkler (2012), Moinescu (2012), Moinescu and Codirlaşu (2012), Beck et al. (2013), Jakubík and Reininger (2013), Klein (2013), Diaconaşu et al. (2014), Erdinç and Abazi (2014), Mileris (2014), Škarica (2014), Çifter (2015), Roman and Bilan (2015a; b) and Tanasković and Jandrić (2015) include Bulgaria in multi-country analysis.

Drawing on existing literature in order to identify variables in the context of the present analysis we note the following: the GDP, the broadest economic-activity metric, is inversely related to credit risk (Festić and Kavkler, 2012; Moinescu, 2012; Jakubík and Reininger, 2013; Diaconaşu et al., 2014; Erdinç and Abazi, 2014; Škarica, 2014; Roman and Bilan, 2015a, b; Tanasković and Jandrić, 2015). So are its main components, i.e. investments, (net) exports and consumption, when tested (Festić et al., 2009, 2011; Festić and Kavkler, 2012). Interestingly, contrary to cross-country evidence, GDP is insignificant

in the country-specific analysis (Kavkler and Festić, 2010; Vogiazas and Nikolaidou, 2011; Vogiazas, 2015).

Unemployment is also found to affect NPLs (Diaconaşu et al., 2014; Mileris, 2014; Škarica, 2014; Çifter, 2015; Roman and Bilan, 2015a, b); only Kavkler and Festić (2010) find its effect insignificant. As probably expected for a small, open, economy, NPLs are sensitive to exchange rates, foreign-currency denominated loans, loans-to-assets and loans-to-deposits ratios (Festić et al., 2009, 2011; Moinescu, 2012; Moinescu and Codirlaşu, 2012; Jakubík and Reininger, 2013; Klein, 2013; Tanasković and Jandrić, 2015). Other factors that have been found to affect NPLs are the performance of major global equity markets (Kavkler and Festić, 2010; Jakubík and Reininger, 2013), real effective exchange rate (Vogiazas and Nikolaidou, 2011; Moinescu and Codirlaşu, 2012), real-estate prices (Festić et al., 2011; Festić and Kavkler, 2012) foreign direct investments (Festić and Kavkler, 2012), M2 (Jakubík and Reininger, 2013; Klein, 2013, Roman and Bilan, 2015b; Vogiazas, 2015) and inflation (Kavkler and Festić, 2010).

In concluding, we should add that the five country-specific studies do not include significant drivers of credit risk, such as consumption, foreign direct and domestic investments, net capital flows, private-sector indebtedness, lending interest rates, profitability, foreign ownership, concentration, size/depth of the banking industry, and other measurable institutional categories, such as business and consumer confidence. Our empirical analysis includes all these variables, as suggested in the relevant international literature.

3 Data and Methodology

Our sample period covers the period from January 2001 to December 2015. We initially include in our analysis 91 potential determinant factors listed in Table 1. All variables are stationary in levels or in first differences (indicated in Table 1).

Table 1: Credit determinants

Variable	Frequency	Level/ Change	Expected sign	Mean	Std. dev	N
Credit risk proxies						
Non-performing loans	Q	Level		0.063	0.053	56
Loan loss provisions	Q	Level		0.044	0.019	56
Problematic loans (total)	M	Level		0.110	0.090	180
Corporate problematic loans	M	Level		0.121	0.100	180
Consumer problematic loans	M	Level		0.085	0.072	180
Mortgage problematic loans	M	Level		0.087	0.091	180
Macroeconomic variables						
Base Interest Rate (BIR)	Q, M	Level	+	0.021	0.018	56
Inter-bank deposit interest rate (short-term)	Q, M	Level	+	0.019	0.017	56
Weighted average yield on newly issued government bonds (long-term)	Q, M	Level	+	0.052	0.013	56
Weighted average interest rate on credits to nonfinancial corporations	Q, M	Level	+	0.097	0.011	56
Long term government bond yield	M	Level	+	0.049	0.014	156
Euribor 3-month	M	Level	+	0.020	0.016	180
Euribor 12 -month	M	Level	+	0.023	0.015	180
Sofia Interbank Offered Rate (Sofibor) 1-month	M	Level	+	0.027	0.019	155
Sofia Interbank Offered Rate (Sofibor) 3-month	M	Level	+	0.035	0.019	155
Unemployment rate	Q, M	Level	+	0.067	0.028	56
Unemployment rate of over 25-year-olds	M	Level	+	0.102	0.034	180
Total corporate/household loans to corporate profits	Q	Level	+	2.456	1.146	60
Total corporate/household loans to gross disposable income	Q	Level	+	0.657	0.347	56
Total corporate/household loans to gross compensation to employees	Q	Level	+	1.835	0.908	56
Total corporate/household loans to gross payroll remuneration	Q	Level	+	2.185	1.052	56
Net current transfers from abroad	Q	Change	-/+	0.278	1.407	56
Households' saving rate	Q	Level	-/+	0.263	0.059	56
Gross operating surplus of firms and mixed (entrepreneurial) income	Q	Change	-/+	0.046	0.237	56
Quarterly gross bank loans and advances over GDP	Q	Level	+	2.386	0.970	56

