The Drivers Behind Household and Corporate Non-performing Loans Ratio: The Case of Croatia

RESEARCH ARTICLE

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Abstract

We analyze the relationship between non-performing loans (NPL) ratio and Croatia's macroeconomic performance in the 4Q2001-1Q2014 period. Analysis is performed separately for two different loan categories (households and corporate) in order to examine their similarities and differences. Our results show that the NPL ratio for both categories is strongly affected by the economic slowdown measured by the real GDP and industrial production index. This confirms the significant effect of economic cycles on households' and companies' ability to service their liabilities, especially during recession. Unemployment rate is found to be significant for corporate sector and is positively related to corporate NPL ratio. Interest rates have mixed implications on the NPL for both categories depending on the duration of the observation period. In the long run we find a positive relationship between interest rates and NPL ratio, meaning that in the long run higher interest rates worsen the debtors' loan repayment capacity and refinancing terms. In the short run we find a negative relationship between interest rates and NPL ratio which can be

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explained by the fact that higher interest rates discourage investments in risky and less profitable ventures.

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JEL classification: C22, D14, G33

1 Introduction[1]

During the transition period of the Croatian economy, significant structural changes occurred in the domestic banking sector that strongly impacted the debt dynamics in the Croatian private and government sector. Some of these changes were the internationalization of the banking sector, credit expansion, increase of the risk exposure, changes in supervision and consolidation. During the years prior to the outbreak of the global financial crisis, Croatian macroeconomic conditions have contributed to the fast growth of household and company indebtedness. Financial liberalization and market deregulation led to enhanced competition among financial institutions that, together with central bank policies and high inflow of foreign capital, reduced borrowing limits, lowered interest rates and generally made loans more appealing and accessible. Croatian level of indebtedness was already relatively high in the mid-2000s. Moreover, its expansion has continued, raising concerns about the stability of the financial system (Herceg and Šošić, 2011).

During the last 15 years, fast credit growth has been present both in the government and in the private sector. Private sector indebtedness has grown significantly faster than that of the government. Within the private sector, the household debt grew at a higher rate compared to corporate sector. It may be argued that banks encouraged consumption more than production (Croatian Banking Association, 2009). The reason for this could be that until the outbreak of the last financial crisis household debt was

[1] *This work has been supported by Croatian Science Foundation under the project "6558 Business and Personal Insolvency – The Ways to Overcome Excessive Indebtedness".*

not considered as a significant source of the financial system instability. This view was supported by the fact that traditionally financial crises were related to the corporate sector (Herceg and Šošić, 2011; Caprio, 1998). The growth of households' debt is also affected by excessive consumption as a consequence of expectations of fast-growing incomes (Herceg and Šošić, 2011). The Croatian labor market suffered major negative consequences due to global financial crisis. The disposable income collapsed and aggravated the debt repayment ability. Furthermore, during economic downturns businesses conduct cost-cutting measures which usually involve layoffs. Consequently, workers who lose their jobs have problems in repaying their debts. The excessive indebtedness of households and companies negatively affects consumption and investments (European Commission, 2015).

With the onset of the financial crisis in 2008, the vulnerabilities of banks were revealed and the upward trend of non-performing loans (NPL), commonly used as a measure of credit risk, started. This has become a significant problem especially because the changes in NPL are correlated with the negative GDP growth (Klein, 2013). Financial crisis caused significant deterioration of household and company's credit quality, but with different dynamics. The quality of corporate loans deteriorated immediately and the economic slowdown had the most powerful effect on this loan category. In the case of household loans this process was somewhat delayed (CNB, 2011). The global financial crisis only further emphasized the significance of relationship between macroeconomic factors and banking system.

The goal of this paper is to explore the drivers behind the evolution of credit risk in the corporate and households sector. Our aim is to address the risks drivers threatening the Croatian banking system in order to improve their identification and understanding for all market participants. Better understanding of the key drivers behind the credit risk enables the policy-makers and regulators to set up rules and policies in order to avoid or at least to minimize the negative impacts of credit risk proliferation on the banking sector and economy in general.

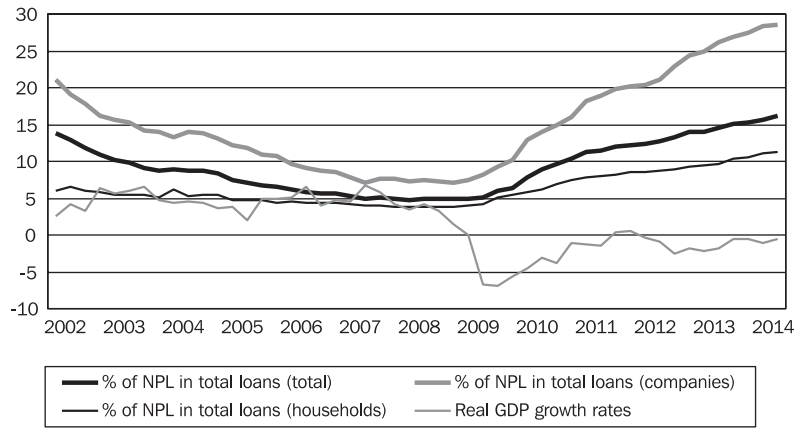
The global financial crisis badly affected the Croatian economy and created considerable economic and social costs. In Croatia the level of NPL started to rise sharply in 2008 and continued to increase ever since. In November 2014 the number of Croatian citizens with blocked bank accounts reached almost 321,000 or 8.4 percent more than the previous year. Their debt totalled more than HRK 30 billion which represents a 30.8 percent annual growth and for the first time it has exceeded the debt of blocked companies. Although the blocked companies' debt has decreased by 15.9 percent compared to November 2013, it is still significant. The reason for this decrease lies in the implementation of a new regulation which created more favorable conditions for faster payment and reduction of enforcement costs (Croatian Debt Recovery Enforcement Act, Procedure for Debt Recovery Enforcement Ordinance, Financial Operations and Pre-Bankruptcy Settlement Act). A further problem is the duration of overdue loans by households and companies that in most cases exceed 360 days (91.54 percent for households and 88.1 percent for companies) (Fina, 2014). The constant deterioration of household and corporate economic and social conditions due to the continuous NPL growth was the main motivation behind this paper.

