What are the Key Determinants of Nonperforming Loans in CESEE?

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Abstract

Credit risk assessment is a crucial part of macroprudential analysis, with the aggregate nonperforming loan (NPL) ratio serving as a proxy for the economy-wide probability of default of the banking sector's overall loan exposure. Therefore, the factors driving the NPL ratio deserve a lot of interest. This study provides a macroeconomic model for nonperforming loans (NPLs) for the Central, Eastern and Southeastern European (CESEE) countries. It is based on panel data for Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine. In line with current literature, our empirical analysis confirms that economic growth is the main driver that is negatively correlated with NPL development. This inverse relation is also indicated by the stock index as a leading indicator for economic developments. However, there are also other important determinants that can help explain the change in NPL ratios in the CESEE countries: past credit growth as well as exchange rate changes coupled with the share of foreign currency loans in total loans. This study confirms and quantifies risk of excessive credit growth as well as foreign exchange lending.

JEL classification: G28, G32, G33, G38

Keywords: Nonperforming loans, credit risk, financial stability, macroprudential framework, Central, Eastern and Southeastern Europe (CESEE), emerging Europe

Introduction

Credit risk assessment and, in particular, non-performing loan (NPL) projection are a crucial part of macro-stress tests. These tests are based on macroeconomic assumptions in order to provide common scenarios for all financial institutions participating in such an exercise. However, due to limited data availability, short time series and structural breaks, especially in emerging markets, it is challenging to estimate a robust model for any single country. It is therefore useful to provide an estimate based on panel data from emerging Europe to be used as a benchmark for countries in this region.

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Credit risk is one key risk for financial stability in Central, Eastern and Southeastern Europe (CESEE), where banks apply the traditional business model based on accepting deposits and granting loans. Although the recent financial crisis had its origin in advanced economies, average bank asset quality in CESEE deteriorated sharply when the subsequent economic crisis hit the global economy. Many research studies empirically confirm that credit quality is tightly linked to the economic cycle. However, there is some disagreement as to the importance of other factors driving credit quality.

In this study, we focus on some specifics of the CESEE region that could determine the key drivers of NPL development. This study follows research conducted by Beck, Jakubík and Piloiu (2013), who empirically investigated the key drivers of NPL development for a global panel covering 75 countries by using annual NPL data. Unlike the above study, we employ quarterly data and a more detailed dataset covering some aspects that were not available for Beck et al. (2013).

This paper is structured as follows: Section 1 provides a review of related studies on determinants of bank asset quality and credit risk. Section 2 presents a comprehensive description of the employed dataset and discusses NPL development in CESEE. Section 3 focuses on the econometric methodology which is applied for quantifying the relationship between nonperforming loans (NPLs) and macroeconomic and financial indicators. On this basis, we present the estimation results of an econometric model which quantifies this relationship. Section 4 summarizes the obtained results by drawing some conclusions with regard to policy implications. The last section concludes.

1 Related Studies

The literature on determinants of bank asset quality or credit risk comprises various approaches. Here, we focus on literature directly relevant for the present paper, following three main criteria.

First, we cover papers that have the same regional focus, namely CESEE. Second, our coverage extends to papers that follow a macro-approach by using macroeconomic variables as determinants for economy-wide aggregate NPLs.[2] Third, our focus is on papers that apply a similar econometric framework as our paper, at least in as far as they apply panel techniques as well.

To our best knowledge, no study has been published so far that meets all three criteria. So, we see the present study as the first to use a macro-based approach to estimate economy-wide aggregate NPL ratios for a set of CESEE countries by applying a panel technique. There are, however, many CESEE-related studies on bank asset quality and credit risk. For a large set of CESEE countries, Barisitz (2011, 2013) compares the national definitions and concepts of NPLs in detail and provides suggestion for aligning the statistical methodologies that measure NPLs.

Available CESEE-related studies on the macro-determinants of changes in the economy-wide aggregate NPL ratio of the banking sector are country-specific. For Croatia, Erjavec, Cota and

[2] Therefore, the following approaches are outside the focus of this section: a) other macro-based approaches that use macro-variables to explain aggregate indicators of bank asset quality other than economy-wide aggregate NPLs, such as sector NPLs, loan loss provision (LLP) ratios or bankruptcy or insolvency rates; b) the micro-approach, which – in contrast to the macro-approach – uses e.g. (panel) data of individual banks or companies to explain bank asset quality or bankruptcy rates. Other micro-approaches are based on survey data, using e.g. surveys on households to explain their share of not timely serviced debt (here, in particular, we would like to mention the study by Beckmann et al., 2012); c) a mixed macro-micro approach, which consists of using macro-variables to explain the asset quality of (a panel of) individual banks.

Jakšić (2012) set up a vector-autoregressive (VAR) model with macro-variables (real economic activity in Croatia and in the EU, inflation and short-term interest rates) and variables of the aggregate banking sector (return on equity (RoE), NPL ratio) and employ Uhlig's sign restriction approach. The VAR model is based on quarterly data for the period from Q2 2000 to Q2 2010. The above-mentioned authors find a strong sensitivity of the Croatian banking sector to contractionary monetary policy shocks and to negative demand shocks. For the Baltic countries, Fainstein and Novikov (2011) published a comparative analysis of credit risk determinants in the banking sector, applying a separate vector-error-correction model (VECM) for each of these three countries, based on quarterly data for the period from (depending on the country) Q3 1997/Q1 2002/Q1 2004 to Q4 2009. In addition to the unemployment rate, real GDP growth and banks' aggregated loan growth, the authors introduce the growth rate of the real estate market as explanatory variable. Their results show real GDP growth as the most significant determinant of NPL growth in all three countries and real estate market growth as playing an important role in two of these countries (Latvia and Lithuania). For Albania, Mancka (2012) estimates the impact of the exchange rate (in relation to the euro and to the U.S. dollar) and of a dummy variable for the world financial crisis on aggregate credit risk (measured by the NPL ratio) for the period from 2002 to 2010 on the basis of quarterly data. Both the exchange rates of the national currency and the dummy variable proved to have significant influence on NPLs.

