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DETERMINANTS OF THE NON-PERFORMING LOAN RATIO IN THE BANKING SECTORS OF CENTRAL AND EASTERN EUROPE COUNTRIES

Abstract. In the last decade, the quality of loan portfolios has deteriorated significantly in most countries around the world. This is result of the financial crisis, that hit the global economy in 2007—2009. Since then, the average quality level of bank assets has deteriorated rapidly due to the global economic recession. The fact, that the quality of credit exposures is closely related to the economic cycle is well known and is not surprising. However, the deterioration in the quality of loan exposures varied widely from country to country. In the article authors attempt to analyze the panel data to assess the impact of different factors on the NPL level in the banks of Central and Eastern European countries that are members of the EU. The literature indicates two basic sets of factors influencing changes in the level of non-performing loans. The first group concerns external factors, which include general macroeconomic conditions that may have a potential impact on borrowers' ability to repay loans. The second group includes bank's specific factors (resulting from the functioning of banks), which, according to the results of previous analyzes, have a smaller impact on the volatility of non-performing loans. Using dynamic and static panel-based approach, authors examine the determinants of the loan portfolios with impairment of 138 banks in the entire available period between 2008 and 2017. The results show that the NPLs of banks operating in Central and Eastern Europe countries can be explained mainly by significant macroeconomic factors, such as GDP and the unemployment rate, as well as bank-specific factors such as ROA, interest margin or bank size measured by the value of assets. The results constitute a significant contribution to the discussion on the possibility of solving the problem of a significant increase in the value of impaired loans in the post-crisis period.

Keywords: NPL, loan, Central and Eastern Europe banks.

JEL Classification G21, G28

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ФАКТОРИ, ЯКІ ВПЛИВАЮТЬ НА ПОКАЗНИК НЕПРАЦЮЮЧИХ КРЕДИТІВ У БАНКІВСЬКИХ СЕКТОРАХ КРАЇН ЦЕНТРАЛЬНОЇ ТА СХІДНОЇ ЄВРОПИ

Анотація. За останнє десятиліття якість кредитних портфельів значно погіршилась у більшості країн світу. Це результат фінансової кризи, яка вразила світову економіку у 2007—2009 роках. Відтоді середній рівень якості банківських активів швидко погіршився через глобальну економічну рецесію. Той факт, що якість кредитних портфельів тісно пов'язаний з економічним циклом, добре відомий і не дивує. Однак погіршення якості кредитних експозицій сильно різнилася від країни до країни. Автори намагаються проаналізувати панельні дані для оцінки впливу різних факторів на рівень непрацюючих кредитів у банках країн Центральної та Східної Європи, які є членами ЄС. У літературі вказані дві основні групи факторів, які впливають на зміни рівня непрацюючих позик. До першої групи належать зовнішні фактори, які включають загальні макроекономічні умови, що можуть мати потенційний вплив на здатність позичальників повертати кредити. До другої — належать специфічні банківські фактори (обумовлені функціонуванням банків), які, за результатами попередніх аналізів, мають менший вплив на змінність непрацюючих кредитів. Використовуючи динамічний і статичний панельні методи, досліджено фактори, що вплинули на погіршення кредитних портфельів 138 банків протягом періоду між 2008 та 2017 рр. Результати демонструють, що показник непрацюючих кредитів у банках, що працюють у країнах Центральної та Східної Європи, можна пояснити в основному за рахунок значних макроекономічних даних, таких як ВВП і рівень безробіття, а також специфічних для банків факторів, таких як *ROA*, процентна маржа або розмір банку, визначений вартістю активів. Результати дослідження є вагомим внеском у дискусію щодо можливості розв'язання проблеми значного збільшення вартості знецінених кредитів у післякризовий період.