Variable	Frequency	Level/ Change	Expected sign	Mean	Std. dev	N
Exports minus imports of goods and services	Q, M	Change	-/+	-1.992	7.188	56
Money supply M1	M	Change	+/-	0.012	0.029	180
Money supply M2	M	Change	+/-	0.011	0.020	180
Money supply M3	M	Change	+/-	0.011	0.020	180
Construction production index	M	Change	+/-	0.080	0.170	180
Industrial production index	M	Change	-/+	0.247	2.475	180
Foreign direct investments	M	Change	+/-	2.190	26.234	180
Retail sales of goods and services	M	Change	-/+	0.005	0.012	180
Average monthly wage	M	Change	-	0.008	0.030	180
SOFIX index	M	Change	-	0.011	0.079	180
Harmonized index of consumer prices	M	Change	+/-	0.003	0.007	180
Consumer price index	M	Change	+/-	0.003	0.008	180
Consumer goods production index	M	Change	+/-	0.002	0.042	180
Real effective exchange rate (CPI deflated)	M	Change	+/-	0.002	0.011	180
International capital flows	M	Change	-/+	-0.318	3.380	180
Bank-specific variables						
Capital to risk-weighted assets (CAR) (tier 1 plus tier 2)	Q	Level	-	0.192	0.052	56
Core Capital to risk-weighted assets (tier 1 only)	Q	Level	-	0.154	0.032	56
Return on assets (ROA)	Q	Level	-	0.010	0.006	56
Loans to assets	Q	Level	+	0.754	0.092	56
Loans to deposits	Q	Level	+	0.938	0.099	56
Net interest income	M	Change	-	10.424	138.88	180
Total gross bank loans and advances (all sectors)	Q	Change	+/-	0.048	0.135	56
Corporate (non-financial) loans	M	Change	+	0.013	0.031	180
Mortgages household	M	Change	+/-	0.025	0.028	180
Consumer loans	M	Change	+/-	0.016	0.022	180
Total to non-financial private sector	M	Change	+/-	0.015	0.024	180

Variable	Frequency	Level/ Change	Expected sign	Mean	Std. dev	N
Bank Loans up to 10,000 BGN	Q	Change	+/-	0.010	0.028	36
Bank Loans up to 50,000 BGN	Q	Change	+/-	0.031	0.048	36
Bank Loans up to 100,000 BGN	Q	Change	+/-	0.036	0.049	36
Bank Loans up to 250,000 BGN	Q	Change	+/-	0.034	0.057	36
Bank Loans up to 500,000 BGN	Q	Change	+/-	0.028	0.055	36
Bank Loans 500,000 BGN and above	Q	Change	+/-	0.033	0.065	36
Bank Loans to manufacturing industry	Q	Change	-/+	0.025	0.043	36
Bank Loans to trade industry	Q	Change	+/-	0.024	0.056	36
Bank Loans to agricultural sectorr	Q	Change	+/-	0.038	0.077	36
Bank Loans to all services sectors	Q	Change	+/-	0.029	0.103	36
Bank Loans to construction sector	Q	Change	+/-	0.043	0.030	36
Foreign-currency corporate loans to total loans	M	Level	+	0.696	0.118	180
Foreign-currency mortgage loans to total loans	M	Level	+	0.387	0.164	180
Institutional variables						
Foreign-owned bank assets to total banking-system assets	Q	Level	-/+	0.786	0.046	32
Bank deposits to GDP	Q	Level	-/+	2.492	0.892	56
Concentration ratio (5 largest banks to total banking-system assets)	Q	Level	+/-	0.536	0.032	56
Consumer confidence index	Q	Change	-/+	0.014	0.174	56
Business confidence index	M	Change	-/+	0.031	0.273	180

We use six credit risk proxies; in particular, we have the following general-level variables:

1) Non-performing loans (NPLs): doubtful and loss loans (over 90 days overdue and unlikely to be repaid (BNB's criteria) to total gross banking-industry loans
2) Loan loss provisions (LLPs): banking-industry impairment loss provisions
3) Problematic loans (total): past-due over 90 days and restructured[4] to total gross loans of banks and money-market funds (MMFs) to the non-financial private sector (NFPS)

In addition, we disaggregate total problematic loans in:

4) Problematic Corporate loans: problematic loans portion to (non-financial) corporations
5) Problematic Consumer loans: problematic loans portion to consumers
6) Problematic Mortgage loans: problematic loans portion to household for house purchases (mortgages)

As shown in Figure 1, the six credit risk proxies exhibit similar time-varying patterns.

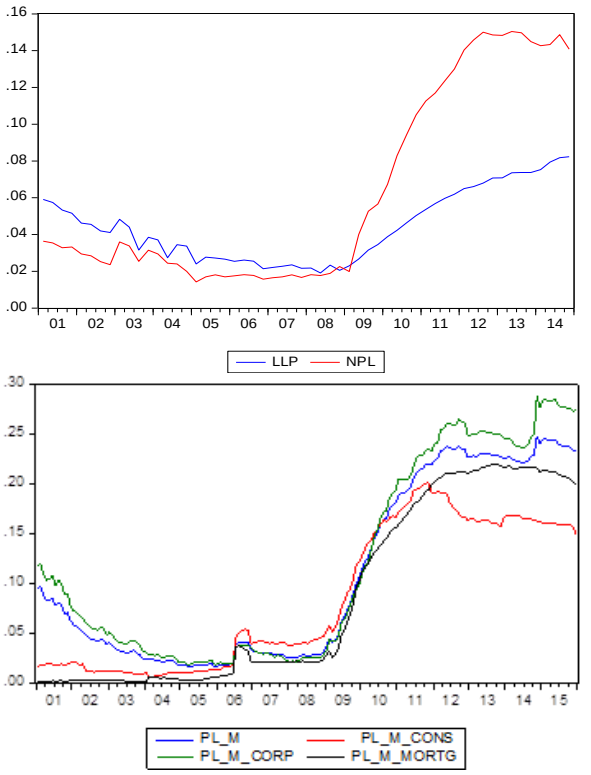

Figure 1: NPLs, LLPs and Problematic Loans

[4] According to Bulgarian National Bank, restructured loans involve contractual alleviations (principal and/or interest reduction, refinancing, debt-for-ownership exchange) to financially strained debtors on non-standard balance-sheet loans ('watch' (past-due 31-60 days), 'substandard' (past-due 61-90 days), and 'non-performing' (91 days and more overdue).