Beyond the CESEE region, several studies estimate aggregate NPL ratios under a macro-based approach for a large set of countries (that may or may not include CESEE countries) by application of panel techniques.

In their paper on macroprudential stress testing of credit risk, Buncic and Melecky (2012) incorporate estimates of NPL elasticities by dynamic panel data regression (unbalanced panel, Arellano-Bond GMM estimator) on the basis of annual data for 54 high- and middle-income countries in the period from 1994 to 2004. Explanatory variables are the NPL ratio (lagged by one period), real GDP growth, CPI inflation, the (ex post) real interest rate and the change in the nominal U.S. dollar exchange rate for each country, while a vector of control variables comprises the log of GDP per capita, the credit-to-GDP ratio and the share of foreign currency loans in total loans. Buncic and Melecky find the exchange rate changes and the control variables to be not statistically significant.

For 26 advanced economies in the period from 1998 to 2009, Nkusu (2011) investigates the macroeconomic determinants of the NPL ratio and of the first difference of the NPL ratio in various panel regressions on the basis of annual data that include the lagged dependent variable. The results confirm that adverse macroeconomic developments, in particular a contraction of real GDP, a higher unemployment rate, higher interest rates, a fall in house prices and a fall in equity prices, are associated with rising NPLs. In a second step, the feedback between NPLs and macroeconomic variables is estimated in a panel vector autoregressive (PVAR) model.

For 25 emerging market economies in the period from 1996 to 2010, De Bock and Demyanets (2012) estimate various panel regressions on the basis of annual data that include the lagged dependent variable and unobserved country effects. Real GDP contraction, currency depreciation against the U.S dollar, weaker terms of trade and outflows of debt-creating capital (portfolio debt and bank loans) lead to a higher aggregate NPL ratio of the banking sector. The sharp deterioration of loan quality following a reversal of portfolio inflows is particularly noteworthy. The (first lagged) increase in the private credit-to-GDP ratio has no significant impact in the whole sample but is significant with a negative sign in the 2004 to 2010 subsample. In a second step, feedback effects from the financial sector on the wider economy are found to be significant according to a PVAR model with fixed effects, in which

GDP growth falls in the wake of shocks that drive NPLs higher or generate a contraction in credit.

For 75 advanced and emerging economies in the period from 2000 to 2010, Beck, Jakubík and Piloiu (2013) estimate fixed-effects and dynamic panel regressions on the basis of annual data for the change in the aggregate NPL ratio. Real GDP growth, share prices, the nominal effective exchange rate of the local currency and the bank lending interest rate are found to significantly affect changes in the NPL ratio. In the case of exchange rates, the direction of the effect depends on the extent of foreign exchange lending to unhedged borrowers. In the case of share prices, the impact is found to be larger in countries which have a large stock market relative to GDP.

2 Data, Stylized Facts and Hypotheses

In contrast to the study by Beck et al. (2013), we focus only on CESEE and have a richer data sample with quarterly frequency. Hence, we are able to better capture some specific effects for emerging Europe that cannot be fully revealed with a global data sample at annual frequency.

Our study covers the following nine CESEE countries: Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine. We include these countries for two main reasons: First, for these countries we can rely upon studies that investigate the applicability of the corresponding national data on NPLs and credit classifications (Barisitz, 2011 and 2013, see below). However, we could not include all the ten countries covered by Barisitz, as we had to exclude Serbia due to problems with data availability related to the explanatory variables. Second, these nine countries together account for a very large part of Austrian banks' credit exposure to the CESEE region.

For NPLs, the dependent variable to be explained, there is, so far, no internationally harmonized definition that has been applied in all or most countries of the world for a considerable period of time. Rather, efforts toward harmonizing NPL definitions have been getting steam only in recent years in the wake of the financial and economic crisis. For the time being, one can resort only to national NPL data established by the national supervisory authorities on the basis of their respective national definitions. However, we use the results of the detailed investigations performed by Barisitz (2011 and 2013) in an effort to minimize the methodological differences reflected in the data. Barisitz looked at both primary elements ("90days+" and/or "well-defined weaknesses") and secondary elements (treatment of replacement loans, impact of collateral and/or guarantees, share of loans classified as NPLs, downgrade requirement) in the CESEE countries' NPL definitions in order to derive NPL ratios that are based on roughly internationally comparable definitions in a transparent and replicable manner. Hence, we use the time series of NPL ratios as suggested by Barisitz (2011 and 2013), built as the country-specific sums of various components of the credit volume classified according to the respective national definitions. From our point of view, this enhances the added value of this empirical study.

Moreover, these level data that were derived by Barisitz on a best-effort basis, form the starting point of the ensuing transformation, as we aim at explaining the relative change in the share of NPLs in total loans, i.e. the percentage change (as opposed to the change in percentage points). Therefore, any remaining methodological differences inherent in the level data are of lesser importance, as we follow the development of each national NPL time series in its own right.

Turning to *possible explanatory variables*, we take into account both the stylized facts of NPL developments in CESEE sketched out above and the body of literature in which econometrical models typically explain NPL ratios by including variables for economic activity, aggregate credit and some additional variables.

As regards real economic activity, we look at real GDP as well as at the two main components of final demand, namely real exports and real domestic demand. Obviously, we hypothesize a negative relation between real GDP growth and a change in the NPL ratio. Moreover, we expect this to be true also for both main demand components.