The problem of rising NPL ratio (share of NPL to total gross loans) in Croatia is accompanied by the decrease in real GDP growth rates (Figure 1). Unfavorable trends in labor market, decline of the consumer confidence and poorer business results, accompanied by absence of new investments, resulted in low growth rates. However, the banking sector made efforts to reduce short- and long-term interest rates and to increase the share of loans in domestic currency. These measures were intended to reduce the loan repayment burden and the currency risk but the NPL still remained relatively high.

The purpose of this paper is to explain how macroeconomic and monetary shocks affect the level of NPL ratio for households and companies in Croatia during 4Q2001-Q2014 period. We test the hypothesis that the quality of loans is sensitive to cyclical developments and is strongly affected by macroeconomic variables. Although the literature on

macroeconomic indicators affecting NPL is quite extensive, most studies analyze these impacts on overall NPL and only few observe it segregated. Recently, Croatian National Bank (CNB, 2015) made a sectoral analysis for households and companies using linear regression. The goal of this paper is to identify the key NPL drivers for households and companies in Croatia and explain their behavior using Vector Error Correction (VEC) model.

Figure 1 **Dynamics of NPL Ratio and Real GDP Growth in Croatia, 4Q2001-1Q2014**



Sources: Croatian National Bank (2014). Quality of loans by sectors; Croatian Bureau of Statistics (2014).

The remainder of the paper is organized as follows: Section 2 presents the literature review and the main determinates of NPL. Section 3 explains the data and the methodology while Section 4 delivers the empirical results and research findings. Section 5 examines variance decomposition of the NPL ratio. The last section concludes.

2 Literature Review on Determinants of Non-Performing Loans

After 2008 and the beginning of the financial crisis, the NPL and other influential factors have generated great interest among researchers. Most empirical studies examine the effects of macroeconomic variables on NPL. The GDP growth, the lending rates and the unemployment rate are identified in the economic literature as the primary macroeconomic drivers of NPL. Most researches use panel data analysis because it is often quite difficult to propose a model for a single country due to the shortness of the time series, limited availability of the data and structural breaks.

A single country study was undertaken by Louzis, Vouldis and Metaxas (2012). In order to define variables that affect different NPL categories in the Greek banking sector they separate loans into consumer, business and mortgage loans. They conclude that NPL for all loan categories can be explained by macroeconomic variables (GDP, unemployment, interest rates, public debt) and management quality. Blanco and Gimeno (2012) analyze the macroeconomic determinants that influence the ability of Spanish households in 50 provinces to repay their debts. Their results indicate that the dynamic behavior of default ratios is characterized by the lagged default ratio variables, contemporary and lagged values of credit growth, the unemployment rate and the interest debt burden. The interest debt burden combines the effects of interest rates, indebtedness and household disposable income. Berge and Boye (2007) find that troubled loans of Norges bank are sensitive to unemployment and real interest rates. Besides the NPL, they also consider the doubtful loans. Doubtful loans are those loans where no formal default has occurred, but which the bank still considers to be doubtful. Sugawara and Zalduendo (2011) perform stress test on Croatian households by testing their elasticity to economic shocks and ability to service debt. They conclude that it is unlikely that the households' debt could hamper the aggregate economic activity. On the other hand, Erjavec, Cota and Jakšić (2012) use VAR analysis in investigating the response dynamics of banking sector to macroeconomic shocks in Croatia. Their results indicate a strong sensitivity of the Croatian banking sector to

macroeconomic shocks, but up till now, the sector was capable of recovering from negative macroeconomic developments. The CNB (2011) carried out a stress test on the Croatian households and companies for macroeconomic shocks. Changes in real GDP and nominal kuna/euro exchange rate are proven to be significant in individual models. Results indicate that the sensitivity of NPL to macroeconomic shocks varies among households and companies. CNB (2015) improved their model by determining the individual models of companies' credit risk for four different segments and on the aggregate level. Results have justified the sectoral approach because statistically significant explanatory macroeconomic variables (real GDP, exchange rate, inflation, interest rates and unemployment rate) vary between different segments.