Notes: the first graph includes quarterly Non-performing loans (NPL) and Loan loss provisions (LLP) figures from January 2001 to December 2015, while the second graph includes monthly figures of Problematic Loans (PL_m), Corporate Problematic loans (PL_m_corp), Consumer Problematic loans (PL_m_cons) and Mortgage Problematic loans (PL_m_mortg).

Our empirical methodology is twofold, we employ VAR and combine ARDL with VECM, where applicable. In particular, the empirical analysis contains the following three stages; we first run bi-variate OLS regressions, to distinguish variables with explanatory power (significant at least at the 10% level) for each credit risk proxy:

$$y_t = \alpha + \beta x_t + u_t \quad (1)$$

in which, Y_t are the six credit risk proxies (NPLs, LLPs, Problematic loans, Problematic Corporate loans, Problematic Consumer loans, Problematic Mortgage loans) and X_t are the 91 potential determinant factors. Then by using a stepwise regression (forwards-method, 0.2-probability threshold) we pre-select the jointly most significant regressors and run the following vector autoregressive model specification:

$$y_t' = \alpha + \sum_{i=1}^{p} \beta_i y_{t-1} + \varepsilon_t \quad (2)$$

in which, y_t' is a vector that contains the six credit risk proxies and the significant determinant factors, p is the lag length, α and b_i are matrices of coefficients to be estimated and ε_t is a vector of innovations that are not serially correlated (although they might be contemporaneously correlated with each other) and are also not correlated with the past endogenous variables prices. The adequacy of the lag length is confirmed by the fact that there is no autocorrelation in the residual terms.

In addition, in order to deal with the problem of different levels of stationarity we also run the following Autoregressive-Distributed Lag (ARDL) model:

$$y_t' = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \lambda_i y_{t-1} + \varepsilon_t \quad (3)$$

in which, β_i coefficients represent the short-run (error-correction) dynamics (on automatically diffrenced series) and the λ_i coefficients denote the long-run relationships on level series, while p is again the selected (optimal) lag length (might differ across the variables).

4 Empirical findings

The empirical findings for Equations (2) and (3) are presented in Tables 2 – 5. We do not present here the results from the bi-variate OLS regressions, that were used to distinguish variables with explanatory power, in order to conserve space, but all relevant results are available upon request. Generally, the overwhelming majority of the bank-specific and institutional indicators under examination are found to be statistical significant, especially concerning loan loss provisions. We next move to more specific comments regarding the empirical results.

Table 2: VAR specifications for NPLs and LLPs

	NPL	***LLP***
Non-performing loans$_{t-1}$	**0.57*****	**0.25*****
	[3.08]	[3.25]
Non-performing loans$_{t-2}$	**0.38***	-0.06
	[1.82]	[-0.68]
Non-performing loans$_{t-3}$	-0.02	0.16
	[-0.07]	[1.65]
Non-performing loans$_{t-4}$	**0.33***	0.10
	[1.85]	[1.32]
Loan loss provisions$_{t-1}$	-0.26	**-0.98*****
	[-0.99]	[-4.31]
Loan loss provisions$_{t-2}$	**-0.59****	-0.01
	[-2.04]	[-0.04]
Loan loss provisions$_{t-3}$	**0.70****	**0.49*****
	[2.29]	[2.49]
Loan loss provisions$_{t-4}$	-0.20	-0.22
	[-0.73]	[-1.06]
Capital to risk-weighted assets$_{t-1}$	**0.24*****	**0.15*****
	[2.81]	[3.45]
Capital to risk-weighted assets$_{t-2}$	**0.26*****	**0.10****
	[3.90]	[2.28]
Capital to risk-weighted assets$_{t-3}$	**-0.21*****	0.03
	[-2.73]	[0.66]
Capital to risk-weighted assets$_{t-4}$	-0.03	0.04
	[-0.36]	[0.68]
Return on assets$_{t-1}$	**-0.99****	**-0.37****
	[-2.62]	[-2.50]
Return on assets$_{t-2}$	**-0.93****	**-0.40*****
	[-2.43]	-[2.79]
Return on assets$_{t-3}$	**-1.09*****	**-0.32****
	[-2.82]	[-2.17]
Return on assets$_{t-4}$	**-1.16*****	**-0.28****
	[-3.23]	[-2.16]
Unemployment rate$_{t-1}$	**-0.32***	
	[-1.92]	
Unemployment rate$_{t-2}$	0.06	
	[0.35]	
Unemployment rate$_{t-3}$	**-0.54*****	
	[-2.88]	
Unemployment rate$_{t-4}$	0.19	
	[1.23]	
Base Interest Rate$_{t-1}$	**-0.31***	
	[-1.80]	
Base Interest Rate$_{t-2}$	0.22	
	[1.10]	
Base Interest Rate$_{t-3}$	**0.53****	