As real economic activity in each CESEE country is heavily influenced by the international environment, we include the Chicago Board Options Exchange (CBOE) Market Volatility Index (VIX), a popular measure of the implied volatility of Standard and Poor's (S&P) 500 index options, the emerging market bond index global (EMBIG) and the national stock indices as proxies for the risk attitude among international financial investors and for the international environment and thus as leading indicators for the financial and economic developments in the CESEE countries.

Regarding the credit aggregate, we look at domestic bank credit to the private sector, including both households and nonfinancial corporations. We highlight, however, that this credit aggregate includes loans denominated in foreign currency or indexed to the exchange rate. Therefore, as we would like to avoid having the development of this credit aggregate blurred by purely statistical effects of exchange rate changes, we used this credit aggregate after adjustment for valuation changes resulting from exchange rate changes. The drawback of this approach was the fact that we had to shorten our sample to the period from 2004 to 2012. At the same time, however, this had the advantages that we avoided the statistical breaks in the NPL series at the end of the 1990s and early 2000s and that we ended up with a nearly balanced panel.

We use the credit aggregate relative to GDP as explanatory variable in the model. An increase in the credit-to-GDP ratio via higher credit growth than GDP growth may indicate a sound, sustainable process of financial deepening on the one hand, but it may also result from excessive loan growth as part of a boom-bust cycle on the other hand.

We hypothesize a two-fold relation between developments in the credit-to-GDP ratio and the NPL ratio. First, in the short run, we expect a denominator effect that has a negative sign. Second, in the medium to long run, we expect a credit cycle effect with the opposite sign. We expect episodes of high credit growth, which are often coupled with low lending standards, to raise the share of NPLs only with a considerable time lag, as the distinction between borrowers evolves over time and the probability of default in the course of a credit's entire life cycle is higher than the probability of default just in the first payment period.

In several CESEE countries the share of foreign currency loans (loans denominated in foreign currency or linked to the exchange rate) in total loans is sizeable; there is an indirect credit risk as borrowers are exposed to higher debt servicing costs if their national currency depreciates against the loan currency and only a part of these borrowers may be adequately hedged. We use the exchange rate against the euro for most CESEE countries and the one against the U.S. dollar for Ukraine and Russia, where foreign currency loans are mostly U.S. dollar-denominated loans. As we assume that a (substantial) part of the foreign currency-denominated loans is extended to unhedged borrowers, our hypothesis is that a depreciation of the national currency leads to a higher NPL ratio, depending on the size of the share of foreign currency-denominated loans in total loans. Therefore, we use the multiplicative term exchange rate change multiplied by the share of foreign currency loans (weighted exchange rate change) as an additional explanatory variable. Clearly, if one of the two components is very small or even zero – like in the case of the Czech Republic, where foreign currency loans

play a very limited role, or in the case of Bulgaria, where the currency does not change against the euro given its currency board arrangement – this variable will hardly have any impact on the development of the NPL ratio.

However, obviously, this explanatory variable does not cover all types of risks potentially attached to foreign currency loans. Apart from possible risks related to the corresponding foreign currency funding of banks, "the interest rate risk profile of foreign currency loans differs from the risk profile of domestic currency loans. This can be detrimental to the quality of foreign currency loans if the interest rate cycles of the foreign currency diverge from that of the domestic economy." (ESRB, 2011). In addition, also the size of the amplitude of the cycles may be quite different. As foreign interest rates are generally less linked to domestic inflation than domestic interest rates, the volatility of implicit real interest rates will be higher. In as far as the share of foreign currency loans is positive, this interest rate risk is relevant also for countries where the respective exchange rate has not changed in the period of observation. Both the exchange rate-related credit risk of foreign currency loans and the interest rate-related one are two-sided risks. As these risks are not necessarily synchronized, the materialization of foreign interest rate risk may mitigate or exacerbate the impact of exchange rate changes, depending on the specific periods under observation. Moreover, the extent of foreign interest rate risk depends on (i) the dominant type of interest rate-setting regime for foreign currency loans in an individual country[3] and (ii) the country-risk premium (thus, in particular, on the anticipated fiscal position of the public sector) and how this premium is taken into account in the interest rate-setting regime of foreign currency loans to the private sector. However, investigating which type of pricing regime is followed to which extent in which country and for which type of foreign currency loan and inserting this information into an NPL model would be a task of its own that we leave for further research. For the moment, we would like to stress that the materialization of foreign interest rate risk, which depends inter alia on the interest rate-setting regime, may blur the measured impact of exchange rate changes on the NPL ratio.

It is conceivable that banks' profitability is somehow related to the NPL ratio in later periods. Thus, we look at the return on assets (RoA) as a measure for banks' profitability that we consider superior to the RoE, as the latter is heavily influenced by the degree of capital adequacy and leverage. One may follow the traditional management quality hypothesis, stipulating that more profitable banking sectors are better managed and more prudent in their granting of credit so that higher profitability in the past leads to a lower NPL ratio. For the sake of clarity, we would like to mention that, in addition, there may well be an impact of the NPL ratio on banks' profitability in later periods, in particular via net creation of loan loss provisions, with the calculation of impairment charges usually taking more time. However, we do not investigate this feedback loop in the present study, but limit our focus on the factors determining the NPL ratio.

Taking all these explanatory variables together, we aim at explaining the development of NPL ratios to a large extent.

For each of the explanatory variables, we tried to get time series ranging from Q1 1993 to Q4 2012. However, due to the aforementioned structural breaks and the limited availability of data that conform to the quality requirements sketched out above for the years up to the first years of the new millennium, we finally ended up with a nearly balanced panel that we could estimate for the time span ranging from 2004 to 2012.