Additional set of more recent studies has used panel data analysis. Jakubík and Reininger (2013) present a macroeconomic model based on a panel data for NPLs for nine CESEE countries. The results reveal that rising NPL is mainly affected by the slowdown in the economic growth. They also highlight past credit growth, the exchange rate changes and the share of foreign currency loans in total loans as factors that explain the changes in NPL. Škarica (2014) also finds that the negative GDP growth is the main driver behind NPL in seven CEE countries. Klein (2013) analyzes NPL in CESEE countries and reveals that the level of NPL has been growing with the increase of unemployment, depreciation of exchange rate and high inflation. Espinoza and Prasad (2010) show that NPL levels in 80 banks in the Gulf Cooperation Council region are affected by both macroeconomic and bank-specific variables. The results show that NPL deteriorates with the decline of economic growth and an increase of risk aversion. Beck, Jakubík and Piloiu (2013) perform their analysis on 75 countries and conclude that real GDP growth, share prices, exchange rate and lending interest rate have the strongest impact on the NPL ratio. Nkusu (2011) shows that growing NPL in 26 advanced economies is affected by the negative GDP growth, higher unemployment rate, higher interest rates, house prices fall and equity prices fall. Furthermore, Rinaldi and Sanchis-Arellano (2006) perform an analysis of seven euro area countries and conclude that debt ratio strongly affects the NPL of households.

According to the abovementioned studies, it is reasonable to expect that the dynamics of NPL ratio will be affected by some of the following variables:

- The negative relationship between NPL and economic growth is common in the NPL literature (Jakubík and Reininger, 2013; Nkusu, 2011; Espinoza and Prasad, 2010; Saurina and Salas, 2002; CNB, 2015). This means that the rise of GDP or industrial production should reduce NPL and vice versa. The same effect on NPL ratio can be expected with the total volume indices of construction work since they are directly associated with economic conditions.
- Unemployment is expected to be positively associated with NPL in households and corporate sector (Blanco and Gimeno, 2012; Nkusu 2011; Klein 2013; Salas and Suarina, 2002; CNB, 2015). Unemployment should negatively affect the ability of households to pay their loans. On the other hand, companies with financial problems may lay off employees to reduce costs, which consequently increase the unemployment rate and NPL.
- Positive correlation is expected between interest rates and NPL. The growth of interest rates could have a negative effect on the ability to service debt (Louzis, Vouldis and Metaxas, 2012).
- Inflation can be both positively and negatively related to NPL. On one hand, it reduces the loan's real value which makes it easier to repay it and it even reduces the unemployment (Phillips' curve). On the other hand, it reduces the real income which makes debt servicing more difficult (Nkusu, 2011). Klein (2013) found positive correlation between NPL and high inflation.
- Like inflation, changes in exchange rate can have both positive and negative implications. Appreciation of the domestic currency can favor the ability of borrowers in the foreign currency to service their debt. On the other hand, companies that are oriented towards export suffer negative consequences due to decreased competitiveness which also decreases their capacity to service their debts (Fofack, 2005; Nkusu, 2011; Beck, Jakubík and Piloiu, 2013). Klein (2013) found negative correlation between exchange rate and NPL. Beck, Jakubík and Piloiu (2013) found that the domestic currency

depreciation causes a higher NPL ratio, depending on the share of foreign currency-denominated loans in total loans. CNB (2011) results indicate that the weakening of the domestic exchange rate has a relatively strong deteriorating impact on the corporate and households sector.

- House price index is expected to impact real GDP positively by increasing the consumption and investment. Accordingly, the house prices index changes would also affect the level of NPL so that the rise of NPL leads to the fall of house prices index (Cuerpo and Pontuch, 2013; Klein, 2013).
- A negative relationship is expected between net wages and NPL ratio (Olaya Bonilla, 2012). Higher net wages can increase households' capability to repay its debts. On the other hand, the impact of higher net wages can have an opposite effect on companies since higher wages can deteriorate their ability to pay their liabilities. Companies usually reduce wages during periods of financial difficulties and increase them during periods of financial growth. This effect is in tight interaction with economic growth (Mahmudi, 2013).
- The foreign trade coverage ratio can be negatively related to the NPL ratio (Abadi, Achsani and Rachmina, 2014). The growth in foreign trade coverage ratio could improve financial conditions and help borrowers to repay their debts, especially in the corporate sector (Beck, Jakubík and Piloiu, 2013).

3 Methodology and Data

3.1 Cointegration and Vector Error Correction Model

Vector autoregressive (VAR) model specified in differences is valid only if the underlying variables are not cointegrated. If the variables are cointegrated, a VEC model should rather be employed since a VAR model is misspecified in the presence of cointegration (Granger, 1988). In a VAR model, long-run relationship is removed by first differencing, and thus it is able to detect only the short-run relationship between the variables. This limitation can

be avoided by using a VEC model which is able to distinguish between the long- and short-run relationships among variables and identify causation sources that cannot be detected by the usual Granger causality test. In this paper, VEC model is estimated separately for the households and corporate sector.