	[2.31]	
Base Interest Rate$_{t-4}$	**-0.37***	
	[-1.99]	
Loans to assets $_{t-1}$		-0.02
		[-1.23]
Loans to assets $_{t-2}$		**0.04*****
		[3.67]
Loans to assets $_{t-3}$		0.01
		[1.26]
Loans to assets $_{t-4}$		-0.007
		[-0.64]
Weighted average interest on new short-term loans to non-financial sector $_{t-1}$		0.07
		[1.66]
Weighted average interest on new short-term loans to non-financial sector $_{t-2}$		**0.13***
		[1.98]
Weighted average interest on new short-term loans to non-financial sector $_{t-3}$		**-0.25*****
		[-3.11]
Weighted average interest on new short-term loans to non-financial sector $_{t-4}$		**-0.23*****
		[-2.85]
Concentration ratio $_{t-1}$		-0.008
		[-0.32]
Concentration ratio $_{t-2}$		0.03
		[0.90]
Concentration ratio $_{t-3}$		-0.04
		[-1.09]
Concentration ratio $_{t-4}$		**-0.08*****
		[-4.26]
Time Dummy (2008 Q1)		**0.006****
		[2.64]
intercept	-0.002	9.50
	[-1.52]	[0.29]
adj.R2	0.69	0.86
F-stat:	5.72	11.69
# observations	51	50

Notes: t-statistic [in brackets]. The coefficients in bold denote statistically significant values.
**** denotes significance at 99%*
*** denotes significance at 95%*
**denotes significance at 90%*

Table 3:VAR specifications for Problematic Loans

Problematic loans (total)		***Corporate problematic loans***		***Consumer problematic loans***		***Mortgage problematic loans***	
Problematic loans$_{t-1}$	**0.06*****	Corporate	-0.05	Consumer	**0.16****	Mortgage Problematic	**0.11***
	[0.62]	Problematic loans $_{t-1}$	[-0.66]	Problematic loans$_{t-1}$	[2.29]	loans$_{t-1}$	[1.93]
Problematic loans$_{t-2}$	0.29	Corporate	**0.31*****	Consumer	0.11	Mortgage Problematic	**0.18*****
	[3.40]	Problematic loans $_{t-2}$	[4.00]	Problematic loans$_{t-2}$	[1.55]	loans$_{t-2}$	[3.06]
Problematic loans$_{t-3}$	**0.19****	Corporate	**0.18****	Consumer	0.09	Mortgage Problematic	0.07
	[2.09]	Problematic loans $_{t-3}$	[2.18]	Problematic loans$_{t-3}$	[1.21]	loans$_{t-3}$	[1.06]
Problematic loans$_{t-4}$	0.11	Corporate	-0.01	Consumer	0.01	Mortgage Problematic	0.09
	[1.29]	Problematic loans $_{t-4}$	[-0.18]	Problematic loans$_{t-4}$	[0.18]	loans$_{t-4}$	[1.55]
Problematic loans$_{t-5}$	0.05	Corporate	-0.003	Consumer	0.09	Mortgage Problematic	**-0.12****
	[0.65]	Problematic loans $_{t-5}$	[-0.04]	Problematic loans$_{t-5}$	[1.06]	loans$_{t-5}$	[-2.07]
Long term	-0.04	Corporate	**0.17****	Consumer	0.07	Unemployment rate$_{t-1}$	**0.27*****
government bond	[-0.39]	Problematic loans $_{t-6}$	[2.48]	Problematic loans$_{t-6}$	[1.08]		[3.15]
yield $_{t-1}$							
Long term	**0.26****	Corporate	0.04	Consumer	0.10	Unemployment rate$_{t-2}$	**-0.20****
government bond	[2.18]	Problematic loans $_{t-7}$	[0.64]	Problematic loans$_{t-7}$	[1.39]		[-2.02]
yield $_{t-2}$							
Long term	0.15	Industrial production	**0.0003***	Consumer	**0.21*****	Unemployment rate$_{t-3}$	0.10
government bond	[1.21]	index $_{t-1}$	[1.92]	Problematic loans$_{t-8}$	[2.88]		[0.99]
yield $_{t-3}$							
Long term	0.10	Industrial production	**0.0006*****	Consumer	-0.03	Unemployment rate$_{t-4}$	-0.04
government bond	[0.83]	index $_{t-2}$	[2.80]	Problematic loans$_{t-9}$	[-0.39]		[-0.40]
yield $_{t-4}$							
Long term	-0.10	Industrial production	**0.0007****	Net interest income$_{t-1}$	-6.41	Unemployment rate$_{t-5}$	**0.17***
government bond	[-0.89]	index $_{t-3}$	[2.58]		-[0.31]		[1.86]
yield $_{t-5}$							
M2 $_{t-1}$	**0.04****	Industrial production	0.0004	Net interest income$_{t-2}$	5.88	Net interest income$_{t-1}$	**1.73*****
	[2.61]	index $_{t-4}$	[1.58]		[0.19]		[5.82]
M2 $_{t-2}$	**0.07*****	Industrial production	-5.71	Net interest income$_{t-3}$	3.48	Net interest income$_{t-2}$	**1.58*****