[3] As exemplified by the ESRB (2011), the pricing regime followed by Hungarian banks allowed them to set the retail borrowers' interest rate unilaterally and to disregard changes in foreign interest rates, while in other countries, like for example Poland and Romania, (at least) the interest rates on foreign currency mortgages are explicitly linked to market interest rates.

3 Empirical Analysis

In this section, we distinguish between the analysis and treatment of the time series used for the models, the econometric framework, the model specification, the estimation results and, finally, the robustness checks on the selected model.

3.1. Analysis and Treatment of Time Series

As our time series have quarterly frequency, they incorporate a degree of seasonality that may distort the relations between the variables. However, for the variables stemming from the national accounts framework, seasonally adjusted data have been published for most countries for all or most of the time period under investigation. For EU countries (including Croatia), in particular, these data have the advantage of including not only a seasonal adjustment but rather a seasonal and working-day adjustment. For the remainder of the time series employed we applied seasonal adjustment[4].

Then we test for panel stationarity, using a unit root test for unbalanced panels. Maddala and Wu (1999) argue that the Fisher unit root test for panel data performs best when compared with other panel data unit root tests, e.g. the Lin, Levin and Chu (2002) and Im, Pesaran and Shin (2003) tests. Moreover, it does not require a balanced panel dataset. We therefore apply the Fisher test for a panel unit root, using an augmented Dickey-Fuller (ADF) test.

We find that the null hypothesis of a common unit root process for all countries as well as the hypothesis of unit root processes for individual countries can be rejected at the 1% significance level for all our variables when taken in logarithmic differences. Thus, we apply logarithm transformation and take first differences of such transformed variables.

3.2. Econometric Framework

We estimate a linear model for panel data explaining changes in the NPL ratio, using all variables in logarithmic differences.

The use of panel data techniques to analyze and quantify the impact of the macroeconomic and financial variables described above on asset quality during the last decade allows us to capture the country-specific effects and the unobservable differences between countries. Using a panel data approach, one can control for the biases generated by potential heterogeneity and omitted variable problems.

In line with the literature, we expect the NPL growth rate to exhibit some degree of persistence. Hence, we include the lagged NPL ratio as an explanatory variable in the model, constructing a dynamic panel. In order to evade problems of correlation between the explanatory variables and the error term and to obtain additional efficiency gains, we applied the generalized method of moments (GMM) with the corresponding GMM type of instrumental variables (IVs) for predetermined and endogenous variables (including the lagged dependent variable) and standard IVs for variables reasonably assumed to be strictly exogenous, like the stock index or the exchange rate.

Following the GMM approach, in order to eliminate the fixed effects (and their correlations), we took the model in first differences. First, we used the GMM-type instruments for this first-

[4] For this purpose, we used TRAMO-SEATS provided by Eurostat via the Demetra software.

difference equation only, thus applying the "difference GMM" proposed by Arellano and Bond (1991) by using past lagged levels as instruments. Then, we used the GMM-type instruments for both the first-difference equation and the level equation, thus applying the "system GMM" elaborated by Arellano and Bover (1995) and Blundell and Bond (1998) by using lagged first-differences as instruments for the level equation. For both GMM estimators we derive the (one-step) robust covariance matrix that is robust to heteroskedasticity in the errors. Regarding the validity of instruments, we first performed the post-estimation check to see whether the null of no second-order autocorrelation has to be rejected. Second, we followed Arellano and Bond (1991) and checked whether the null of the Sargan test, namely the joint validity of all moment conditions (including the overidentifying restrictions), has to be rejected in the nonrobust case as the small sample size prevents the use of the robust Hansen J statistic.

Moreover, given the special features of our sample, namely the number of countries being much smaller than the effective length of the time series in the unbalanced panel, combined with a relatively small effective sample size, we took the following safeguard measures: First, we applied t-statistics and an F-test instead of a Wald chi-squared test of overall model fit. Second, we reduced the size of the instrument matrix by implementing the collapsing method designed by Roodman (2009).

3.3. Model Specification

We start by considering all explanatory variables up to six lags (1.5 years). We do not assume contemporaneous explanatory variables as we look for leading indicators of NPL development – see equation (1):

$$d(\log(npl))_{i,t} = \sum_{l=1}^{6} d(\log(npl))_{i,t-l} + \sum_{j=1}^{k}\sum_{l=1}^{6} b_j X_{j,i,t-l} + f_i + u_{i,t}$$

where $X_{(j,i,t-l)}$ is the jth indicator for country i and time t–l, f_i is the fixed effect for country i and $u_{i,t}$ is the stochastic error term, with errors assumed as i.i.d.

On the one hand, we consider economically meaningful combinations of our potential regressors (see section 2), while on the other hand, we follow the principle of parsimony, aiming at reducing the number of lagged explanatory variables, considering also the relatively small sample size.

3.4. Estimation Results

Adequate statistical performance is obtained for the following model, which explains the development of the NPL ratio by the changes in the following variables: the lagged NPL ratio, real GDP, the stock index, credit to private sector relative to GDP and the nominal exchange rate combined with the share of foreign currency loans in total loans (see table 1). The number in parenthesis indicates, for each indicator, the respective number of lags in quarters.

