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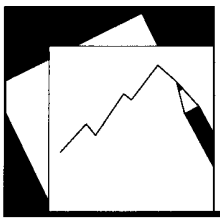

IMF Working Paper

Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance

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Non-Performing Loans in CESEE: Determinants and Macroeconomic Performance

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Abstract

The paper investigates the non-performing loans (NPLs) in Central, Eastern and South-Eastern Europe (CESEE) in the period of 1998–2011. The paper finds that the level of NPLs can be attributed to both macroeconomic conditions and banks' specific factors, though the latter set of factors was found to have a relatively low explanatory power. The examination of the feedback effects broadly confirms the strong macro-financial linkages in the region. While NPLs were found to respond to macroeconomic conditions, such as GDP growth, unemployment, and inflation, the analysis also indicates that there are strong feedback effects from the banking system to the real economy, thus suggesting that the high NPLs that many CESEE countries currently face adversely affect the pace economic recovery.

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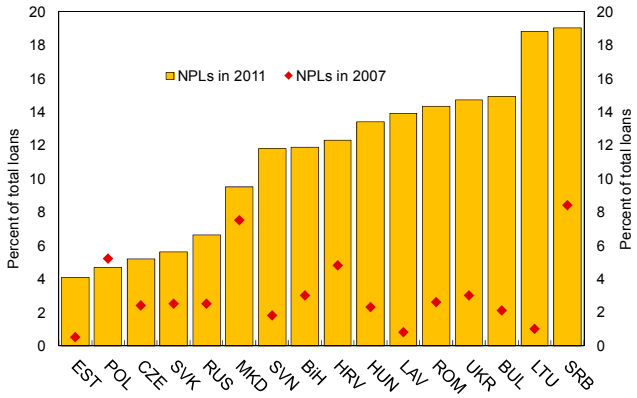
I. INTRODUCTION

High and rising levels of non-performing loans (NPLs) in many Central and Eastern and South-Eastern Europe (CESEE) continue to exert strong pressure on banks' balance sheet, with possible adverse effect on banks' lending operations.[2] Since the onset of the crisis, NPLs in the region increased to an average of 11 percent (end-2011) from just above 3 percent in 2007 (Figure 1), and in many of the CESEE economies NPLs have yet to reach their peaks. While at this juncture the surge in NPLs is not viewed as an immediate de-stabilizing factor, the feedback effects from the banking system to economic activity undermine a sustained recovery and may pose significant vulnerabilities going forward. Acknowledging the gravity of the problem, policymakers have placed the resolution of the NPLs problem as a priority.[3]

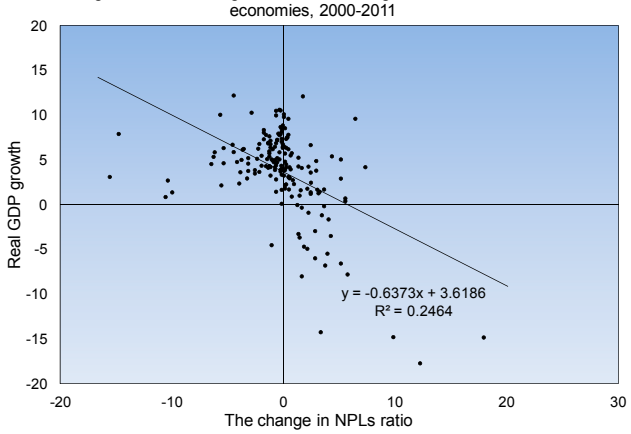
Figure 1. Non-performing loans in CESEE economies



Source: Global Financial Stability Reports.

The recent rise in NPLs is widely spread across banks and is evident in both retail and corporate segments. The upward trend of NPLs started immediately with the outbreak of the financial crisis in 2008, but the sharp increase occurred a year later, when GDP in most of the CESEE economies contracted. Although more moderately, NPLs continued to rise since then, exhibiting strong and negative correlation with pace of economic recovery (Figure 2). The upward trend reflects in part the consequences of heightened unemployment across the region which, together with depreciated currency and tight financial conditions, weakened the borrowers' repayment capacity. Beyond the macroeconomic factors, the relatively high variability in NPLs ratio (even within countries), indicates that there may be non-negligible contribution of banks' specific factors.

Figure 2. Real GDP growth and the change in NPLS in CESEE economies, 2000-2011



Against this background, the objective of this study is twofold. First, the study aims to evaluate the determinants of non-performing loans in CESEE economies by looking at both bank-level data and macroeconomic indicators over 1998–2011. Such an exercise would be useful not only

[2] The subdued credit growth in many countries in the region is attributed to both demand and supply factors.
[3] See, for instance, the "European Bank Coordination Vienna Initiative".

to evaluate the relative importance of bank-level vs. macroeconomic factors but also to examine how the relative importance has changed since the onset of the financial crisis. The second part of the study evaluates the feedback effects from the banking sector to the real economy through a panel vector auto-regression (VAR) analysis, which includes five endogenous variables (NPLs, real GDP growth, unemployment rate, the change in credit-to-GDP ratio and inflation) in order to assess how the recent increase in NPLs in the CESEE region is likely to affect economic activity in the period ahead.

The results suggest that NPLs are indeed affected by both macroeconomic and bank-level factors. Among the macroeconomic determinants, the results suggest that higher unemployment rate, exchange rate depreciation (against the euro) and higher inflation contribute to higher NPLs while higher Euro area's GDP growth results in lower NPLs. Higher global risk aversion (VIX) was also found to increase NPLs. The impact of bank-specific factors is broadly in line with the literature: equity-to-asset ratio and return on equity (ROE) are negatively correlated with NPLs while excessive lending (measured by loan-to-asset ratio and the past growth rate of banks' lending) leads to higher NPLs. Although bank-level factors have a significant impact on NPLs, their overall explanatory power was found to be low.

The panel VAR analysis broadly confirms the existence of strong macro-financial linkages. In particular, the impulse response functions reveal that a positive shock to GDP growth and credit (as a ratio of GDP) contributes to the reduction of NPL while a higher inflation leads to higher NPLs. In addition, other things being equal, a positive shock (increase) to NPLs ratio leads to a contraction of credit-to-GDP ratio and real GDP and to a higher unemployment rate. As a result of a weaker economic activity, CPI inflation also declines.

The rest of the paper is structured as follows. Section II provides a brief literature review on both the macroeconomic and bank-level determinants of NPLs, and on empirical evidence related to the feedback effects between NPLs to the real economy. Section III describes the data, presents the empirical model that is used to analyze the NPLs' determinants, and discusses the results; Section IV evaluates the feedback effects from the banking sector to the real economy through a panel VAR analysis. Section V concludes and offers some policy implications.

II. LITERATURE

A. The Determinants of Non-Performing Loans

The literature identifies two sets of factors to explain the evolution of NPLs over time. One group focuses on external events such as the overall macroeconomic conditions, which are likely to affect the borrowers' capacity to repay their loans, while the second group, which looks more at the variability of NPLs across banks, attributes the level of non-performing loans to bank-level factors. Empirical evidence, however, finds support for both sets of factors.