	[3.37]	index $_{t-5}$	[-0.21]		[0.11]		[6.05]
M2 $_{t-3}$	**0.07*** **	Industrial production	-0.0003	Net interest income$_{t-4}$	-1.46	Net interest income$_{t-3}$	**1.31*** **
	[2.91]	index $_{t-6}$	[-1.36]		[-0.05]		[5.96]
M2 $_{t-4}$	**0.05** **	Industrial production	-3.11	Net interest income$_{t-5}$	-1.69	Net interest income$_{t-4}$	**1.08*** **
	[2.13]	index $_{t-7}$	[-0.20]		[-0.61]		[6.05]
M2 $_{t-5}$	**0.02***	EURIBOR 3-month $_{t-1}$	-0.32	Net interest income$_{t-6}$	**-8.59*** **	Net interest income$_{t-5}$	**7.60*** **
	[1.68]		[-1.11]		[-3.33]		[6.26]
Industrial production	6.90	EURIBOR 3-month $_{t-2}$	-0.27	Net interest income$_{t-7}$	**-4.38***	Consumer goods	**0.009***
index$_{t-1}$	[0.57]		[-0.78]		[-1.80]	production index$_{t-1}$	[1.85]
Industrial production	**0.0004*** **	EURIBOR 3-month $_{t-3}$	0.15	Net interest income$_{t-8}$	**-3.43***	Consumer goods	**0.02*** **
index$_{t-2}$	[2.70]		[0.43]		[-1.66]	production index$_{t-2}$	[2.72]
Industrial production	**0.0006*** **	EURIBOR 3-month $_{t-4}$	0.28	Net interest income$_{t-9}$	-1.47	Consumer goods	**0.02** **
index$_{t-3}$	[3.37]		[0.76]		[-0.96]	production index$_{t-3}$	[2.39]
Industrial production	**0.0007*** **	EURIBOR 3-month $_{t-5}$	0.03	EURIBOR 3-month$_{t-1}$	0.16	Consumer goods	0.009
index$_{t-4}$	[4.02]		[0.08]		[0.75]	production index$_{t-4}$	[1.12]
Industrial production	**0.0002***	EURIBOR 3-month $_{t-6}$	-0.33	EURIBOR 3-month$_{t-2}$	-0.14	Consumer goods	0.002
index$_{t-5}$	[1.96]		[-0.88]		[-0.54]	production index$_{t-5}$	[0.28]
Exports minus	0.0002	EURIBOR 3-month $_{t-7}$	**-0.58***	EURIBOR 3-month$_{t-3}$	0.31	Foreign-currency	-0.01
imports of goods and	[0.91]		[-1.80]		[1.20]	mortgage loans to	[-0.32]
services $_{t-1}$						total loans$_{t-1}$	
Exports minus	**0.0006** **	M2 $_{t-1}$	**0.05*** **	EURIBOR 3-month$_{t-4}$	0.23	Foreign-currency	-0.02
imports of goods and	[2.24]		[2.63]		[0.84]	mortgage loans to	[-0.35]
services $_{t-2}$						total loans$_{t-2}$	
Exports minus	**0.0008*** **	M2 $_{t-2}$	**0.11*** **	EURIBOR 3-month$_{t-5}$	-0.51	Foreign-currency	-0.004
imports of goods and	[2.76]		[3.73]		[-1.87]	mortgage loans to	[-0.08]
services $_{t-3}$						total loans$_{t-3}$	
Exports minus	**0.0008*** **	M2 $_{t-3}$	**0.13*** **	EURIBOR 3-month$_{t-6}$	-0.44	Foreign-currency	0.04
imports of goods and	[3.10]		[3.63]		[-1.60]	mortgage loans to	[0.90]
services $_{t-4}$						total loans$_{t-4}$	
Exports minus	**0.0005** **	M2 $_{t-4}$	**0.09** **	EURIBOR 3-month$_{t-7}$	-0.30	Foreign-currency	**0.09***
imports of goods and	[2.25]		[2.50]		[-1.02]	mortgage loans to	[2.07]

services $_{t-5}$				total loans$_{t-5}$	
M2 $_{t-5}$	**0.07***	EURIBOR 3-month$_{t-8}$	0.21	Time dummy (Jul	**0.03*****
	[1.99]		[0.66]	2006)	[10.90]
M2 $_{t-6}$	0.03	EURIBOR 3-month$_{t-9}$	-0.18	Time dummy (Jun	**0.04*****
	[1.23]		[-0.63]	2009)	[6.61]
M2 $_{t-7}$	0.01	Bank Loans to	-0.005		
	[0.89]	construction sector$_{t-1}$	[-1.59]		
SOFIX $_{t-1}$	-0.008	Bank Loans to	**-0.008****		
	[-1.55]	construction sector$_{t-2}$	[-2.35]		
SOFIX $_{t-2}$	-0.006	Bank Loans to	**-0.007***		
	[-1.15]	construction sector$_{t-3}$	[-1.97]		
SOFIX $_{t-3}$	**-0.02*****	Bank Loans to	**-0.008****		
	[-3.42]	construction sector$_{t-4}$	[-2.09]		
SOFIX $_{t-4}$	**-0.02*****	Bank Loans to	-0.005		
	[-3.08]	construction sector$_{t-5}$	[-1.25]		
SOFIX $_{t-5}$	**-0.02*****	Bank Loans to	**-0.008****		
	[-2.93]	construction sector$_{t-6}$	[-2.24]		
SOFIX $_{t-6}$	-0.0008	Bank Loans to	0.0008		
	[-0.14]	construction sector$_{t-7}$	[0.19]		
SOFIX $_{t-7}$	-0.01*	Bank Loans to	0.002		
	[-1.80]	construction sector$_{t-8}$	[0.51]		
Exports minus	0.0002	Bank Loans to	0.002		
imports of goods and	[0.74]	construction sector$_{t-9}$	[0.74]		
services $_{t-1}$					
Exports minus	**0.0007****	Harmonized index of	-0.04		
imports of goods and	[2.19]	consumer prices$_{t-1}$	[-0.90]		
services $_{t-2}$					
Exports minus	**0.0008****	Harmonized index of	-0.09		
imports of goods and	[2.15]	consumer prices$_{t-2}$	[-1.61]		
services $_{t-3}$					
Exports minus	**0.0009****	Harmonized index of	-0.02		