Table 1: Estimated Main Model

	Type of model		
	Difference GMM	System GMM	System GMM with constant
Explanatory variables: coefficients			
NPL ratio (first lag)	0.21	0.22	0.21
t-statistic	*1.76*	*1.84*	*1.78*
p-value	*0.11*	*0.10*	*0.11*
Real GDP (first lag)	-1.65	-1.58	-1.64
t-statistic	*-3.92*	*-3.86*	*-3.86*
p-value	*0.00*	*0.00*	*0.00*
Private sector credit-to-GDP ratio (sixth lag)	0.47	0.48	0.46
t-statistic	*4.46*	*4.54*	*4.33*
p-value	*0.00*	*0.00*	*0.00*
National stock index (fifth lag)	-0.10	-0.10	-0.10
t-statistic	*-2.92*	*-2.87*	*-2.91*
p-value	*0.02*	*0.02*	*0.02*
Exchange rate,			
weighted by foreign currency share (first lag)[1]	0.36	0.37	0.37
t-statistic	*2.37*	*2.38*	*2.37*
p-value	*0.04*	*0.04*	*0.05*
Constant			0.02
t-statistic			*1.88*
p-value			*0.10*
Number of observations	285	294	294
F-test (p-value)	0.00	0.00	0.00
AR-1 test (p-value)	0.04	0.04	0.04
AR-2 test (p-value)	0.20	0.17	0.19
Sargan test (p-value)	0.12	0.12	0.13
Source: Authors' estimations.			
[1] *A positive sign denotes a depreciation of the national currency.*			
Note: All variables in logarithmic differences. Dependent variable: NPL ratio.			

Among the leading indicators for the financial and economic developments in the CESEE countries, the national stock indices clearly outperformed the EMBI Global and the VIX. This is quite plausible. While the EMBI Global and the VIX reflect the risk attitude among international financial investors and, in the case of the EMBI Global, the global market sentiment toward emerging markets in general, the national stock index more precisely represents (national and international) investors' perception of the international environment and of its future impact on the financial and economic development in the relevant CESEE country. Given the relatively limited role of stock exchange markets in CESEE countries compared to advanced economies, we do not claim that the stock market constitutes an import source of direct financing (through new equity issues) for economic growth in CESEE and

hence would have an impact on the NPL ratio via a financing channel. Nor do we argue that the transmission mechanism consists in direct wealth effects among borrowers. However, we would like to stress the role of the national stock index as leading variable for financial and economic developments that directly influence the NPL ratio; it effectively captures part of future effects of GDP and currency developments. In addition, one may hypothesize that the stock index plays a role as early proxy indicator for the value of loan collateral, at least with respect to the direction of collateral value (and property price) development in several countries, although this would warrant a separate investigation. Finally, stock indices might capture some other effects not included in our model.

We could not confirm a significant impact of profitability on the NPL ratio. Neither the level nor the change of RoA proved to play a significant role.

Apart from profitability, the estimation results strongly confirm the initial hypotheses. The chosen explanatory variables proved to be significant and their coefficients have the expected signs (compare section 2).

Comparing our results with those of other studies, in particular those mentioned in section 1, the income variable plays a significant and important role in our model as well as in most models of macro-studies on NPL[5] and in the survey data-based study by Beckmann et al. (2012). In these models, the income variable enters in different forms, as (simultaneous and/or lagged) unemployment rate and/or GDP growth and/or foreign demand growth (proxied by main trading partners' GDP growth). Here, our result is pretty much standard.

With respect to the impact of credit growth, the situation is less clear cut. For advanced economies, the macro-models applied by Nkusu (2011) use the simultaneous change in house prices (as explanatory variable that corresponds to credit growth) and yield a statistically significant negative coefficient. For emerging market economies, the macro-models applied by De Bock and Demyanets (2012) use two variables that are related to credit growth, namely the ratio of portfolio and bank flows to GDP (as a proxy for foreign funding of credit growth) and the first lag of the private credit-to-GDP ratio. The former is highly significant with a negative sign, and the latter is insignificant in the sample as a whole, but significant with a negative sign in the 2004 to 2010 subsample. By contrast, Klein (2013) and Espinoza and Prasad (2010) apply a mixed macro-micro approach, using (inter alia) the second lag of loan growth to explain bank-level data of impaired loans in CESEE and Gulf Cooperative Council countries, respectively, and find a significant effect in the majority of their models, albeit relatively small and only at the 5% or 10% significance level. Our main model uses an even higher lag of credit growth (here, the sixth lag) and yields a statistically significant and relatively strong positive impact for this explanatory variable, which is measured more precisely in terms of exchange rate-adjusted change in the private sector credit-to-GDP ratio. Moreover, as will be shown in the next subsection, if we incorporate the first lag of credit growth into our model, this new variable is significant as well, but with a negative sign, in line with the results of De Bock and Demyanets (2012) and Nkusu (2011) and conforms to our initial hypotheses.

With respect to the impact of the exchange rate, our results are in line with the results of other macro-studies on NPLs[6] and with the results of Klein (2013). Moreover, our results confirm the following observation by the ESRB (2011): "In some countries, foreign currency loans have higher non-performing loan (NPL) ratios and higher levels of loan restructuring (for

[5] In particular, in most models of the panel studies by Nkusu (2011), Buncic and Melecky (2012), De Bock and Demyanets (2012) and Beck, Jakubík and Piloiu (2013).

[6] In particular, most models in the panel studies by De Bock and Demyanets (2012) and Beck, Jakubík and Piloiu (2013) as well as the country-specific study by Mancka (2012) on a country with a flexible exchange rate regime.

example Hungary and Romania). This conclusion is reached when the vintage of loans is taken into account, i.e. generally borrowers that took out a foreign currency-denominated mortgage loan at a stronger exchange rate tend to have higher default ratios. This further demonstrates that, most likely, at least some borrowers are unaware of the risks in which they engage when taking out a foreign currency loan."