Bank-level factors

Berger and DeYoung (1997), who studied the links between NPLs, cost efficiency and capitalization in the US commercial banks for the period 1985–94, found a two-way causality between cost efficiency to NPLs. While they explained the causality from NPLs to cost efficiency as "**bad luck,**" driven mainly by deterioration in macroeconomic conditions, they explained this causality from cost efficiency to NPLs through the hypothesis of "**bad management**." In particular, this hypothesis argues that low cost efficiency is a signal of poor management practices, thus implying that as a result of poor loan underwriting, monitoring and control, NPLs are likely to increase. Williams (2004) who focused on the relationship between loan quality and cost efficiency among European savings banks from 1990–1998, Podpiera and Weil (2008), who analyzed the Czech banks between 1994–2005, and Louzis, Vouldis and Metaxas (2010), who examined the determinants of NPLs in the Greek banking sector, found support for this hypothesis.[4]

An alternative hypothesis ("**skimping**"), that was also proposed by Berger and DeYoung (1997) suggests a possible positive causality between high cost efficiency and NPLs. In particular, they suggest that high cost efficiency may reflect little resources allocated to monitor lending risks and therefore may result in higher NPLs in the future. This hypothesis is consistent with the findings of Rossi, Schwaiger, and Winkler (2005) who looked at a sample of 278 banks from nine transition countries from 1995 to 2002.

The "**moral hazard**" hypothesis, which was discussed by Keeton and Morris (1987), argues that banks with relatively low capital respond to moral hazard incentives by increasing the riskiness of their loan portfolio, which in turn results in higher non-performing loans on average in the future. Keeton and Morris (1987) indeed showed that excess loss rates were prominent among banks that had relatively low equity-to-assets ratio. The negative link between the capital ratio and NPLs was also found in Berger and DeYoung (1997), and Salas and Saurina (2002).

More generally, Keeton and Morris (1987) argued that banks that tend to take more risks, including in the form of **excess lending** eventually absorbed higher losses. Their finding was supported by Salas and Saurina (2002) and Jimenez and Saurina (2005).

Macroeconomic factors

There is significant empirical evidence regarding the anti-cyclical behavior of the NPLs. The general explanation is that higher real GDP growth usually translates into more income which improves the debt servicing capacity of borrowers. Conversely, when there is a slowdown in the

[4] These studies used different measures to capture "cost efficiency", including profitability indicators such as return on equity or return on assets (Louize et al, 2010), expenditures-to-assets (Espinosa and Prasad, 2010), or by estimating a "cost frontier" (Podpiera and Weil, 2008).

economy the level of NPLs is likely to increase as unemployment rises and borrowers face greater difficulties to repay their debt (Salas and Suarina, 2002; Rajan and Dhal, 2003; Fofack, 2005; and Jimenez and Saurina, 2005).

Other macroeconomic variables, which were found to affect banks' asset quality, include the exchange rate, interest rate, and inflation. In this regard, exchange rate depreciation might have a negative impact on asset quality, particularly in countries with a large amount of lending in foreign currency to un-hedged borrowers,[5] and interest rate hikes affect the ability to service the debt, particularly in case of floating rate loans (Louzis, Vouldis and Metaxas, 2010). The impact of inflation, however, may be ambiguous. On one hand, higher inflation can make debt servicing easier by reducing the real value of outstanding loan, but on the other hand, it can also reduce the borrowers' real income when wages are sticky. In countries where loan rates are variable, higher inflation can also lead to higher rates resulting from the monetary policy actions to combat inflation (Nkusu, 2011). Several studies also found that NPLs are affected by stock prices arguing that a drop in shares prices might lead to more default via wealth effects and decline in the value of collaterals.

B. Feedback Effects

The literature offers a large number of models and empirical evidence on the feedback effects between the real and financial sectors. The impact of the real economy on NPLs is mainly explained by weakening the borrowers' capacity to repay their debt, while the feedback from NPLs to the real economy is often identified through the credit supply channel. Diawan and Rodrik (1992), for instance, suggested that high NPLs increase the uncertainty regarding the capital position of the banks and therefore limit their access to financing.[6] This in turn increases the banks' lending rates and thus contributes to lower credit growth. Two additional mechanisms that are mentioned in the literature are the high costs associated with managing high NPLs (Mohd et al, 2010), and the lower capital that results from provisioning. Both contribute to lower credit supply, and therefore may have implications for economic activity. A recent paper, which focused on central, eastern and southeastern European countries indeed found causality between NPLs and credit growth.[7]

The feedback effects from NPLs to the real economy may also work through non-credit supply channels. For example, debt overhang can discourage companies from investing in new projects since future profits will be shared with the banks (Myers, 1977). Households may also show little enthusiasm to improve their houses or apartments if they may lose it down the road (Meltzer, 2010).

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[5] ECB Financial Stability Review, December 2011.

[6] This channel, of course, highly depends on the banks' level of provisioning as high rates of loan loss provisioning reduce the uncertainty regarding the banks' capital position.

[7] Working group report on NPLs in central, eastern and southeastern Europe, which was done under the umbrella of Vienna Initiative (2012).

A number of studies examined the feedback effects from the banking system to the real economy from a cross-country perspective. For instance, Espinosa and Prasad (2010) who looked at a sample of 80 banks of the Gulf Cooperation Council (GCC) region found that an increase in NPLs reduces credit growth and the non-GDP growth. Nkusu (2011), who focused on 26 advanced economies in the period of 1998–2009, found that adverse shocks to asset prices, macroeconomic performance and credit to the private sector lead to a worsening of loan quality. In turn, higher NPLs lead to a decline in house prices, credit-to-GDP ratio, and GDP growth. De Bock and Demyanets (2012), who assessed the vulnerability of emerging markets to financial shocks in the period of 1996-2010, found that economic activity slows down when non-performing loans increase while exchange rate tends to depreciate.

III. DATA AND EMPIRICAL APPROACH

Data

The analysis uses panel data of individual banks' balance sheets from Bankscope as well as macroeconomic indicators from the *Haver and World Economic Outlook (WEO)* datasets. Data is based on annual frequency for 1998–2011, and covers the ten largest banks (commercial, savings, cooperate, and real estate & mortgage) in each of the 16 countries covered in the analysis.[8] While for some banks data is not available for the entire period, the dataset's coverage is relatively large and includes above 60 percent of the banking sector's assets in most of the countries in the sample (Table 1).

While many variables were considered in the estimation process, the baseline specification includes four explanatory bank-level variables (equity-to-assets ratio, return on equity (*RoE*), Loan-to-Assets ratio, and the Loans growth rate (*D_Loans*)); three country specific variables (inflation, the change in exchange rate vis-à-vis the euro, and the change in unemployment rate); and two "global variables (the Euro zone's GDP growth, and the global risk aversion captured by the implied volatility of the Standard & Poor's 500 stock market index (*VIX*). It is worth mentioning that Bankscope reports the level of "impaired loans," which may be different than the official classification of non-performing loans. "Impaired loans" is an accounting concept, which reflects cases in which it is probable that the creditor will not be able to collect the full amount that it is specified in the loan agreement, while "NPL is a regulatory concept,

[8] Bosnia and Herzegovina (BiH), Bulgaria (BUL), Croatia (HRV), Czech Rep. (CZE), Estonia (EST), Hungary (HUN), Latvia (LAT), Lithuania (LTU), Macedonia (MKD), Poland (POL), Romania (ROU) Russia (RUS), Serbia (SRB), Slovak Rep. (SVK), Slovenia (SVN), and Ukraine (UKR).

which primarily reflects loans that are more than 90 days past due.[9] Acknowledging these differences, we treat "impaired loans" as NPLs in this analysis.