imports of goods and services $_{t-4}$	[2.29]	consumer prices$_{t-3}$	[-0.34]
Exports minus imports of goods and services $_{t-5}$	0.0003 [0.90]	Harmonized index of consumer prices$_{t-4}$	0.02 [0.26]
Exports minus imports of goods and services $_{t-6}$	-0.0003 [-0.99]	Harmonized index of consumer prices$_{t-5}$	-0.002 [-0.04]
Exports minus imports of goods and services $_{t-7}$	-0.0003 [-1.36]	Harmonized index of consumer prices$_{t-6}$	0.10* [1.90]
Time dummy (Dec 2012)	**-0.01***** [-3.80]	Harmonized index of consumer prices$_{t-7}$	0.09* [1.84]
Time dummy (Nov 2014)	**0.03***** [8.36]	Harmonized index of consumer prices$_{t-8}$	0.004 [0.09]
		Harmonized index of consumer prices$_{t-9}$	0.05 [1.35]
		Industrial production index$_{t-1}$	-**0.0003***** [-2.77]
		Industrial production index$_{t-2}$	-**0.0004**** [-2.10]
		Industrial production index$_{t-3}$	-**0.0007***** [-2.84]
		Industrial production index$_{t-4}$	-**0.0006***** [-2.56]
		Industrial production index$_{t-5}$	-**0.0006***** [-2.57]

				Industrial production index$_{t-6}$	**-0.0005****		
					[-2.21]		
				Industrial production index$_{t-7}$	**-0.0005****		
					[-2.27]		
				Industrial production index$_{t-8}$	**-0.0003***		
					[-1.69]		
				Industrial production index$_{t-9}$	-0.0002		
					[-1.79]		
				Time dummy (Jul 2006)	**0.03*****		
					[9.34]		
				Time dummy (Dec 2006)	**0.01*****		
					[-3.54]		
				Time dummy (Dec 2013)	**0.01*****		
					[-3.96]		
intercept	0.0005	intercept	0.0002	intercept	-0.0002	intercept	0.0003
	[1.58]		[0.75]		[-0.75]		[1.44]
adj.R2	0.33	adj.R2	0.62	adj.R2	0.71	adj.R2	0.72
F-stat:	3.93	F-stat:	6.32	F-stat:	7.25	F-stat:	14.35
# observations	149	# observations	147	# observations	145	# observations	142

Notes: t-statistic [in brackets]. The coefficients in bold denote statistically significant values.
**** denotes significance at 99%*
*** denotes significance at 95%*
**denotes significance at 90%*

Table 4: ARDL specifications for NPLs and LLPs

Panel A: Short-run dynamics			
	NPL		***LLP***
Non-performing loans$_{t-1}$	**0.21*** **	Loan loss provisions$_{t-1}$	**-0.37*** **
	[4.52]		[-3.44]
Non-performing loans$_{t-2}$	**0.65*** **	Weighted average interest on new	0.03
	[12.42]	short-term loans to non-financial	[1.31]
		sector$_t$	
Loan loss provisions$_t$	**1.79*** **	Loans to assets$_t$	**-0.04*** **
	[15.21]		[-12.78]
Loan loss provisions$_{t-1}$	**-1.03*** **	Loans to assets$_{t-1}$	-0.004
	[-5.30]		[-0.77]
Loan loss provisions$_{t-2}$	**-2.96*** **	Loans to assets$_{t-2}$	**0.01*** **
	[-18.28]		[3.17]
Unemployment rate$_t$	**-0.31*** **	ROA$_t$	**-0.30*** **
	[-4.40]		[-8.41]
Unemployment rate$_{t-1}$	**0.13** **	ROA$_{t-1}$	**0.41*** **
	[2.68]		[7.09]
Unemployment rate$_{t-2}$	**-0.33*** **	ROA$_{t-2}$	**0.16*** **
	[-5.86]		[4.00]
Total corporate/household loans to	**0.04*** **	CAR$_t$	**0.04***
gross disposable income $_t$	[14.89]		[1.96]
Total corporate/household loans to	**-0.06*** **		
gross disposable income $_{t-1}$	[-11.73]		
Total corporate/household loans to	**-0.02*** **		
gross disposable income $_{t-2}$	[-6.69]		
Net current transfers from abroad$_t$	**0.001*** **		
	[9.42]		
Net current transfers from abroad$_{t-1}$	**-0.001*** **		
	[-6.39]		
Net current transfers from abroad$_{t-2}$	**0.0006*** **		
	[4.85]		
Time dummy (2008 Q2)	**- 0.004*** **		
	[-3.99]		
Error Correction Term	**- 0.69*** **	Error Correction Term	**-0.22*** **
	[-14.94]		[-9.73]
intercept	**-0.16*** **	intercept	**0.01*** **
	[-15.08]		[10.04]
adj.R2	0.99	adj.R2	0.99
F-stat:	3301	F-stat:	1204
# observations	29	# observations	52

Panel B: Long-term relationships			
Loan loss provisions$_t$	**5.56*** **	Weighted average interest on new short-term loans to non-financial sector$_t$	**0.26***
	[12.53]		[1.72]
Unemployment rate$_t$	-0.21	Loans to assets$_t$	**-0.07*** **
	[-0.86]		[-3.35]
Total corporate/household loans to gross disposable income $_t$	**0.18*** **	ROA$_t$	**-4.52*** **
	[10.95]		[-7.19]
Net current transfers from abroad$_t$	**0.004*** **	CAR$_t$	**0.23*** **
	[5.85]		[8.63]
Time dummy (2008 Q2)	**-0.006***	Trend	**0.0009*** **
	[-2.82]		[5.58]
Trend	**-0.007*** **		
	[-9.73]		

Notes: t-statistic [in brackets]. The coefficients in bold denote statistically significant values.
*** denotes significance at 99%*
** denotes significance at 95%*
**denotes significance at 90%*