However, the ESRB (2011) also remarks: "In other countries, such as Poland, data shows that foreign currency loans tend to perform better than the domestic currency ones." In a similar vein, some micro-level evidence shows mixed results on the performance of foreign currency mortgage loans[7]. Apart from methodological issues, there are economic explanations why foreign currency loans may not show higher NPL ratios than local currency loans: (1) As described in section 2, the materialization of foreign interest rate risk can have an influence on the nonperformance of foreign currency loans. In countries with a floating exchange rate, such risk materialization can substantially mitigate the impact of exchange rate changes. Indeed, as the ESRB (2011) mentions, in some countries (for example Poland and Romania), the negative effects of local currency depreciation were partly offset by declining interest rates in euro and Swiss francs. This beneficial form of risk materialization was a result of both the prevalent interest rate-setting regime and the specific situation in advanced economies and global financial markets during the crisis years of the time period examined in our study. In some countries with fixed/pegged regimes, borrowers in foreign currency did not suffer from currency devaluation but rather benefited from foreign interest rate cuts during the crisis years. For our sample countries, this was true for Bulgaria, but not Ukraine. (2) Another explanation may be borrower selection as a result of prudent behavior on banks' own initiative and/or of early measures by authorities (like the "Recommendation S" in Poland) that guided the extension of foreign currency loans above all to higher income borrowers. (3) A third economic reason may be the bank practice of converting foreign currency loans into domestic currency when they are close to becoming delinquent or being restructured, as the ESRB (2011) highlights in the annex to its recommendation. Especially the latter point suggests that it may be misleading to compare (only partially available) bank-level or supervisory data on NPL ratios disaggregated by currency. Rather, estimating the impact of exchange rate changes on the aggregated NPL ratio (comprising both foreign and domestic currency loans) may provide more reliable insights. Referring to the corresponding results of such estimates in our study, we highlight that we found a significant and sizeable adverse impact of currency depreciation on the NPL ratio, *although* borrower selection had been at work to a varying degree in the countries of our sample (probably most notably so in Poland).[8]

3.5. Robustness Checks

We performed several robustness checks. First, we introduced an additional lag for the credit variable, corresponding to our hypothesis on the relation between developments in the credit-to-GDP ratio and the NPL ratio that in the short run we expect a denominator effect that has a

[7] For instance, micro-studies cited in EBRD (2011): Foreign currency mortgage loans tend to be of better quality than local currency loans, but foreign currency borrowers had to adjust their consumption more than local currency borrowers in countries with large depreciation (and could afford to do so).

[8] While we could not control explicitly for foreign interest rate risk of foreign currency loans (see section 2), we stress that potentially blurring impacts of the materialization of this risk partly offset each other, as they went into opposite directions (given differences in the interest rate-setting regimes) during the crisis years, exerting a mitigating impact in some countries (like Poland and Romania), but an amplifying impact in others (in particular Hungary) – see ESRB (2011). Hence, we found a significant and sizeable adverse impact of currency depreciation on the NPL ratio, although such mitigating impacts and partly because such amplifying impacts were at play.

negative sign (see above). While the estimation result indeed shows the expected sign (see table A1 in the annex), the main outcome does not change substantially. However, from a statistical point of view, the autocorrelation structure of the residuals is somewhat negatively affected, as the null hypothesis of zero second-order autocorrelation could be rejected at the 10% significance level, so that this specification is definitely inferior to the main model presented above in statistical terms.

In a next step, we replaced real GDP as the explanatory variable reflecting real economic activity by the two main components of final demand, i.e. real exports and real domestic demand (see table A2 in the annex). Both demand components proved to be significant, having the right sign and being roughly equally important with respect to the development of the NPL ratio. Indeed, in this model specification the presence of the lagged dependent variable becomes even more justified, given the rising significance level.

In view of the difficulties of combining the special features of our sample (in particular the relatively small sample size) with the GMM estimator and given the partly low significance of the lagged dependent variable, we additionally provided the following complementary static panel models with fixed effects (see table A3 in the annex).

Post-estimation tests support the fixed-effects approach, as running a pooled ordinary least squares (OLS) regression is rejected, as indicated by the F-statistic of the F-test on the joint significance of the fixed effects.

These static models confirm the explanatory power of the variables found to be significant in the dynamic model, including the signs of the coefficients. Interestingly, this also applies to the additional lag (first lag) of the credit variable.

4 Policy Implications

Our empirical research renders a quite plausible macro-model for explaining the development of the aggregate NPL ratio during the boom-bust cycle the CESEE countries experienced in the past decade.

In boom times, the national economy is characterized by high, possibly overheating GDP growth amid a benign international environment in which financial investors have a positive perception of future financial and economic developments in the country concerned, leading to higher national stock index levels and (depending on the exchange rate regime) a nominal appreciation of the national currency (moving down the exchange rate variable in the model). These factors exert downward pressure on the NPL ratio. Once this downward movement sets in, it exhibits features of self-reinforcing persistence as described by the autoregressive (AR) component. Coupled with the factors mentioned above, credit to the private sector tends to outpace GDP growth, often by far, and the rise in the private credit-to-GDP ratio has a lagged increasing effect on the NPL ratio that is held in check by the short-term decreasing effect for as long as the boom goes on. Excessively high credit growth in boom times can also be seen as a proxy for loosening bank lending standards and underwriting criteria, often implemented in the quest for market shares.

When the boom comes to an end, a fall in the stock index often foreshadows the bust. GDP growth slows down sharply or even turns negative. Depending on the exchange rate regime, a depreciation of the national currency helps absorb part of the shock to the real variables, which in turn dampens the NPL-raising impact of the slowdown. However, in as far as the share of foreign currency loans is positive, the currency depreciation leads to an additional

rise in the NPL ratio that may well outpace the mentioned dampening effect (and would be smaller if the share of foreign currency loans were lower). At the same time, the credit-to-GDP ratio stops increasing strongly, withdrawing the short-term decreasing effect on the NPL ratio. (How quickly the credit-to-GDP ratio stops increasing or even starts declining depends not only on credit supply and demand reactions but also on the size of the recession and the inflationary impact of any possible currency depreciation.) By contrast, the lagged effect of strong increases of the credit-to-GDP ratio in previous quarters persists for quite a while, raising the NPL ratio. In this context, the feature of self-reinforcing persistence consists in an adverse development of the NPL ratio that may be given the economic interpretation that payment difficulties of one agent or one part of the economy quickly affect other agents or other parts of the economy, driving up the aggregate NPL ratio.