Ключові слова: непрацюючі кредити, позики, банки Центральної та Східної Європи.
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ФАКТОРЫ, ВЛИЯЮЩИЕ НА ПОКАЗАТЕЛЬ ПРОСРОЧЕННЫХ КРЕДИТОВ В БАНКОВСКОМ СЕКТОРЕ ЦЕНТРАЛЬНОЙ И ВОСТОЧНОЙ ЕВРОПЫ

Аннотация. За последнее десятилетие качество кредитных портфелей значительно ухудшилось в большинстве стран мира. Такое положение является последствием финансового кризиса, который потряс мировую экономику в 2007—2009 годах. С тех пор средний уровень качества банковских активов быстро ухудшился из-за глобального экономического спада. Факт, что качество кредитных средств тесно связано с экономическими циклами, хорошо известен и не удивляет. Тем не менее, ухудшение качества предоставленных кредитов очень разнилось в разных странах. Проанализированы панельные данные, чтобы оценить влияние различных факторов на уровень просроченных кредитов в банках стран Центральной и Восточной Европы, являющихся членами ЕС. В литературе указаны две основные группы факторов, влияющих на изменение уровня просроченных кредитов. Первая группа состоит из внешних факторов, которые включают общие макроэкономические условия, которые могут оказать потенциальное влияние на способность заемщиков погашать кредиты. Во вторую группу входят специфические для банков факторы (обусловленные функционированием банков), которые, согласно результатам предыдущих анализов, оказывают меньшее влияние на изменчивость просроченных кредитов. Используя динамический и статический панельные методы, анализируются факторы, влияющие на ухудшение кредитных портфелей 138 банков за период с 2008 по 2017 год. Результаты исследования показывают, что просроченные кредиты банков, функционирующих в странах Центральной и Восточной Европы, можно объяснить главным образом за счет значительных макроэкономических факторов, таких как ВВП и уровень безработицы, а также таких специфических для банков факторов, как *ROA*, процентная маржа или размер банка, измеряемый стоимостью активов. Полученные результаты вносят значительный вклад в дискуссию о возможности решения проблемы значительного увеличения стоимости обесцененных кредитов в посткризисный период.

Ключевые слова: просроченные кредиты, кредиты, банки Центральной и Восточной Европы.

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Introduction. Lending activity is one of the most important segment of banking activity, enabling them to obtain revenues to cover the incurred costs, such as money obtained costs and the institution's functioning costs [1]. Banks are the only entities authorized to grant loans [2].

Proper credit policy is considered to be fundamental determinant of financial stability of banks. The management of co-operative banks for many years remains aware of the credit risk significance in banking operations and since 2013 in surveys indicates them as the greatest threat to the financial stability of banks [3]. Bad credit policy and lack of control were the reasons for the largest bankruptcy in Polish co-operative banking sector — Spółdzielczy Bank Rzemiosła i Rolnictwa in Wołomin (SK Bank)¹.

A very important factor affecting the profitability of individual banks and the entire banking sector is the quality of assets. Loans are the main asset, hence their is expected positive impact on the level of profits. The increase in banks' involvement in lending activity often leads to higher profits, but increases their susceptibility to deterioration of their microeconomic situation and may in the future lead to an increase in the share of non-performing loans [4]. Over the last decade, the quality of loan portfolios has deteriorated significantly in most countries around the world. This is the result of the financial crisis of 2008-2009. The increase in the number of banks with high-risk loans leads to an increase in the value of loans not repaid on time and an increase in provisions created on this account, and consequently reduces the profitability of the entire banking sector. Comparative researches on loan quality are very important for at least three reasons. First of all, the quality of loans is one of the most important criteria for assessing the financial stability of bank and

¹ More information about the Bank's bankruptcy and its causes is available on the KNF website: https://www.knf.gov.pl/popzednie_lata/komunikaty?articleId=53880&p_id=18 (4.11.2018).

the probability of its bankruptcy. Credit quality analysis also allows to assess the level of credit risk in the bank. Non-performing loans are the result of a credit function, carried out in banks. Their high level and rapid growth indicates the materialization of the credit risk in the bank. Secondly, the quality of loans is used to measure financial stability of the entire banking sector. Credit quality assessment is therefore also important for the micro-prudential and macro-prudential supervising institutions. And finally, the analysis of loan quality is important for the entire economy. High credit risk and banks' losses related to their lending activities may lead to limiting the scale of lending activities, which will have a negative impact on economic activity.