VEC model for the households has the following form:

$$\Delta LNPL_t^h = \alpha_1 + \sum_{i=1}^{n}(\beta_{1i}\Delta LNPL_{t-i}^h + \beta_{2i}\Delta LRGDP_{t-i} + \beta_{3i}\Delta LIPI_{t-i} + \beta_{4i}\Delta UNEMP_{t-i} +$$
$$+ \beta_{5i}\Delta LCPI_{t-i} + \beta_{6i}\Delta LHCPI_{t-i} + \beta_{7i}\Delta LNW_{t-i} + \beta_{8i}\Delta IRL_{t-i}^h + \beta_{9i}\Delta IRS_{t-i}^h +$$
$$+ \beta_{10i}\Delta LCHF\_HRK_{t-i} + \beta_{11i}\Delta LEUR\_HRK_{t-i}) + \theta ECM_{t-1} + u_t \ .$$

Model specification for the corporate sector can be expressed as follows:

$$\Delta LNPL_t^c = \alpha_1 + \sum_{i=1}^{n}(\beta_{1i}\Delta LNPL_{t-i}^c + \beta_{2i}\Delta LRGDP_{t-i} + \beta_{3i}\Delta LIPI_{t-i} + \beta_{4i}\Delta UNEMP_{t-i} +$$
$$+ \beta_{5i}\Delta LCPI_{t-i} + \beta_{6i}\Delta LHCPI_{t-i} + \beta_{7i}\Delta LCW_{t-i} + \beta_{8i}\Delta LNEX_{t-i} + \beta_{9i}\Delta LGW_{t-i} +$$
$$+ \beta_{10i}\Delta LNW_{t-i} + \beta_{11i}\Delta IRL_{t-i}^c + \beta_{12i}\Delta IRS_{t-i}^c + \beta_{13i}\Delta LEUR\_HRK_{t-i}) + \theta ECM_{t-1} + u_t .$$

The superscripts *h* and *c* denote the type of loan (i.e., households and corporate loans). Δ stands for the first difference operator while *L* stands for logarithmic transformation of the underlying variable. *LNPL* is the corresponding non-performing loans ratio, *LRGDP* is the real gross domestic product, *LIPI* is the industrial production index, while *UNEMP* is the unemployment rate. *IR* represents the corresponding interest rate (short- or long-term interest rates are treated separately for households and corporate sector). *LCPI* and *HCPI* denote the consumer price and hedonic housing index, while *LGW* and *LNW* represent the average gross and net wages. The total volume indices of construction works – *LCW* and foreign trade coverage ratio – *LNEX* are used as additional explanatory variables for corporate-level non-performing loan ratio. Besides kuna/euro (*LEU_HRK*) exchange rate, kuna/swiss franc (*LCH_HRK*) exchange rate is used as additional explanatory variable for the household model specification. Finally, *ECM* denotes error correction term which represents the long-run dynamics between variables. Causality can be confirmed by taking a joint

F-test of the ECM coefficient and the coefficients of lagged explanatory variables since causality derives from two parts – the EC term and lagged variables.

Innovation analysis is used to obtain information regarding the interaction between variables in the VEC model.[2] Since we are interested in examining the impact of macroeconomic and monetary shocks on the NPL, the variance decomposition is performed on the NPL. In determining the order of variables, we have used the Cholesky factorization, where the largest variance is attributed to the variable which is ranked first.

3.2 Descriptive Analysis of the Data

The NPL of the private sector (households and companies) and its capability to repay the accumulated debt provides insight into the country's financial fragility and macroeconomic stability. Although NPL definitions vary across countries, they usually represent the loans past due over 90 days (Rinaldi and Sanchis-Arellano, 2006). According to the Basel Committee on Banking Supervision (paragraph 452): "a default occurs when the bank considers that an obligor is unlikely to repay its credit obligations to the banking group in full, without recourse by the bank to actions such as realizing security; or the obligor is past due for more than 90 days on any material credit obligation to the banking group". Croatia implemented the Basel core principles and therefore has the same definition of NPL as the Basel Committee on Banking Supervision. Accordingly, in this paper NPL stands for partially recoverable (risk group B) and fully irrecoverable claims (risk group C) with more than 90 days overdue. This definition is also based on the national credit quality classification (CNB, 2010).

Macroeconomic and monetary variables used in explaining the NPL are given in Table A1 in the Appendix. Variables are seasonally adjusted using X12ARIMA method and consist of quarterly data in the period 4Q2001-1Q2014. All variables except long and short-term interest rates

[2] *The explanations of the procedures can be found in Enders (2010) or Bahovec and Erjavec (2009).*

and unemployment rate are expressed in logarithm. Data on NPL, interest rates, consumer price index and exchange rates are collected from Croatian National Bank. Industrial production index, housing price index, average net wages, total volume indices of construction works and import/export figures are collected from the Croatian Bureau of Statistics, while the unemployment rate is obtained from Eurostat.

4 Empirical Results

In order to find the best model specification, we use different combination of explanatory variables which satisfy the expected signs of coefficients in accordance with the economic theory.[3] Real GDP or industrial production index and corresponding interest rates are found to be significant in all of the tested models. These variables are also stated as primary determinants of NPL in Greece (Louzis, Vouldis and Metaxas, 2012). The choice of the variables is not surprising since it has a strong justification in the theoretical literature on the life-cycle consumption models. Besides these variables, unemployment rate is also proven to be significant in both model specifications for companies.[4]

In order to perform our analysis we must examine the presence of non-stationarity and order of integration for each variable. We use two unit roots tests – Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP). Unit root tests are performed allowing for an intercept or intercept and time trend. The null hypothesis for both tests is that there is a unit

[3] *Regarding the selection of variables, we started our model from a general case and isolated several specific models. In the case of households, several model specifications are found to be satisfying, combining both the presence of cointegration and expected signs. One of the models includes a vector of five endogenous variables: LNPL, LCHF_HRK, LIPI, IRS and UNEMP. In the underlying model LCHF-HRK exchange rate is found to be significant in explaining LNPL ratio since the appreciation of Swiss franc negatively affects households' ability to service debt. Although cointegration is identified with the abovementioned variables, log of industrial production index is not significant both in the long and short term. Finally, the best model for households with regards to the significance of variables, their expected signs and diagnostic test results is found for the model specification with the similar variables, as in the case of corporate model I.*

[4] *In the corporate case, cointegration was found for the two model specifications presented in Table 1. The first model includes LRGDP, while the second model used the log of the industrial production index.*

root process i.e., non-stationarity of the underlying variable. Table A2 in the Appendix presents the results of the unit root tests for chosen variables.