There are at least two main aspects in relation to which the findings of this study support the adoption of a cautious macroprudential stance.

The first is foreign currency lending (prevalent in most of the nine CESEE countries under study), as a high share of foreign currency loans in total loans combined with a depreciation of the national currency significantly contributes to a rise in the NPL ratio. Therefore, ongoing macroprudential efforts to curtail foreign currency lending with respect to unhedged borrowers may well contribute to make bank asset quality and credit risk less volatile.

The second aspect relates to periods when credit growth is high relative to GDP growth, as high credit growth rates tend to lower the NPL ratio initially, but to increase it later on, with the latter effect still persisting after the period of high credit growth has come to an end. Therefore, ongoing efforts to establish and make active use of macroprudential tools to address excessive credit growth should mitigate negative consequences of excessive credit expansion on bank asset quality. Among the currently discussed tools are e.g. countercyclical capital buffers, changes in sectoral risk weights, a time-varying leverage ratio or limits to loan-to-value (LTV) and loan-to-income (LTI) ratios, which may help reduce credit risk as well as address different types of credit booms (e.g. housing loan boom). There is a non-negligible twofold challenge: First, macroprudential authorities have to strengthen their forward-looking attitude, i.e. ignore benign developments in the NPL ratio today while anticipating adverse developments in the NPL ratio tomorrow. In the context of catching-up countries like the nine CESEE countries under observation, the second challenge may prove to be even more difficult in practice: Like real currency appreciation, financial deepening (defined as an increase in the credit-to-GDP ratio) forms part of any long-term catching-up process, which in turn requires a positive real growth differential. Therefore, the decision-makers in macroprudential policy have to assess whether any increase in the private credit-to-GDP ratio exceeds the fundamentally justified, sustainable speed of financial deepening.

5 Conclusions

This study presents a macro-model that explains the development of the economy-wide aggregate nonperforming loan ratio in the CESEE countries. We aimed to reveal the key macroeconomic drivers determining the quality of banks' assets and compared our results with the recent empirical research based on global samples (Beck et al., 2013) or national models (e.g. Erjavec, Cota and Jakšić, 2012; Jakubík, 2007).

In line with other studies, our research suggests that domestic economic activity plays a key role for nonperforming loans. Going beyond the scope of current literature, however, we show how the development of both main aggregate demand components, i.e. domestic demand and foreign demand, can affect NPL growth. Our empirical results further show a lagged effect of stock prices on NPLs. Stock indices work as leading variables for financial and economic developments that directly influence the NPL ratio, and they might also capture other effects that are not included in our model. Stock indices might also signal a direct effect that works through the value of loan collateral. Due to the relatively limited role of stock exchange markets in CESEE compared with advanced economies, the transmission mechanism might not work via wealth effects among borrowers or via the reduced potential of financing through new equity issues. Moreover, our results confirm the conclusion by Beck et al. (2013) that the depreciation of a local currency can have a sizeable negative impact on the quality of banks' assets. The size of this impact depends on the share of foreign currency loans in total loans; data on this share were directly available for the countries covered in the present study and could thus be combined with the exchange rate changes to form an explanatory variable that turned out to be significant and relevant. Finally, we empirically assessed the impact of the private credit-to-GDP ratio. This indicator seems to be crucial for explaining the development of banks' asset quality as has been repeatedly mentioned in some recent studies and policy discussions (see e.g. Borio, 2012).

Apart from the above-mentioned conclusions, the model presented in this study can be used by policymakers or supervisors as a benchmark for verifying comparable models developed by commercial banks for the CESEE countries. Moreover, it could serve the purpose of high-level cross-checks of country-specific models, which on the one hand can better capture country-specific effects, but on the other hand often have drawbacks from a statistical and econometric point of view, especially given the shortness of available time series in most of these countries. As a matter of fact, the countries included in our panel, despite their geographic proximity, show a number of differences, including, for instance, the quality of institutions, repayment culture and market standards. These differences are largely captured by country-specific fixed effects, but probably not entirely so. Therefore, these factors may still influence the country-specific strength of response to shocks of the same variable. It follows that our model, while useful for identifying economic processes that are relevant for all the countries in the sample, can be considered less reliable for forecasting for each individual country.

Further topical research related to the CESEE region could focus on the question whether it might be possible to extract thresholds below which the credit growth rate or the pace of financial deepening observed in the past have no significant impact on the development of the NPL ratio and thus could be considered to constitute a sustainable or equilibrium growth rate. Moreover, further research could focus on the feedback loop between rising NPL ratios on the one hand and the real economy, including the development of credit aggregates, on the other.