Table 1. Coverage of Dataset as a Percent of the Banking System Total Assets[1]

	2006	2011		2006	2011
Bosnia and Herzegovina	92.2	83.2	Macedonia	96.4	96.0
Bulgaria	81.9	87.9	Poland	82.7	71.9
Hungary	95.1	89.9	Romania	86.7	85.9
Croatia	92.4	90.2	Russia	48.4	64.1
Czech Rep.	89.6	86.8	Serbia	67.4	80.5
Estonia	100.0	99.8	Slovak Rep.	100.0	93.5
Latvia	78.8	88.1	Slovenia	91.1	86.1
Lithuania	100.0	99.6	Ukraine	64.5	64.7

[1]Figures are expressed as a percent of the available data in each year.

The correlation matrix (Table 1A in the Appendix) broadly supports the expected signs, although the magnitude of the correlation is not very high. NPLs exhibit a positive correlation with the change in unemployment (*D_unemp*), exchange rate depreciation (*Ex_rate*), and the VIX, while negatively correlated with return on equity (ROE), and the euro area real GDP growth (*D_rgdp_euro*). The negative correlation of NPLs with Loans-to-Assets ratio and loans' growth results from the contemporaneous effect of the volume of loans on the denominator of NPLs. Panel unit root tests (Fischer) reject the null hypothesis of a unit root in all panels (Table 2A in Appendix).

Overall, the data on NPLs includes 976 observations, which are unevenly divided over the sample's period: the first half of the sample (1998–2005) include 330 observations and the second half (2006–2011) include 646 observations. A close look at the evolution of the NPLs ratios indicate that they varied significantly over time, and across countries and banks (Table 2).

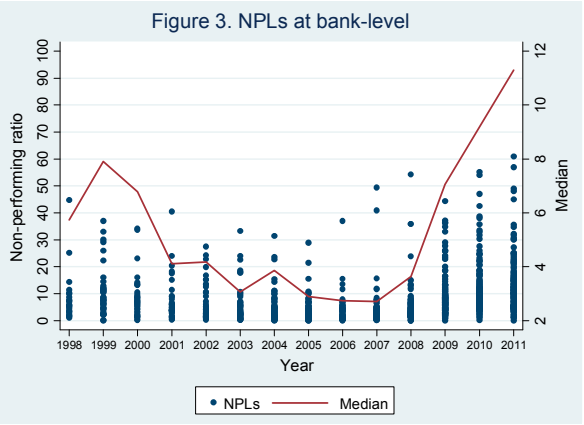
[9] A survey on NPLs definitions and reporting standards reveals that there are substantial differences among countries in the classification of NPLs (see report on NPLs by the European Banking Coordination "Vienna" Initiative (2012).

Table 2. Summary Statistics, Bank-Level Indicators, 1998–2011

Variable |	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
NPLs	976	8.25	9.02	0.07	60.82
Equity-to-Assets	1547	12.29	8.18	-19.50	77.70
Return on Equity (RoE)	1538	10.68	35.61	-200.88	570.17
Loans-to-Assets	1529	56.70	15.62	0.544	84.88
D_Loans	1347	24.83	37.05	-60.17	327.77

The Bank-level data also shows that the deterioration in the banks' assets quality since the outbreak of the financial crisis is wide-spread and evident in the balance sheets of most of the banks. Figure 3 indeed shows that following a significant improvement in the banks' NPLs in 2000–07, the median of NPLs climbed sharply from just below 3 percent in the pre-crisis period to about 11 percent in 2011, surpassing the high level that was observed in the late 1990s.

Figure 3. NPLs at bank-level



The country-specific variables also show high variability across time and countries (Table 3). For instance, high double digit levels of inflation were recorded mainly in Russia, Serbia, and Romania in late 1990s and early 2000s while negative rates of inflation were mostly evident in the financial crisis period (Bosnia and Herzegovina, Estonia, and Latvia). Exchange rate also moved sharply in some countries such as Ukraine, Russia, and Poland, particularly in response to the financial crisis in 2008-9.

Table 3. Summary Statistics, Country-Specific and Global Indicators, 1998-2011

Variable |	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Country-specific					
D_unemp	223	0.04	1.87	-5.61	9.70
Inf	221	8.07	11.63	-1.22	85.74
Ex_rate	206	2.40	9.45	-13.40	63.13
Global variables					
D_rgdp_euro	14	1.60	1.93	-4.39	3.90
Vix	14	22.72	5.98	12.78	32.65

Dynamic panel - econometric specification

We run a dynamic panel regression of the form:

$$y_{i,t} = \alpha y_{i,t-1} + \beta B_{i,t-1} + \gamma C_t + \delta G_t + u_{i,t} \qquad (1)$$

Where $y_{i,t}$ denotes the logit transformation of the NPLs ratio for bank *i* at year *t*. Such transformation ensures that the dependent variable spans over the interval [$+\infty$, -∞] and is distributed symmetrically. The dependent variable is explained by its lag, $y_{i,t-1,}$; bank-level variables ($B_{i,t-1}$), country specific variables, (C_t), non-country (global) variables(G_t).

We consider three alternative estimation techniques. The first one is a **fixed effects model**, which allows controlling for unobserved heterogeneity across banks. While this approach is rather simple and intuitive; it may give rise to "dynamic panel bias", which results from the possible endogeneity of the lagged variable and the fixed effects in the error term, $u_{i,t}$. This can be avoided by applying a "**difference GMM**" method of Arellano and Bond (1991), which transforms the data to first differences to remove the fixed effect element and uses the lagged levels of the right hand-side variables as instruments. One drawback of this approach, however, is that, in samples with a limited time dimension (small T) and high persistence, the estimation has low precision (Blundell and Bond (1998)).[10] Therefore, we also estimate a "**system GMM**" developed Arellano and Bover (1995) and Blundell and Bond (1998), which addresses this concern.[11] Under this approach, the lagged bank level variables were modeled as pre-determined (thus instrumented GMM-style in the same way as the lagged dependent variable) while the country-level variables and the global variables were treated as strictly exogenous (instrumented by itself as "IV style" instrument, see Roodman 2009).[12]

Three major caveats are worth noting. First, the classification of non-performing loans may not be consistent across countries due to differences in accounting approaches and regulations, and consequently national supervisors apply different criteria for "overdue loans".[13] Assuming that classification of NPLs has not changed significantly over time (within countries), this problem is somewhat mitigated by controlling for unobserved fixed effects in the econometric analysis. Second, in some countries, the non-performing loans are masked by sizable amount of restructured and "ever-greened" loans, which are not captured in this analysis. In these countries, the reported figures for NPLs underestimate the true stress in the banking system, and

[10] Blundell and Bond (1998) showed that the performance of the difference GMM estimator is worsened with the degree of persistency of the series because, as persistency increases lagged levels become less correlated with subsequent changes so they turn out to be weak instruments.
[11] This approach involves estimation of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments).
[12] In this approach we used the forward orthogonalization procedure of Arellano and Bover (1995) to reduce observation losses due to differencing, and the collapsing method of Holz-Elkin, Newely, and Rosen (1988) to limit the number of instruments (see Roodman, 2009).
[13] See Stephan Barisitz (2011).

therefore could potentially bias the estimations' results. Lastly, while the determinants of NPLs are likely to be affected by composition of outstanding loans (local vs. foreign currency, corporate vs., retail, and housing vs. consumption) across countries, the analysis does not control for composition impact due to data limitations.