Literature review and the problem statement. Banks can use different methods and tools to measure the quality of their loan portfolios. Generally, most of them focus on the assessment of the portfolio risk level. The most popular indicator is the ratio of non-performing loans, measured as a percentage of receivables classified as endangered in total loan portfolio (NPL) [5]. Amounts due from bank customers, that are at risk, are usually determined on the basis of internal bank's regulations. These regulations are mostly based on national legal regulations, e. g. in Poland on the Ordinance of the Minister of Finance [6]. The basic criteria for the category of receivables are: timely repayment and the economic and financial situation of the borrower.

A part of scientific research, devoted to bank lending, is trying to state the determinants of the banks' loan portfolios size. It results from the influence of the amount and value of granted loans on long-term economic growth [7]. There are also research, that focuses on the determinants of the banks' loan portfolios quality.

The literature indicates two basic sets of factors influencing changes in the level of non-performing loans. The first group concerns external factors, which include general macroeconomic conditions that may have a potential impact on borrowers' ability to repay loans. The second group includes bank's specific factors (resulting from the functioning of banks), which, according to the results of previous analyzes, have a smaller impact on the volatility of non-performing loans [8].

Literature devoted to the interaction between macroeconomic factors and the quality of bank assets is extensive and diverse. In the current research, there is presented the most often positive relationship between the quality of assets and the dynamics of economic growth. Messai and Jouni [9] in their research on a group of 85 banks from Italy, Greece and Spain showed, that, thanks to the improvement of the macroeconomic situation, the financial situation of borrowers is also improving and thus the possibility of timely repayment of their debts. Studying a group of 75 banks in the years 2000-2010 Beck et al. [10] proved that the increase in GDP contributed to the decline in the share of non-performing loans in the entire loan portfolio. Similar conclusions were found in researches of Espinoza and Parad [11], Jakubik and Reininger [12] or Marki et al. [13].

Another macroeconomic determinant described in the literature is the unemployment rate, the increase of which has a negative impact on the quality of the loan portfolio. The loss of employment by borrowers results in deterioration in the quality of banks' loan portfolios. Such dependencies were found in the research of, e. g. Dimitrios et al. [14]. Using the GMM model and the quarterly data of the euro area banks in 1990-2015, they stated that the increase in the unemployment rate has a strong impact on the deterioration of their loan portfolio quality. The conclusions from the analyzes concerning the 7 countries of Central and Eastern Europe in the years 2007—2012, conducted by Skarica [15], also confirm the positive relationship between the unemployment rate and the value of non-performing loans. Similar conclusions from their own research have drawn, among others, Messai and Jouini [9].

The results of previous studies, regarding the relationship between the inflation rate and the quality of banks' loan portfolios, are not straightforward. Research conducted by Klein [16], which included the largest banks from the Central and Eastern European countries, showed, that the level of not repaid loans regularly increases with the increase in inflation. However, in the studies of Dimitrios et al. [14], it was shown that the increase in inflation rate makes debts cheaper, which contributes to improving the quality of banks' loan portfolios.

Among the studies on macroeconomic determinants of the bank's loan portfolio quality, there are also studies regarding influence of sovereign debt on the number of loans that are not

repaid by borrowers [7; 13; 14]. The increase in public debt causes an increase in fiscal burdens imposed on citizens, and thus a deterioration in their repayment capacity. These studies confirm a positive correlation between public debt and non-performing loans. Fiscal problems in the euro area countries may lead to a significant increase in non-performing loans.

Cifter [18] in his research focused on how the concentration of the banking sector affects the NPL. However, his research did not have an unambiguous result.

There is also a series of studies devoted to the influence of variables dependent on banks on the NPL level. Hu et al. [19] analyzed non-performing loans in the banking sector in Taiwan in the years 1996—1999. The authors showed that the size of banks, measured by the value of their assets, is negatively related to the NPL indicator. Larger banks are more likely to take credit risk than smaller ones.

Studies, carried out by authors like Klein [14] and Marki et al. [13], confirm, that the higher value of indicators describing the quality of bank management (ROA, ROE, NIM) contributes to a lower share of non-performing loans in total loans. Better managed banks have, on average, better asset quality and generate higher profits. NIM is a good indicator of how optimal bank's investment decisions are. However, studies conducted by Salas and Saurin [20] showed, that this variable does not affect the value of the NPL index. On the other hand, Espinoza and Prasad [11] found, that there is a significant relationship between NIM and NPL. A fall in NIM indicator can cause a change in lending policy, making it more risky. The increase in risk will create a portfolio of loans with a higher probability of default in the future.