Table A2 presents stationarity tests in levels and in first differences for common and loan-specific variables for each type of loan. Based on the results, at 5-percent significance, we cannot reject the presence of a unit root in levels for all variables, except for the real GDP when only constant is included in the PP test. The presence of a unit root in levels is rejected for long-term interest rate (households) when only a constant is included. This indicates that dynamics of the underlying variable can be explained by including a simple time trend and an intercept. The first-difference variables are found to be stationary for all variables except for unemployment and NPL for households in which ADF test does not reject non-stationarity but PP test strongly rejects it. A decisive role is attributed to the results of the PP test, which showed that the differenced variables are stationary and integrated of order one I(1).

An important feature of I(1) variables is that there can exist a linear combination of these variables that is stationary, meaning that there exists a long-run equilibrium between variables i.e., cointegration relationship (Engle and Granger, 1987). Since our variables are first-order integrated, we examine the existence of a cointegration relationship between the NPL for each type of loan and macroeconomic/monetary variables. This is done by performing the Johansen multivariate cointegration procedure (Johansen 1988; 1991) which is based on two test statistics (the Trace test and the Maximum Eigenvalue test). The null hypothesis for the Trace test is that the number of the cointegrating vectors is less than or equal to *r*. In the maximum eigenvalue test, the null hypothesis is that there are *r* cointegrating vectors present against the alternative that there are (*r*+1) present.

Table A3 in the Appendix reports the estimation results for the number of cointegrating vectors containing five lags for household model while the cointegration tests for both corporate model specifications are performed

using four lags.[5] For all loan types the Trace test and the Max Eigenvalue test indicate one cointegrating vector at 5-percent level. Hence, the variables are bound by a long-term equilibrium relationship. Also, cointegration rank test results show that chosen model specification for all loan types contains constant term and trend in the cointegration vector and constant term without trend in ECM.

After detecting the cointegration vector we estimate the VEC model. The main advantage of VEC specification is that it distinguishes between long- and short-term relationships among variables. Residuals from the cointegration regression are used as an additional explanatory variable in the short-run equation (EC term). Cointegration regression (long-run equation) and ECM results (short-run coefficients) for both loan categories are presented in Table 1.

Table 1 **Long- and Short-Run VEC Coefficients**

LNPL(-1)	**Households**	**Companies (I)**	**Companies (II)**
Cointegrating Equation (Long-run dynamics)			
LRGDP(-1)	-3.244*** [-7.276]	-2.586*** [-3.469]	
LIPI(-1)			-1.598*** [-2.358]
IRL _ H(-1)	0.169*** [5.463]		
IRL _ C(-1)		0.102*** [4.922]	0.171*** [7.008]
UNEMP(-1)		0.077*** [4.67]	0.085*** [4.314]
Trend	0.033*** [24.34]	0.017*** [5.540]	0.013*** [6.286]
Constant	35.44	29.08	7.42
Vector Error Correction Estimates			
Speed of adjustment (EC term)	-0.511*** [-4.215]	-0.5*** [-3.407]	-0.529*** [-4.875]
$\Delta LNPL_{t-1}$	0.276** [2.106]	0.518*** [3.111]	0.309** [1.923]
$\Delta LNPL_{t-2}$	0.144 [1.097]	0.193 [1.072]	0.112 [0.659]
$\Delta LNPL_{t-3}$	0.112 [0.953]	-0.174 [-1.01]	-0.193 [-1.107]
$\Delta LNPL_{t-4}$	-0.045 [-0.422]	0.256 [0.583]	0.262 [0.168]
$\Delta LNPL_{t-5}$	-0.098 [-1.024]		

[5] *The optimal lag length is chosen by Akaike (AIC) and Schwartz Bayesian information criteria (SBC). Wald test is performed to test the exclusion of insignificant lags.*