Results

The results presented in Table 4 broadly confirm that both bank-level and macroeconomic factors play a role in affecting the banks' asset quality, although the contribution of bank-level factors is relatively low – their inclusion marginally increases the "within" explanatory power of each group while it significantly reduces the "between" explanatory power (in the fixed effects estimations). The Hansen-test suggests that the instruments used are uncorrelated with the residuals, and the Arellano-Bond tests rejects the hypothesis that the errors are not autocorrelated in the first order (AR(1)), but cannot reject this hypothesis for the second order

Table 4. NPLs: Macroeconomic and Bank-Level Determinants, 1998-2011

	Fixed Effects		Difference GMM		System GMM	
NPLs (-1)	0.664*	0.598*	0.805*	0.798*	0.933*	0.878*
Macroeconomic variables						
D_unemp	0.040**	0.010	0.026	-0.002	0.049*	0.039***
Inf (-1)	0.006	0.026*	0.030*	0.038**	0.012***	
Ex_rate[1]	0.003	0.006	0.012*	0.009**	0.005	0.009**
D_rgdp_euro (-1)	-0.053*	-0.034*	-0.038	-0.028**	-0.030*	-0.017***
Vix	0.028*	0.020*	0.022	0.014**	0.024*	0.022*
Bank-level variables						
Equity-to-Assets (-1)		-0.040*		-0.061*		-0.044**
RoE (-1)		-0.008*		-0.000		-0.005**
Loans-to-Assets (-1)		0.017*		0.032*		
D_loans(-2)		0.000		0.001		0.002***
Country dummies	no	no	no	no	yes	yes
Number of Obs.	764	604	587	464	764	608
R-squared (within)	0.601	0.620				
R-squared (between)	0.830	0.693				
Number of banks	135	120	124	105	135	120
Number of instruments			84	85	44	70
Hansen test p-value					0.624	0.206
A-B AR(1) test p-value					0.000	0.000
A-B AR(2) test p-value					0.289	0.433

Significance level: *significant at 1 percent; ** significant at 5 percent; ***significant at 10 percent.

[1] An increase in exchange rate indicates depreciation.

(AR(2)).[14] Beyond this, the NPLs were found to have high auto-correlation: the coefficient's size of the lagged NPLs ranges between 0.6 to 0.93, thus suggesting that a shock to NPLs is likely to have a prolong effect on the banking system.

Starting with the bank-level indicators, the estimations show that higher equity-to-assets ratio leads to lower NPLs, therefore confirming the "moral hazard" effect; and higher profitability (RoE) contributes to lower NPLs and suggests that better managed banks have, on average, better quality of assets (corroborating the "bad management" hypothesis).[15] Excessive lending, as measured by the loans-to-assets ratio, leads to higher NPLs in both fixed effects and difference GMM. The effect of past excess lending is also captured by the lagged lending growth, which results in higher NPLs as well. Unlike in other studies mentioned earlier, other bank-level indicators such as the bank size and expense-to-income ratio were not found to have significant impact.

On the macroeconomic level, the results show that an increase in unemployment contribute to higher NPLs, thus validating the strong link between the business cycles and the banking sector's resilience. In addition, both higher inflation and the depreciation of currency were found to increase NPLs. As expected, the global environment also contribute to the evolution of NPLs among CESEE banks: Higher volatility index and lower Euro area growth reduce the firms' capacity to repay, perhaps because of higher rates in the international financial markets, which reduce the firms' ability to rollover their debt, and because of lower export revenues. In addition, these two factors may also lead to lower external funding of the banks and therefore may result in negative credit growth (thus affecting NPLs ratio through the denominator).[16]

Robustness

To examine the robustness of the results, and particularly to evaluate the effect of the financial crisis, we split the sample to two sub-samples—the pre-crisis period (1998–2007) and 2008-11 ("post-crisis" hereafter). The results, which are presented in Tables 4A and 5A in the appendix, suggest that inflation and the change in unemployment had larger impact on the level of NPLs during the pre-crisis period. In the post-crisis period, the contribution of the exchange rate was much more prominent while the contribution of inflation was not found to be significant. The bank-level factors seem to play a role in both periods, though their coefficients' significance highly depends on the estimation technique.[17]

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[14] This is expected since differencing generates autocorrelation of order one.
[15] The causality between equity-to-assets and NPLs and RoE and NPLs is likely to be two ways, as higher NPLs also worsen the banks' equity position and profitability and, in turn, reduce equity-to-assets and RoE ratios.
[16] Because of the relatively high contemporaneous correlation between inflation and the change in exchange rate (0.51), and between the VIX and the euro area GDP growth (-0.69), they are introduced with different lags in the regressions.
[17] The results may be also driven by differences in the composition of banks within each sub-sample.

IV. THE DYNAMICS OF NON-PERFORMING LOANS AND THEIR MACROECONOMIC EFFECTS

This section explores the feedback effects from the banking sector to the real economy. In particular, we are interested in the linkages between NPLs of the banking-system as a whole, credit-to-GDP ratio, GDP growth, unemployment and inflation. The assessment of these linkages—causality, magnitude and duration—may shed some light on the macro-financial vulnerabilities that are associated with the recent surge of NPLs in many CESEE countries.