Table 5: ARDL specifications for Problematic Loans

Panel A: short-run dynamics				
	Problematic loans (total)	***Corporate problematic loans***	***Consumer problematic loans***	***Mortgage problematic loans***
Construction production index$_t$	-0.002	0.003	**-0.007***	**-0.004****
	[-0.59]	[0.81]	[-1.95]	[-2.19]
Base Interest Rate$_t$		-0.13	-0.16	-0.10*
		[-1.16]	[-1.21]	[-1.72]
Foreign-currency corporate loans to total loans$_t$		0.007		
		[0.15]		
Foreign-currency mortgage loans to total loans$_t$				**0.09*****
				[3.42]
Average monthly wage$_t$			**-0.02*****	**-0.01*****
			[-3.55]	[-3.96]
Long term government bond yield$_t$	-0.03			
	[-0.26]			
Real effective exchange$_t$	**-0.05****			
	[-2.28]			
Total to non-financial private sector$_t$	**-0.08*****			
	[-7.64]			
Corporate (non-financial) loans$_t$		**-0.03*****		
		[-3.44]		
Unemployement rate$_t$			0.007	
			[0.09]	
Time Dummy (Dec 2012)		**-0.01*****		
		[-5.41]		
Time Dummy (Nov 2014)		**0.04*****		
		[11.56]		
Time Dummy (Jul 2006)				**0.03*****
				[18.88]
Time Dummy (Dec 2006)				**-0.01*****
				[-7.85]
Time Dummy (Nov 2009)				**0.01*****
				[8.12]
Error Correction Term	**-0.01*****	**-0.03*****	**-0.04*****	**-0.04*****
	[-8.93]	[-10.45]	[-6.34]	[-19.31]
intercept	0.0003	**-0.007*****	**0.01*****	**0.0007*****
	[0.97]	[-8.24]	[6.70]	[4.46]
adj.R2	0.99	0.99	0.99	0.99
F-stat:	26164	659	11410	755
# observations	154	154	154	152

Panel B: **long-term relationships**				
	Problematic loans (total)	***Corporate problematic loans***	***Consumer problematic loans***	***Mortgage problematic loans***
Construction production index$_t$	**-0.59*** ** [-2.87]	**0.25*** ** [-3.42]	**-0.28*** ** [-4.48]	**-0.15*** ** [-4.05]
Base Interest Rate$_t$		**-3.40*** ** [-5.39]	**-2.73*** ** [-4.03]	**-2.66*** ** [-10.16]
Average monthly wage$_t$			**-0.70** ** [-2.35]	**-0.31** ** [-2.56]
Foreign-currency corporate loans to total loans$_t$		**0.69*** ** [4.24]		
Long term government bond yield$_t$	7.30 [1.09]			
Corporate (non-financial) loans$_t$		**-0.76** ** [-2.14]		
Total to non-financial private sector$_t$	**-6.86*** [-1.85]			
Foreign-currency mortgage loans to total loans$_t$				**0.38*** ** [10.45]
Unemployement rate$_t$			**-1.32*** ** [-3.14]	
Real effective exchange$_t$	-5.18 [-1.45]			
Time Dummy (Dec 2012)		**-0.43*** ** [-3.32]		
Time Dummy (Nov 2014)		**1.02*** ** [5.07]		
Time Dummy (Jul 2006)				**0.61*** ** **[6.80]**
Time Dummy (Dec 2006)				**-0.21*** ** [-4.35]
Time Dummy (Nov 2009)				**0.25*** ** [4.50]

Notes: t-statistic [in brackets]. The coefficients in bold denote statistically significant values.
**** denotes significance at 99%*
*** denotes significance at 95%*
**denotes significance at 90%*

Lenders (banks) rely on strong capital base to absorb higher risk from higher-profit, higher-risk lending strategies (Keeton and Morris, 1987; Boudriga et al., 2009), while strong profits relax the high growth-high risk pressure and allow access to more solvent borrowers (Godlewski, 2006; Boudriga et al., 2009; Festić et al., 2009; Erdinç and Abazi, 2014; Makri and Papadatos, 2014); these facts are generally confirmed by our findings. Furthermore, the negative coefficient of banking sector concentration ratio suggests that larger and more profitable/efficient banks (Athanasoglou, 2011) limit riskiest borrowers' access to credit (Boudriga et al., 2009). Foreign ownership on the other hand, initially infuses banks with financial, technological, human, knowledge and relationship capital (Boudriga et al., 2009), but in the long run the pressure for contributing to parent bank's profitability reverses/outweighs the benefits (Erdinç and Abazi, 2014).

Regarding borrowers, we can say that they immediately use their core income (wages, capital flows from abroad) to regularly service debt. Additional income (savings, transfers from abroad, risk-free investment income from government bonds) enables the 'luxury' of riskier borrowing/lending, evident typically after 1 year. Consumption, GDP's largest component, remains insignificant, as do the other national income proxies. However, the positive coefficient of consumer goods index reflects the rising consumer demand when spendable income increases that leads to increased debt burden which is hard to service.

Another interesting finding is the discrepancy between the constituent indices and the wider category's significance. For example, in certain cases, the wider figure is more appropriate than their constituent indices: significant indebtedness proxies, such as Total corporate/household loans to gross disposable income, Total corporate/household loans to gross compensation to employees and Total corporate/household loans to gross payroll remuneration are found to be significant, while income proxies (gross disposable income, gross payroll compensations/remuneration) are not. Similarly, gross disposal income (GDI) and private consumption are found to have no statistical significance, while households' saving rate (GDI over consumption) is found to have interpretating power. For other categories, both the wider and narrower indicators prove significant: International capital flows and its constitutive FDI. Comparing significant foreign-direct with insignificant domestic investments confirms the economy's dependence on foreign capitals inflow, and the need for stronger domestic investments.