$\Delta LRGDP_{t-1}$	1.251 [1.477]	0.176 [0.236]	
$\Delta LRGDP_{t-2}$	0.536 [0.69]	-0.716 [-0.841]	
$\Delta LRGDP_{t-3}$	-0.136 [-0.192]	-0.391 [-0.426]	
$\Delta LRGDP_{t-4}$	0.613 [0.788]	1.393 [1.457]	
$\Delta LRGDP_{t-5}$	1.291 [1.589]		
$\Delta LIPI_{t-1}$			0.48 [1.663]
$\Delta LIPI_{t-2}$			0.041 [0.167]
$\Delta LIPI_{t-3}$			0.171 [0.706]
$\Delta LIPI_{t-4}$			0.333 [1.584]
ΔIRL_H_{t-1}	-0.056*** [-2.987]		
ΔIRL_H_{t-2}	-0.042** [-2.168]		
ΔIRL_H_{t-3}	-0.088*** [-4.404]		
ΔIRL_H_{t-4}	-0.023 [-0.964]		
ΔIRL_H_{t-5}	0.033 [1.009]		
ΔIRL_C_{t-1}		-0.08*** [-2.704]	-0.114*** [-4.206]
ΔIRL_C_{t-2}		-0.076** [-2.094]	-0.108*** [-3.308]
ΔIRL_C_{t-3}		-0.057* [-1.781]	-0.078*** [-2.761]
ΔIRL_C_{t-4}		-0.03 [-1.354]	-0.035* [-1.69]
$\Delta UNEMP_{t-1}$		0.002 [0.131]	0.007 [0.511]
$\Delta UNEMP_{t-2}$		0.008 [0.544]	0.016 [1.223]
$\Delta UNEMP_{t-3}$		0.003 [0.202]	0.015 [1.123]
$\Delta UNEMP_{t-4}$		0.023 [1.66]	0.168 [1.463]
Constant	0.004 [0.354]	-0.004 [-0.43]	-0.0002 [-0.027]
Number of lags	5	4	4
Number of observations	44	45	45
R^2 (Adj R^2)	0.83 (0.74)	0.81 (0.68)	0.84 (0.75)

*Notes: Corporate (II) – alternative model specification of corporate NPL ratio; Δ – first-difference, L – lag operator, * significant at 10% level, ** significant at 5% level, *** significant at 1% level, t-statistics in brackets.*

First, the cointegration equation with its long-run parameters is estimated for each loan category. Using the residuals from corresponding cointegration equation, the relevant adjustment parameter (EC coefficient) is obtained and included as an additional explanatory variable in the VEC model. EC term restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing individual short-run adjustments. In all model specifications, EC term is significant and has the appropriate negative sign implying that variables are cointegrated and converge to their long-run equilibrium. The negative sign indicates the speed at which deviations from long-run equilibrium are eliminated in each quarter through a series of partial short-run adjustments.

During economic prosperity the NPL ratios for households and companies are low. Consequently, banks apply relaxed credit criteria and are willing to provide loans to riskier clients. In the recession phase, most of the increase in the NPL ratio can be attributed to the realization of risks that have been building up on banks' balance sheets during the credit expansion phase.[6] As was previously stated, it can be expected that NPL ratio for households and companies will increase during the recession period.

Results indicate that the NPL for all loan categories is significantly and negatively affected by the economic slowdown, measured by the real GDP or industrial production index. Just like for the households, the first corporate model specification uses the real GDP, while the industrial production index is used as an alternative measure of macroeconomic situation in the second corporate model specification. This finding confirms the significant effect of economic cycles on economic subject's ability to pay their liabilities. This process is even more pronounced in recession times, when deterioration in the macroeconomic environment, proxied by the unemployment rate and GDP, results in debt repayment problems reflected by the rising NPL. This is in line with CNB findings (CNB, 2011; 2015) in which unfavorable macroeconomic conditions and general economic slowdown (measured by the growth rate of the real GDP) lead to an increase in the share of

[6] *Detailed overview of research where business cycle conditions are considered in credit risk modelling, can be found in Bonfim (2009).*

non-performing placements and potential liabilities for certain corporate and household sectors. Our finding corresponds to similar studies on a set of CESEE countries (Jakubík and Reininger 2013; Klein 2013) and CEE countries (Škarica, 2014).

The impact of long-term interest rates is examined for each loan category. Interest rates have mixed implications on NPL depending on the duration of the observation period. In the short run, higher interest rates have a negative effect on the NPL since higher interest rates discourage investments in the more risky and less profitable ventures which are usually funded in the low interest rate environment. In the long run, the effect of interest rates is positively related to the NPL since higher interest rates worsen the borrower's debt repayment capacity and refinancing terms. In addition, household spending in Croatia is mainly financed by bank and credit card loans, and higher interest rates lead to an increase in NPL, especially in recession times. Higher interest rates also effect company's profitability and increase the debt burden.

Our results show that unemployment rate is a significant variable for corporate category and has the expected positive sign.[7] Long-run positive relationship between NPL and unemployment rate means that they move in the same direction. According to theoretical expectations (Klein, 2013; Blanco and Gimeno 2012; Nkusu 2011; Salas and Suarina, 2002) and empirical estimation, unemployment rate is a leading variable since the rise in the unemployment deteriorates households' ability to spend on new products and services which consequently leads to an increase in the corporate NPL. Companies faced with financial difficulties will cut costs by laying off their employees, which will result in a higher unemployment rate. Consequently, this will result in a vicious circle leading to even lower demand for company's products and decrease in revenues and debt service problems (Louzis, Vouldis and Metaxas, 2012). This is also in accordance

[7] *The unemployment rate is excluded as an explanatory variable from households' model. The reason for the exclusion is very high coefficient of correlation between unemployment and households' non-performing loans. This significant multicollinearity caused unemployment coefficient estimates to change significantly due to small changes in model specification and data transformations. Since multicollinearity does not reduce the predictive power and reliability of the whole model but only affects the estimates of individual predictors, we opted to exclude the unemployment variable from our households' model.*

with the findings by Tomas Žiković (2016), where unemployment rate is cointegrated with the corporate insolvencies in Croatia. Likewise, in credit risk modelling, CNB (2015) finds that the deterioration in the labor market (measured by the unemployment rate) will contribute to the increase in the share of NPL for corporate and household sector.