Methodology

The analysis applies a panel VAR methodology, which serves as a useful tool to evaluate the magnitude and duration of the effects. This technique also combines the traditional VAR approach, which treat all the variables in the system as endogenous, with a panel data approach, which allows for unobserved individual heterogeneity. The advantage of this methodology is that it does not require any a priori assumptions on the direction of the feedback between variables in the model. The panel VAR is computed from a program written by Love and Zicchino (2006) and is based on the following model:

$$Y_{i,t} = \Gamma_0 + \sum_{s=1}^{n} \Gamma_s Y_{i,t-s} + f_i + e_{it} \quad , \; Y_{i,t} = [npl_{i,t}, \Delta credit_{i,t}, unp_{i,t}, \Delta gdp_{i,t}, \Delta cpi_{i,t}] \qquad (2)$$

where $Y_{i,t}$ is a vector of five endogenous variables. The variable $npl_{i,t}$, is the ratio of non-performing loans-to-total loans of the overall banking system in country i and year t; $\Delta credit_{i,t}$ is the change in the credit (to the private sector)-to-GDP ratio, $\Delta gdp_{i,t}$ is the real GDP growth, $unp_{i,t}$ is the unemployment rate, and $\Delta cpi_{i,t}$ is the inflation rate. The countries' specifics are captured in this framework in the fixed effect variable, denoted in the model by f_i.[18] Since the fixed effects are correlated with the regressors due to lags of the dependent variable, the analysis uses a forward mean-differencing (Helmert procedure), which removes the mean of all forward future observations available for each country-year (Arellano and Bover, 1995).[19]

The dynamic behavior of the model is assessed using impulse response functions, which describe the reaction of one variable in the system to innovations in another variable in the system while holding all other shocks at zero.[20] The shocks in the VAR were orthogonized using Cholesky decomposition, which implies that variables appearing earlier in the ordering are considered more exogenous, while those appearing later in the ordering are considered more

[18] One of the caveats in this approach is that it assumes that the country's characteristics are fixed over time.
[19] This transformation preserves the orthogonality between the transformed variables and lagged regressors. The estimation uses lagged regressors as instruments and estimate the coefficient by GMM methodology.
[20] Monte Carlo simulations are used to generate the confidence intervals.

endogenous. In this specification, we follow the presumption that the GDP growth, unemployment, and inflation affect NPLs only with a lag, while NPLs have a contemporaneous effect on economic activity mainly through credit. Therefore, npl appears first in the ordering, and $\Delta credit_{i,t}$,unp Δgdp, and Δcpi appear later (in this order).[21] Qualitatively, the results remain broadly unchanged for alternative ordering.

Data

The analysis covers 16 CESEE economies over the period of 1998–2011.[22] Data for GDP growth, unemployment and CPI inflation was obtained from the World Economic Outlook database while the ratio of non-performing loans-to-total loans was taken from the IMF's Financial Soundness Indicators (FSI) dataset and from GFSR publications. Credit to the private sector was obtained from the International Financial Statistics (IFS). Table 6A in the appendix provides summary statistics.

The sample includes 206 annual observations of NPLs, which are mostly clustered in the 0-10 percent segment (Figure 4). The change in NPLs is nicely distributed around zero, though with a relatively high variance. The latter mainly reflects periods such as early 2000s when NPLs fell sharply in few countries such as Czech Rep., and Slovak Rep., and the financial crisis period (2008–09) when NPLs increased rapidly in Lithuania, Latvia and Ukraine. The correlation between the five variables is broadly in line with economic theory: NPLs are negatively correlated with GDP growth, and the change in credit to GDP ratio, and positively correlated with the change of unemployment. Inflation is positively correlated with the change in credit and GDP growth and negatively correlated with unemployment. Interestingly, the contemporaneous correlation of NPLs and inflation is negative (Table 5).

[21] This ordering is close in spirit to De Bock and Demyanets (2012). Marcucci and Qualiariello (2008) propose a related identification scheme where they rank default rates first.
[22] The composition of countries is the same as in section III.

Figure 4. Distribution of the Level and the Change of NPLs, 1998–2011

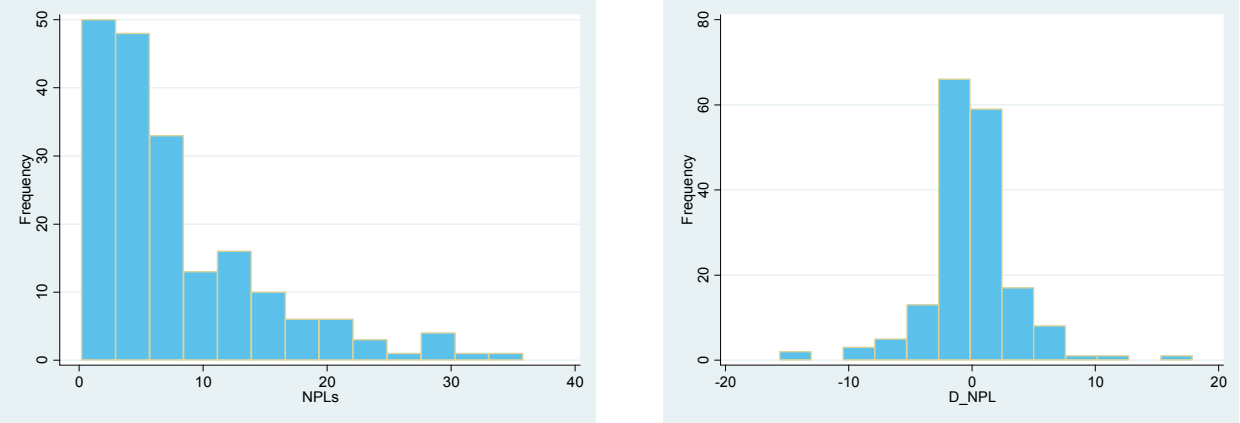


Figure 5. Correlation between the Change in NPLs, Unemployment and GDP Growth

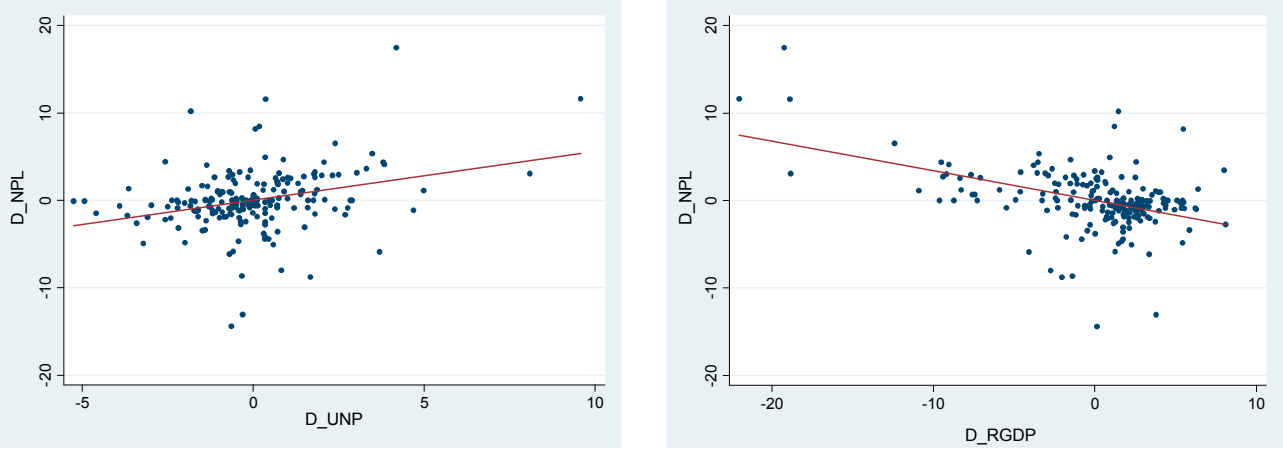


Table 5. Correlation Matrix

	npl	$\Delta credit$	unp	Δgdp	Δcpi
npl	1				
$\Delta credit$	-0.327	1			
unp	0.239	-0.136	1		
Δgdp	-0.290	0.114	-0.072	1	
Δcpi	-0.055	0.099	-0.357	0.056	1

To assess the level of integration we applied Fisher-ADF and Fisher-PP tests, which do not require a balanced sample and allow for data gaps. These tests conduct unit-root tests for each panel individually, and then combine the p-values from these tests to produce an overall test. The results in Table 3A (Appendix) indicate that, at least in one of the tests performed, the five

endogenous variables are stationary I (0) as the null hypothesis of a unit root in all panels can be rejected with a confidence of 95 percent or higher.