In their study, Podpiera and Weill [21] verified the relationship between NPL and cost effectiveness as an indicator of the quality of bank management. This trend is also included in the study of the Argentine banking system instability in 1993-1996, conducted by Jose Bercoff, Julian Giovanni and Franque Grimard [22]. It showed, that the bank's factors, which influence the NPL rate, are: asset growth and operational costs incurred in connection with the entity's core business. However, the relationship between cost effectiveness and the NPL index is ambiguous. Banks, that will allocate less funds to investigate the creditworthiness of borrowers and for risk monitoring in the short term, will be more profitable. On the other hand, this may be reflected in the increased number of non-performing loan in the long term.

The literature also showed that the excessive level of lending (measured by the ratio of loans granted to the sum of total assets) leads to an increase in the NPL ratio in banks. The increase in bank lending activity is often associated with lowering standards when granting loans, which increases the number of not repaid loans. Such results have received, among others [9; 16].

One of the indicators, which is characteristic for banks, is the capital adequacy ratio (TCR). It indicates whether the bank has sufficient equity to be solvent. The TCR measures the level of equity in relation to the risk taken by the bank. In general, although capital adequacy ratios are extensively analyzed in similar studies, the results regarding the impact of this indicator on the level of non-performing loans are ambiguous [11; 13; 23]. On the one hand, there are studies, in which banks with a lower TCR rate are characterized by a higher NPL level.

On the other hand, there are also analyzes showing, that banks with a higher TCR level create risky loan portfolios. That can cause the growth in non-performing loans.

In the research, carried out by Gosha [17], the size of the bank (measured by the value of its assets) is also a factor, that influences the quality of the loan portfolio. Large banks, using financial leverage, may excessively increase their lending activity, which is usually associated with a lowering of credit standards, and thus expose themselves to the risk of losses on granted loans.

In addition to the research mentioned above, there are many empirical studies suggesting that bank-specific factors such as size, market power, concentration and risk profile are important determinants of the NPL, as they may increase risky loans in the portfolio [19].

The aim of this article is to analyze the panel data to assess the impact of both macroeconomic and microeconomic factors on the NPL level in the banks of Central and Eastern European countries that are members of the EU. The authors carried out studies on determinants of the non-performing loan ratio in the banking sectors of Central and Eastern Europe countries on

unit data obtained from Orbis database (Bankscope in an earlier version). Panel data cover the years 2008—2017 and includes information on the financial ratios of 138 banks (NPL, ROE, asset value, loan value, deposit value, capital ratio) operating continuously since 2008. Macroeconomic data (GDP per capita, inflation rate and unemployment rate) were taken from the websites of Eurostat and the World Bank.

Research methods used to achieve the goal are: analysis and synthesis, method of comparison, descriptive statistics methods and methods of economic-mathematical modeling to determine the relationship between NPL and its determinants.

Research results. The CEE countries share a common history of limited development opportunities after the Second World War, resulting from the world political order, shaped after 1945. After the political transformation in the early 1990s, differences in the direction of development the banking systems were observed. One of the important changes was, for example, the inflow of foreign capital and an increase in market concentration. However, the final shape of the banking sector in individual CEE countries remains diversified (Table 1). In the majority of countries, banks with dominant foreign capital prevail (up to 98.9% of the market in Slovakia). The Polish (45.5%) and Slovenian (49.2%) sectors remain an exception to the dominance of foreign capital banking sector. The level of concentration and competition in the banking sectors also remain diversified in the examined group of countries. The lowest concentration level (measured by CR5 indicator) is characterized by the Polish banking sector (47.8%), the highest — the banking sector in Estonia (95.8%). The value of the total capital ratio varies from 18.8% (in Lithuania and Slovakia) to 30.1% in Estonia (*Table 1*).