A major hypothesis[5] of credit risk counter-cyclicality by sign (Klein, 2013; Škarica, 2014), but procyclical by nature (Bikker and Hu, 2002) cannot be fully confirmed by our analysis, as risk builds up with improved economic activity even in the short-run. The gradual growth of domestic capital market improves corporate loan servicing ability, by increasing wealth and collateral values (Kalirai and Scheicher, 2002; Klein, 2013). The sharp boom-bust in capital, as in real-estate (construction) markets over the tested period translates into large fluctuations, enhancing these variables' significance. Few sectors, as construction, achieved abnormally high profit margins, untypical for mature economies, which helped absorb, for both firms and individuals, the consequent collapse.

[5] Risk accumulates during the credit/economic upsurge/boom but materializes with a time-lag, in the following downturn, when credit crunch and loan repayment difficulties following deteriorating income/revenue/profits, consumption, investments, output, etc. worsen NPL (Borio and Lowe, 2002; Bonfim, 2009; Fainstein and Novikov, 2011; Festić et al., 2011).

Our empirical analysis also captures the effects of the global financial crisis: at the beginning, the crisis effectively disciplined the domestic economic agents, trying to milden the consequences (negative coeffient for Q1-Q2/2008 time dummies), but soon overwhelmed them (positive coefficient for second-half of 2009 time dummies and 2014 domestic banking crisis). Furthermore, BNB's loan-growth restrictive measures (2005) did not substantially affect sub-standard lending, but their removal unleashed it (positive coefficient for mid-2006 time dummies).

Compared to existing empirical literature, our effort includes certain novel significant findings. In particular, this is the first attempt in the credit risk literature that net current transfers from abroad, consumer goods production index and households' savings rate are included in the empirical examination; only Bonfim (2009) and Fainstein and Novikov (2011) include consumption, while May and Tudela (2005) and Anić et al. (2015) include household savings as an independent variable in certain attempts similar to ours. Furthermore, this is the first study of the Bulgarian banking system that tests and confirms the significance of the following variables in regard to credit risk: households' indebtedness, consumer and business confidence, international capital flows, loan amount, industry categories, long-term convergence rated, corporate indebtedness, sales and profits. In addition, our analysis confirms existing literature concerning the significance of several factors, such as loans-to-assets , credit-to-GDP, construction index, SOFIX, M2, Industrial production index, real exchange rate, loan growth and inflation and the insignificance of GDP growth. More importantly though, our findings show that consumption and investments are found not to affect credit risk, in contrast to the findings of Festić et al. (2009), Festić et al. (2011), Festić and Kavkler (2012), Mileris (2012) and Çifter (2015), while we find that capital to risk-weighted assets (in contrast to Vogiazas, 2015; Festić et al., 2011; Festić and Kavkler, 2012), bank profitability (in contrast to Boudriga et al., 2009; Athanasoglou, 2011; Jakubík and Reininger, 2013; Festić et al., 2011) and average monthly wage and 3-month Euribor (in contrast to Vogiazas and Nikolaidou, 2011; Vogiazas, 2015) are significant credit risk determinants. In concluding the comparison to existing literature, we need to analyze further the initially puzzling findings regarding interest rates and unemployment. The estimated coefficients for short-term rates are significantly negative, while the respective coefficients for long-term rates are positive. Traditionally, central banks lower their base rate in order to stimulate economic activity by lending, as most bank loan rates use it as a benchmark rate. Hence, we can expect that short-term interest are lower when the economy is struggling; but this is the exactly the time when non-performing loans are higher. Long-term government interest rates on the other hand, indicate favorable long-term economic outlook and thus, mislead borrowers and lenders into riskier borrowing aggreements. This effect though is slower and weaker, both in significance and elasticity, compared to the almost instantaneous robust effect of the base rate. Regarding unemployment rate, we note that in the short-run (first lags) unemployment has a negative coefficient concerning NPLs suggesting that it "disciplines" loan servicing. In the long-run (further lags), drained, unemployment's usual income-depleting effect prevails, but the respective results are statistically less/non-significant.

In concluding, we could say that all three credit risk proxies (NPLs, LLPs and Problematic Loans) yield comparable and plausible results. Statistically, the LLP specifications are more robust and have higher explanatory power (followed by NPL models).

5 Conclusions

The particular paper examines the credit risk determinants of the Bulgarian banking system during 2001-2015. Our empirical findings show a bi-directional causality between non-performing loans and loan-loss provisions, while from the 91 determinant factors tested, we show that credit risk is determined by the following macroeconomic factors: interest rates, unemployment, M2, the construction index, wages. We also find that indebtedness level, foreign-currency loans, loan growth, banks' return on assets, capital adequacy and profitability also affect credit risk proxies. Interestingly, although strong capital adequacy is considered to be a systemic-stability factor, it actually turns out to perpetuate high credit risk. We also show a bi-directional causality with lending rates, industrial production, trade balance, loans-to-assets, banking-industry concentration and foreign ownership.

Furthermore, our empirical analysis generally confirms existing evidence regarding the insignificant effect of GDP and the significant effects of stock market returns, inflation, real effective exchange rate, foreign direct investments and bank-capital concentration. In concluding, our paper shows for the first time in the relevant empirical literature, that factors such as households' indebtedness and savings rate, international capital flows, net current transfers from abroad, consumer goods production index, loan industry categories and business and consumer confidence play a significant role in determining the credit risk of banks of an emerging market, as Bulgaria.

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