Results

- *Response of NPLs to shocks in other variables*: An increase of one percentage point in credit-to-GDP ratio and real GDP leads to a cumulative decline of 0.7 percentage point and 0.6 in NPLs, respectively (in the subsequent year, Figure 6). Additionally, an increase of one percentage point in inflation leads to an increase of 0.4 percentage point in NPLs (in the subsequent year). While in this specification a shock to unemployment was not found to have a significant impact on NPLs, in an alternative specification, where NPL and unemployment were introduced in their first difference the impact was found to be significant (see robustness below).

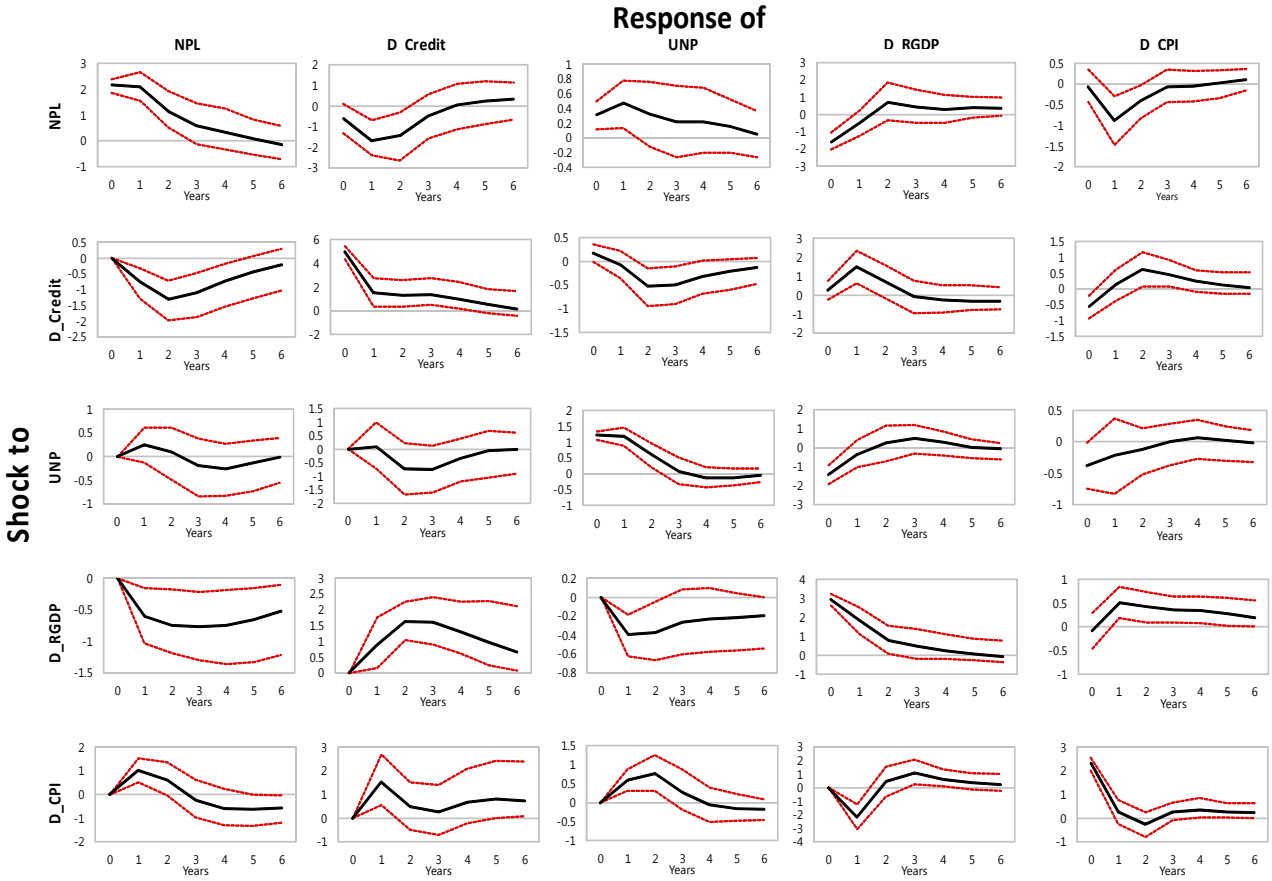
- *Impact of a shock to NPLs*: An increase in NPLs has a negative and significant effect on credit, inflation, and real GDP growth, while contributing to higher unemployment. In this regard, a one percentage point increase in NPLs results in a cumulative decline of 1.7 percentage points in credit-to-GDP ratio and a cumulative increase of 0.5 in unemployment (over three years). Such a shock also results in a cumulative contraction of about one percentage point in real GDP (over two years), and a cumulative decline in inflation of 0.6 percentage points (over three year horizon).

The impact of NPL on credit and GDP growth was found to be rather large compared to previous findings.[23] While point estimates should be treated with caution given the relatively wide confidence intervals, the large effects of NPL in this analysis may reflect the fact that this sample of countries exclusively consists of emerging markets that are in general more reliant on bank lending (compared to advance economies) and where individuals are in general more liquidity-constrained. Moreover, the results are affected by the massive credit boom in the period that preceded the financial crisis where in some countries (particularly Lithuania and Ukraine) the sharp drop in NPLs was facilitated by rapid expansion of credit and double digit GDP growth (or close to that). Excluding Ukraine and Lithuania, the effect of an NPL shock on GDP growth is significantly more moderate.[24]

[23] Nkusu (2011), who studied the feedback effects in advanced economies in 1998-2009, found that a one percentage point increase in NPLs leads to a cumulative decline of about 0.6 percentage points in GDP over three years. Espinosa and Prasad (2010), who focused on GCC region in 1995-2008, found that such a shock leads to a decline of 0.4 percentage point in the non-oil GDP in the first year.

[24] In this sub-sample, a one percentage point increase in NPLs results in a cumulative contraction of 0.7 percentage point in GDP over two years.

Figure 6. Impulse Response Functions*



Errors are 5 percent on each side generated by Monte-Carlo with 300 reps.

*Shocks are of one standard deviation.