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Annex

Table A1: Model with an Additional Lag for the Credit Variable

	Type of model		
	Difference GMM	System GMM	System GMM with constant
Explanatory variables: coefficients			
NPL ratio (first lag)	0.18	0.20	0.18
t-statistic	*1.65*	*1.72*	*1.66*
p-value	*0.13*	*0.12*	*0.14*
Real GDP (first lag)	-1.50	-1.42	-1.48
t-statistic	*-3.81*	*-3.65*	*-3.74*
p-value	*0.00*	*0.01*	*0.01*
Private sector credit-to-GDP ratio (first lag)	-0.42	-0.34	-0.39
t-statistic	*-2.17*	*-2.16*	*-2.18*
p-value	*0.06*	*0.06*	*0.06*
Private sector credit-to-GDP ratio (sixth lag)	0.53	0.53	0.52
t-statistic	*3.77*	*3.97*	*3.80*
p-value	*0.00*	*0.00*	*0.01*
National stock index (fifth lag)	-0.10	-0.10	-0.10
t-statistic	*-3.12*	*-3.06*	*-3.14*
p-value	*0.01*	*0.01*	*0.01*
Exchange rate,			
weighted by foreign currency share (first lag)[1]	0.39	0.40	0.39
t-statistic	*2.54*	*2.58*	*2.55*
p-value	*0.03*	*0.03*	*0.03*
Constant			0.02
t-statistic			*2.37*
p-value			*0.05*
Number of observations	285	294	294
F-test (p-value)	0.00	0.00	0.00
AR-1 test (p-value)	0.05	0.04	0.04
AR-2 test (p-value)	0.07	0.07	0.07
Sargan test (p-value)	0.17	0.15	0.17
Source: Authors' estimations.			
[1] *A positive sign denotes a depreciation of the national currency.*			
Note: All variables in logarithmic differences. Dependent variable: NPL ratio.			

Table A2: Model with Main Final Demand Components Replacing GDP

	Type of model		
	Difference GMM	System GMM	System GMM with constant
Explanatory variables: coefficients			
NPL ratio (first lag)	0.26	0.27	0.26
t-statistic	*2.35*	*2.33*	*2.35*
p-value	*0.04*	*0.04*	*0.05*
Real exports (first lag)	-0.27	-0.26	-0.27
t-statistic	*-3.05*	*-3.26*	*-3.06*
p-value	*0.01*	*0.01*	*0.02*
Real domestic demand (first lag)	-0.62	-0.61	-0.62
t-statistic	*-2.24*	*-2.09*	*-2.26*
p-value	*0.05*	*0.07*	*0.05*
Private sector credit-to-GDP ratio (sixth lag)	0.40	0.43	0.40
t-statistic	*4.02*	*3.83*	*3.92*
p-value	*0.00*	*0.00*	*0.00*
National stock index (fifth lag)	-0.09	-0.09	-0.09
t-statistic	*-2.16*	*-2.18*	*-2.20*
p-value	*0.06*	*0.06*	*0.06*
Exchange rate,			
weighted by foreign currency share (first lag)[1]	0.51	0.51	0.50
t-statistic	*2.41*	*2.46*	*2.52*
p-value	*0.04*	*0.04*	*0.04*
Constant			0.01
t-statistic			*2.00*
p-value			*0.08*
Number of observations	285	294	294
F-test (p-value)	0.00	0.00	0.00
AR-1 test (p-value)	0.03	0.03	0.03
AR-2 test (p-value)	0.12	0.10	0.12
Sargan test (p-value)	0.66	0.67	0.68
Source: Authors' estimations.			
[1] *A positive sign denotes a depreciation of the national currency.*			
Note: All variables in logarithmic differences. Dependent variable: NPL ratio.			

Table A3: Static Panel Model with Fixed Effects (FE)

	Type of model					
	FE model, main version		FE model, including additional lag		FE model, with demand components	
		with robust standard errors		*with robust standard errors*		*with robust standard errors*
Explanatory variables: coefficients						
Real GDP (first lag)	-1.87	-1.87	-1.59	-1.59		
t-statistic	*-6.32*	*-6.87*	*-5.30*	*-6.27*		
p-value	*0.00*	*0.00*	*0.00*	*0.00*		
Private sector credit-to-GDP ratio (sixth lag)	0.45	0.45	0.60	0.60	0.42	0.42
t-statistic	*3.22*	*3.44*	*4.15*	*3.32*	*2.99*	*3.56*
p-value	*0.00*	*0.01*	*0.00*	*0.01*	*0.00*	*0.01*
Private sector credit-to-GDP ratio (first lag)			-0.55	-0.55		
t-statistic			*-3.55*	*-3.08*		
p-value			*0.00*	*0.02*		
National stock index (fifth lag)	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12
t-statistic	*-4.48*	*-6.04*	*-4.23*	*-5.61*	*-4.30*	*-4.52*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Exchange rate,						
weighted by foreign currency share (first lag)[1]	0.51	0.51	0.48	0.48	0.61	0.61
t-statistic	*2.07*	*2.71*	*1.99*	*2.62*	*2.55*	*2.42*
p-value	*0.04*	*0.03*	*0.05*	*0.03*	*0.01*	*0.04*
Real exports (first lag)					-0.29	-0.29
t-statistic					*-2.82*	*-2.36*
p-value					*0.01*	*0.05*
Real domestic demand (first lag)					-0.84	-0.84
t-statistic					*-5.11*	*-2.90*
p-value					*0.00*	*0.02*
Constant	0.02	0.02	0.03	0.03	0.02	0.02
t-statistic	*3.81*	*6.94*	*4.65*	*8.96*	*3.38*	*5.33*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Number of observations	295	295	295	295	295	295
F-test (p-value)	27.69	30.27	25.58	38.93	21.67	40.46
F-test on fixed effects (p-value)	3.80		3.74		4.54	
Correlation between error term and explanatory	0.15	0.15	0.15	0.15	0.10	0.10
Sigma_u	0.03	0.03	0.03	0.03	0.03	0.03
Sigma_e	0.08	0.08	0.08	0.08	0.08	0.08
Rho	0.13	0.13	0.12	0.12	0.15	0.15
R^2_within	0.28	0.28	0.31	0.31	0.28	0.28
R^2_between	0.89	0.89	0.86	0.86	0.94	0.94
R^2_overall	0.30	0.30	0.33	0.33	0.28	0.28
Source: Authors' estimations.						
[1] A positive sign denotes a depreciation of the national currency.						
Note: All variables in logarithmic differences. Dependent variable: NPL ratio.						