Based on the obtained *t* statistics, we can conclude that the macroeconomic variables are well determined and influence the dynamics of NPL. The disequilibrium error term is statistically significant in all equations which confirm the existence of a long-run relationship between the variables in the VEC models.

5 Variance Decomposition and Diagnostic Testing

Residual tests are carried out in order to test the robustness of the estimated VEC models. Based on the LM test statistics, none of the test statistics could reject the null of no serial correlation and heteroskedasticity in the residuals, showing that the estimation is unbiased. The residual normality tests are computed using the Jaque–Berra statistic with Cholesky (Urzua) orthogonalization. According to the test, the residuals for the corporate model specification (I) are multivariate and normally distributed, while the same cannot be claimed for the households and corporate (II) models. Nevertheless, according to Hendry and Juselius (2000), such properties of the model can be enough to achieve a valid statistical inference and we can conclude that the models are adequately specified and statistically acceptable.[8]

Inter-variable dynamics are examined by variance decomposition, which shows the extent to which the forecast error variance of NPL in the system is associated with the exogenous shock to endogenous variables. During the ten quarter span, NPL for households is largely explained by the shocks in the long-term interest rates and real GDP. Also, real GDP holds the most information regarding NPL for companies (I), followed by the variation in

[8] *Specification tests are available from the authors upon request.*

their own lagged shocks. In the alternative corporate model (II) the variance decomposition shows that, over a two-year horizon, NPL ratios are largely explained by the change in the industrial production index, its own lagged shocks and variation of the unemployment rate.

Table 2 **Variance Decomposition of NPL Ratio for Households and Companies**

Households				
P	S.E.	LNPL	LRGDP	IRL_H
1	0.032	100.0	0.000	0.000
2	0.036	89.76	2.932	7.306
3	0.048	68.85	15.64	15.51
4	0.059	50.97	34.55	14.48
5	0.084	29.48	37.97	32.55
6	0.117	18.78	36.01	45.22
7	0.149	16.31	33.74	49.95
8	0.192	13.51	31.01	55.48
9	0.233	12.78	32.17	55.05
10	0.271	13.23	31.10	55.67

Companies (I)						Companies (II)					
P	S.E.	LNPL	LRGDP	IRL_C	UNEMP	P	S.E.	LNPL	LIPI	IRL_C	UNEMP
1	0.037	100.0	0.000	0.000	0.000	1	0.033	100.0	0.000	0.000	0.000
2	0.064	92.95	0.132	0.574	6.339	2	0.060	78.89	7.646	0.855	12.61
3	0.093	85.31	4.459	0.289	9.939	3	0.096	57.44	24.85	0.535	17.18
4	0.126	74.82	17.98	0.197	6.998	4	0.125	47.60	35.50	0.717	16.18
5	0.164	69.76	24.75	0.208	5.283	5	0.155	42.51	40.02	0.967	16.51
6	0.204	63.19	31.94	0.877	3.999	6	0.189	36.04	43.89	3.063	17.00
7	0.246	57.40	38.05	1.360	3.194	7	0.222	31.06	46.36	5.075	17.50
8	0.289	53.02	42.46	1.806	2.715	8	0.258	26.90	48.57	6.812	17.71
9	0.331	49.12	45.98	2.494	2.409	9	0.297	22.67	50.14	9.319	17.86
10	0.373	45.67	49.10	3.121	2.116	10	0.334	19.33	51.21	11.67	17.78
Ordering: LNPL _ C LRGDP IRL _ C UNEMP						Ordering: : LNPL _ C LIPI IRL _ C UNEMP					

Notes: P – period, S.E. – standard error.

6 Conclusion

The significant increase of loans for households and companies that occurred during the past twenty years caused massive macroeconomic implications. This fact was highlighted by the outbreak of the global financial crisis which led to a significant increase of NPL in the banking sector. For the first time, the total debt of blocked households exceeded the debt of

blocked companies. This paper examined the effects of macroeconomic and monetary shocks on NPL for households and companies. We prove that the NPL ratio moves in the same direction as the economic slowdown measured by real GDP or industrial production index. This confirms the significant effect of economic cycles on households' and companies' ability to service their liabilities, especially during recession. The findings also accent the unemployment rate as a significant variable in case of the corporate sector NPL. Companies faced with financial difficulties cut costs by laying off employees which again causes higher unemployment rates. Higher unemployment rates lead to a decrease in demand which forces companies to further decrease their production. This creates a vicious circle that leads to debt servicing problems for companies. As expected, the empirical estimation confirmed a positive long-run relation between interest rates and NPL since higher interest rates worsen the borrower's loan repayment capacity and refinancing terms. Contrary to the long-run effect the short-run influence of the interest rates is negative since higher interest rates discourage investments in risky and less profitable ventures.

Variance decomposition shows that during a ten-quarter period the shocks in the long-term interest rates and real GDP explain, to a large degree, the dynamics of households' NPL. NPL in the first corporate model is largely explained by the variation of real GDP and its own lagged shocks, while NPL in the second corporate model is primarily explained by the change in the industrial production index, its own lagged shocks and the unemployment rate.