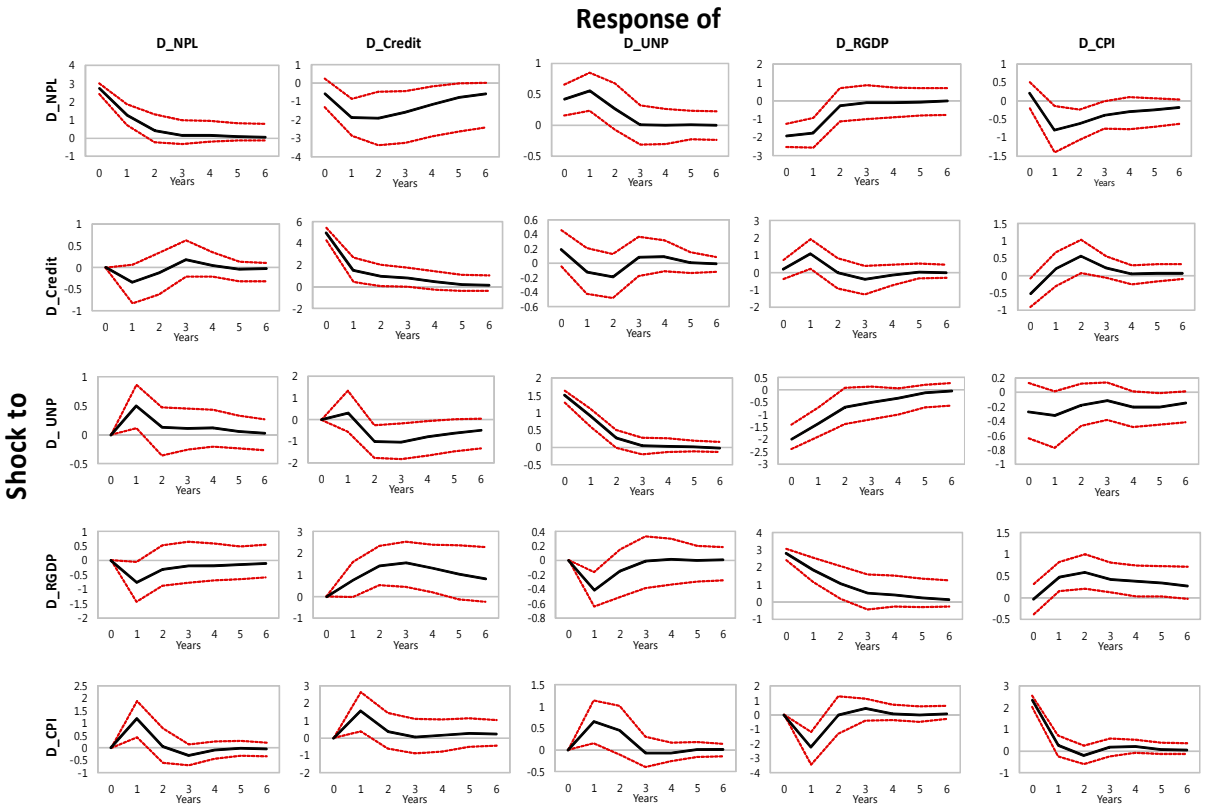
Robustness

In view of the different definitions of NPLs across countries, the level of NPL may not be comparable. Therefore, for robustness, we apply an alternative estimation that replaces the levels of NPL and unemployment with their change $[\Delta npl_{i,t}, \Delta credit_{i,t}, \Delta unp_{i,t}, \Delta gdp_{i,t}, \Delta cpi_{i,t}]$. The results show that the variables' dynamics are broadly similar to that in the baseline specification, although the magnitude of the effects is slightly different. In particular:

- *Response of NPLs to shocks in other variables:* The impulse response functions confirm the effect of economic activity on NPLs (Figure 7). An increase of one percentage point in unemployment and inflation results in an increase of NPLs in the subsequent year by 0.3 percentage point and 0.5 percentage point, respectively. Similarly, an increase of one percentage point in real GDP leads to a decline of 0.8 percentage points in NPLs (including through an expansion of credit) in the subsequent year.

- *Impact of a shock to NPLs:* An increase in NPLs leads to a prolonged period of reduction in credit-to-GDP ratio with repercussions to economic activity. Other things being equal, a one percentage point increase in NPLs results in a cumulative decline of 1.5 percentage point in credit-to-GDP ratio, and a cumulative increase of nearly 0.5 percentage points in unemployment (over a three-year horizon). Additionally, such a shock leads to a cumulative contraction of 1.3 percentage points in real GDP over two years. As a result of weaker economic activity, inflation also declines by a cumulative 0.4 percentage points over three years.

Figure 7. Impulse Response Functions, Alternative Specification*



Errors are 5 percent on each side generated by Monte-Carlo with 300 reps.

*Shocks are of one standard deviation.

Variance decomposition

The panel VAR dynamics were also assessed by variance decomposition, which shows the extent of which the forecast error variance of one variable in the system is associated with exogenous shock to other endogenous variable (Table 7). The variance decomposition shows that, in a 5-year horizon, NPLs plays an important role in affecting real economic variables as it explains about 10 percent of the forecast error of the rest of the endogenous variables. Among the variables in the system, the change in credit has the most information regarding the variation of NPLs, and then equally important are inflation and real GDP growth. In the alternative specification, the explanatory power of D_NPL regarding the variation of other variables is somewhat higher (10-20 percent), but the explanatory power of other endogenous variables with regards to the variation of D_NPL is on average lower.

Table 6. Variance Decomposition[1]

	Horizon	*NPL*	*D_CREDIT*	*UNP*	*D_RGDP*	*D_CPI*
NPL	5	0.573	0.212	0.009	0.109	0.097
D_CREDIT	5	0.109	0.646	0.025	0.157	0.064
UNP	5	0.088	0.113	0.557	0.071	0.171
D_RGDP	5	0.127	0.101	0.090	0.457	0.225
D_CPI	5	0.109	0.115	0.024	0.082	0.670
			Alternative estimation			
		D_NPL	*D_CREDIT*	*D_UNP*	*D_RGDP*	*D_CPI*
D_NPL	5	0.689	0.152	0.015	0.072	0.073
D_CREDIT	5	0.129	0.622	0.045	0.140	0.064
D_UNP	5	0.119	0.075	0.642	0.042	0.122
D_RGDP	5	0.189	0.083	0.163	0.362	0.203
D_CPI	5	0.154	0.103	0.022	0.071	0.649

[1] Percent of variation in the row variable explained by column variable.

V. CONCLUSIONS AND SOME POLICY IMPLICATIONS

In recent years many banks in the CESEE region experienced a rapid deterioration in assets' quality, leading to substantial losses and reduction of capital buffers. The fast increase in NPLs not only increased banks' vulnerability to further shocks but also limited their lending operations with broader repercussions for economic activity. This paper assesses these feedback effects and identifies the main determinants of the NPLs over time and across sixteen CESEE countries using a variety of panel estimation techniques.

While the paper's main findings remain robust for alternative specifications and time periods, they should be treated with caution as they are subject to caveats, including those that arise from the NPLs' data quality and differences in the classification of NPLs across countries. With this in mind, the paper finds that the level of NPLs can be attributed to both macroeconomic conditions and banks' specific factors. In particular, the results confirm that the level of NPLs tends to increase when unemployment rises, exchange rate depreciates, and inflation is high. Beyond the country-specific effects, factors, such as the euro area GDP growth and the global risk aversion, have a direct impact on banks' asset quality.