Appendix

Table A1 **List of Variables**

Variables	Description, source and variable transformation	Expected sign (NPL)
LNPL _ c	Non performing loans - corporate sector (CNB), log transformation	
LNPL _ h	Non performing loans - households (CNB), log transformation	
LRGDP	Gross domestic product - constant prices, 2010 base year (CBS), log transformation	negative
EX	Exports, constant prices, 2010 base year (CBS)	negative
IM	Imports, constant prices, 2010 base year (CBS)	ambiguous
LNEX	Foreign trade coverage ratio (EX/IM * 100), log transformation	negative
LIPI	Industrial production index (CNB), deseasoned, log transformation	negative
LCW	Total volume of construction works index (CBS), deasoned, log transformation	negative
UNEMP	Unemployment rate (EUROSTAT)	positive
LCPI	Consumer price index - 2010 base year, quaterly data (CNB), log transformation	ambiguous
HCPI	Hedonic housing index, 2010 base year (CBS), log transformation	negative
LNW	Average net wages, constant prices (CBS), log transformation	negative
LGW	Average gross wages, constant prices (CNB), log transformation	ambiguous
LEUR _ HRK	EUR/HRK FX rate (CNB), seasonally adjusted, log transformation	positive
LCHF _ HRK	CHF/HRK FX rate (CNB), seasonally adjusted, log transformation	positive
IRS _ c	Short-term weighted monthly interest rate for corporate sector indexed to foreign currency (CNB)	positive
IRS _ h	Short-term weighted monthly interest rate for households indexed to foreign currency (CNB)	positive
IRL _ c	Long-term weighted monthly interest rate for corporate sector indexed to foreign currency (CNB)	positive
IRL _ h	Long-term weighted monthly interest rate for households indexed to foreign currency (CNB)	positive

Sources: CNB – Croatian National Bank and CBS – Croatian Bureau of Statistics.

Table A2 **Unit Root Test**

Levels				
Variable	**ADF value, constant included**	**ADF value, constant and trend included**	**Phillips-Perron t, constant included**	**Phillips-Perron t, constant and trend included**
Common variables				
LRGDP	-1.859 (0.349)	-0.914 (0.946)	-3.096 (0.033)	-1.684 (0.744)
UNEMP	-1.261 (0.64)	-1.210 (0.897)	-0.925 (0.772)	-0.864 (0.952)
Households				
LNPL _ h	-0.628 (0.842)	-1.533 (0.804)	0.202 (0.97)	-1.086 (0.921)
IRL _ h	-3.415 (0.02)	-3.042 (0.132)	-3.349 (0.02)	-3.032 (0.134)
Corporate				
LNPL _ c	-0.484 (0.885)	-1.374 (0.856)	-0.669 (0.845)	-1.553 (0.797)
IRL _ c	-1.302 (0.621)	-1.225 (0.893)	-2.735 (0.075)	-2.711 (0.237)
LIPI	-1.971 (0.3)	-1.939 (0.619)	-1.880 (0.339)	-1.799 (0.690)
First differences				
Variable	**ADF value, constant included**	**ADF value, constant and trend included**	**Phillips-Perron t, constant included**	**Phillips-Perron t, constant and trend included**
Common variables				
ΔLRGDP	-4.836 (0.000)	-5.454 (0.000)	-4.861 (0.000)	-5.502 (0.000)
ΔUNEMP	-1.994 (0.288)	-2.363 (0.393)	-6.288 (0.000)	-7.033 (0.000)
Households				
ΔLNPL _ h	-1.95 (0.31)	-2.209 (0.473)	-6.854 (0.000)	-7.852 (0.000)
ΔIRL _ h	-7.74 (0.000)	-7.739 (0.000)	-7.657 (0.000)	-7.671 (0.000)
Corporate				
ΔLNPL _ c	-3.203 (0.026)	-3.783 (0.026)	-3.068 (0.036)	-3.802 (0.025)
ΔIRL _ c	-3.869 (0.005)	-3.763 (0.028)	-10.544 (0.000)	-10.415 (0.000)
ΔLIPI	-8.702 (0.000)	-9.084 (0.000)	-8.679 (0.000)	-9.538 (0.000)

Notes: h – households, c – corporate. Variables: log of corresponding non-performing loan ratio (LNPL_h, LNPL_c), corresponding interest rates (IRL_h, IRL_c), log of real GDP (LRGDP), log of industrial production index (LIPI) and unemployment rate (UNEMP). Δ is the difference operator. MacKinnon (1996) critical values are used for the rejection of the hypothesis of a unit root (p-values in brackets).

Table A3 **Trace and Maximum Eigenvalue Cointegration Test**						
Type of loan	**H_0: Rank<=r**	**Trace Stat.**	**5% Crit. Value**	**H_0: Rank=r**	**Max-Eigen St.**	**5% Crit. Value**
Households	None *	52.969	42.915	None *	28.204	25.823
	At most 1	24.766	25.872	At most 1	17.133	19.387
	At most 2	7.633	12.518	At most 2	7.633	12.518
Companies (I)	None *	94.431	63.876	None *	53.034	32.118
	At most 1	41.397	42.915	At most 1	18.855	25.823
	At most 2	22.542	25.872	At most 2	11.656	19.387
	At most 3	10.886	12.518	At most 3	10.886	12.518
Companies(II)	None *	86.251	63.876	None *	45.071	32.118
	At most 1	41.180	42.915	At most 1	18.218	25.823
	At most 2	22.963	25.872	At most 2	15.375	19.387
	At most 3	7.587	12.518	At most 3	7.587	12,518

*Notes: * denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values.*

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