The paper also finds that NPLs are sensitive to bank-level factors. Higher quality of the bank's management, as measured by the previous period's profitability, leads to lower NPLs, while moral hazard incentives, such as low equity, tend to worsen NPLs. In addition, excessive risk-taking (measured by loans-to-assets ratio and the growth rate of bank's loans) was found to contribute to higher NPLs in the subsequent periods. These bank-level effects were significant during both the pre-crisis and post-crisis periods.

The examination of the feedback effects between the banking system and economic activity broadly confirms the strong macro-financial linkages in the CESEE region. While NPLs were found to respond to macroeconomic conditions, such as GDP growth, the results also indicate that there are feedback effects from the banking system to the real economy. More specifically, the estimations suggest that an increase in NPLs has a significant impact on credit (as a share of GDP), real GDP growth, unemployment, and inflation in the periods ahead, thus validating the notion that a healthy and sustainable growth cannot be achieved without a sound and resilient banking system.

Lastly, the paper's findings have some policy implications. First, given the adverse effect of NPLs on the broad economy and also in view of the significant contribution of bank-level factors to NPLs, there is merit to strengthen supervision to prevent a sharp buildup of NPLs in the future, including by ensuring that banks avoid excessive lending, maintaining high credit standards, and limiting foreign currency lending to un-hedge borrowers. Beyond this, the fact that high levels of NPLs continue to pose a burden on the economy, inter alia through limited bank lending, highlights the need for a swift, but orderly, clean-up of banks' portfolios. While the resolution of NPLs should, in principle, be led by banks in a collective and cooperative

fashion that will benefit both the debtors and creditors, policymakers can take a more proactive approach, including by removing tax, legal, and regulatory impediments to help banks accelerate the cleanup process of their portfolios in a non-disruptive manner taking into account banks' ability to absorb losses.

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APPENDIX

Table 1A. Correlation Matrix, 1998-2011

	NPLS	*d_unemp*	*Inf*	*Ex_rate*	*d_rgdp_euro*	*Vix*	*Equity-to-Assets*	*RoE*	*Loans-to-Assets*	*D_loans*
NPLS	1.00									
d_unemp	0.20	1.00								
Inf	-0.10	-0.11	1.00							
Ex. rate	0.04	0.17	0.51	1.00						
d_rgdp_euro	-0.13	-0.42	0.15	-0.26	1.00					
Vix	0.24	0.31	0.09	0.21	-0.69	1.00				
Equity-to-Assets	0.04	0.02	0.17	0.17	0.00	0.03	1.00			
RoE	-0.13	-0.13	0.06	0.02	0.13	-0.12	-0.15	1.00		
Loans-to-Assets	-0.06	0.10	-0.08	-0.02	-0.14	0.09	0.05	-0.05	1.00	
D_loans	-0.44	-0.30	0.13	-0.10	0.28	-0.32	-0.02	0.10	0.03	1.00

Table 2A. Panel Unit Root Tests (Fisher), NPLs Determinants

		Fisher-ADF	Fisher-PP
NPLS	level	778*	718*
D_unemp	level	1029*	628*
INF	level	1261*	1465*
Ex_rate	level	1217*	1087*
D_rgdp_euro	level	651*	809*
VIX	level	781*	367*
Equity-to-Assets	level	836*	1022*
RoE	level	1075*	1171*
Loans-to-Assets	level	517*	469*
D_Loans	level	406*	799*

*and ** denote significance at 1 and 5 percent, respectively.

Table 3A. Panel Unit Root Tests (Fisher), NPLs determinants

		Fisher-ADF	Fisher-PP
npl	level	46.62**	70.74*
Δnpl	level	42.61	72.87*
Δgdp	level	62.54*	86.11*
unp	level	65.92*	21.95
Δunp	level	113.67*	94.03*
Δcpi	level	124.50*	106.17*
$\Delta credit$	level	38.47	120.22*

*and ** denote significance at 1 and 5 percent, respectively

Table 4A. Macroeconomic and Bank-Level Determinants, Pre-Crisis Period (1998-2007)

	Fixed Effects		Difference GMM		System GMM	
NPLs (-1)	0.471*	0.511*	0.163	0.203	0.830*	0.741*
Macroeconomic variables						
D_unemp	0.120*	0.114*	0.093*	0.094**	0.047	0.091***
Inf (-1)	0.015**	0.025*	0.034*	0.038*	0.019**	0.025*
Ex_rate[1]	0.003	0.007	0.011**	0.012**	0.010	0.005
VIX	0.024*	0.032*	0.024*	0.027***	-0.006	0.003
Bank-level variables						
Equity-to-Assets (-1)		-0.014		-0.000		0.009
RoE (-1)		-0.007***		-0.003		-0.003
Loans-to-Assets (-1)		0.019*		0.014*		0.007
Country dummies	no	no	no	no	yes	yes
Number of Obs.	347	344	240	238	347	344
R-squared (within)	0.480	0.518				
R-squared (between)	0.715	0.503				
Number of banks	93	92	72	71	93	92
Number of instruments			41	44	28	55
Hansen test p-value					0.380	0.153
A-B AR(1) test p-value					0.015	0.026
A-B AR(2) test p-value					0.521	0.515

Significance level: *significant at 1 percent; ** significant at 5 percent; ***significant at 10 percent.

[1] An increase in exchange rate reflects depreciation.

Table 5A. Macroeconomic and Bank-Level Determinants, Post-Crisis Period (2008-2011)

	Fixed Effects		Difference GMM		System GMM	
NPLs (-1)	0.312*	0.300*	0.480*	0.459*	0.452*	0.513*
Macroeconomic variables						
D_unemp	0.013	0.008	0.028**	0.020***	0.023	0.037**
Inf (-1)	-0.007	-0.006	0.000	-0.000	-0.004	0.012
Ex_rate[1]	0.005*	0.005	0.008**	0.006**	0.007**	0.010**
Bank-level variables						
Equity-to-Assets (-1)		-0.037**		-0.048*		-0.005
RoE (-1)		-0.004*		-0.001		-0.007*
Loans-to-Assets (-1)		0.017*		0.016*		-0.006
Country dummies	no	no	no	no	no	yes
Number of Obs.	337	336	207	206	337	336
R-squared (within)	0.257	0.325				
R-squared (between)	0.821	0.464				
Number of banks	130	130	115	115	130	130
Number of instruments			7	10	22	31
Hansen test p-value					0.018	0.206
A-B AR(1) test p-value					0.675	0.034
A-B AR(2) test p-value					.	.

Significance level: *significant at 1 percent; ** significant at 5 percent; ***significant at 10 percent.

[1] An increase in exchange rate reflects depreciation.

Table 6A. Summary Statistics

	Obs.	Mean	Std. Dev	Min	Max
npl	206	8.757	7.937	0.200	41.300
Δnpl	189	-0.176	3.704	-15.600	17.900
$\Delta credit$	167	3.564	5.752	-16.587	19.262
unp	238	12.626	8.165	1.620	37.250
Δunp	208	0.039	1.936	-5.605	9.700
Δgdp	223	3.570	4.589	-17.729	12.194
Δcpi	235	9.214	13.746	-1.224	85.742