Table 1

Selected characteristics of the CEE countries banking sectors in 2017

Country	Share of foreign capital (%)	HHI	CR5 (%)	TCR (%)
Bulgaria	76.5	0.0976	55.9	22.1
Croatia	90.3	0.1453	75.0	23.8
Czech Republic	92.1	0.1021	63.9	19.3
Estonia	89.0	0.2400	95.8	30.1
Hungary	79.0	0.0890	52.8	20.2
Latvia	78.6	0.1240	73.3	21.4
Lithuania	88.9	0.2214	90.6	18.8
Poland	45.5	0.0648	47.8	19.0
Romania	77.0	0.0909	59.4	20.0
Slovakia	98.9	0.1333	74.6	18.8
Slovenia	49.2	0.1079	60.6	19.8

Source: data from Banking Supervisors from Central and Eastern European Countries (BSCEE) Review 2017, www.bscee.org.

The credit policy of banks, operating in the CEE countries, was in the last decade strongly determined by the financial crisis and its consequences — both within the financial sector and in the real economy. In the analyzed CEE countries, there is a huge variation in the dynamics of bank lending activity for the non-financial sector in the post-crisis period. In spite of emerging disturbances on the financial market in 2008—2015, the value of loans for the non-financial sector increased in the Polish banking sector by nearly 52%, in Slovakia by 48.5%, and in the Czech Republic by 30.6%. (*Fig. 1*). At the same time, in Hungary and Slovenia, the value of loans for the non-financial sector decreased by over 32%.

Figure SEQ Figure * ARABIC 1: Growth of loans to non-financial sector in the period

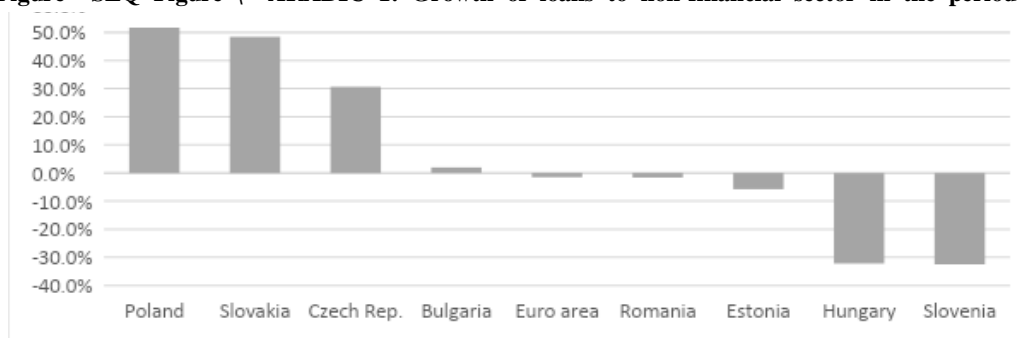


Fig. 1.

Source: Own study based on NBP data, <https://www.nbp.pl/home.aspx?f=/systemfinansowy/stabilnosc.html> (figures for the February 2016 report).

The CEE countries are also significantly different in terms of loan portfolio structure. In particular, attention should be paid to the share of consumer loans (excluding housing loans) in the banking sectors of the studied group. This group of loans has the greatest importance in Romania and Bulgaria, while it plays much smaller role in banks operating in the Baltic countries (Lithuania, Latvia, Estonia) — *Fig. 2.*

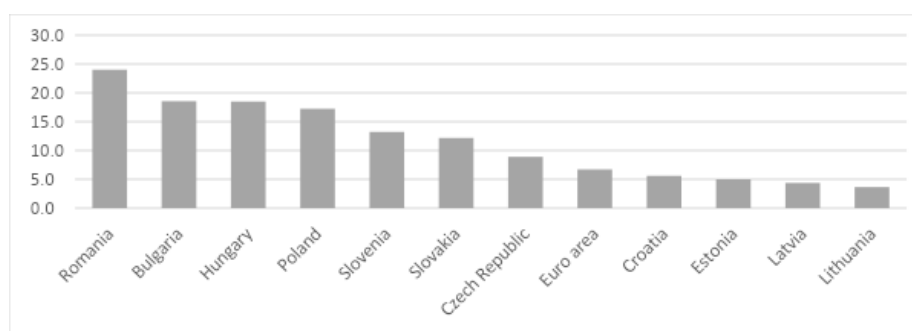


Fig. 2. Share of consumer loans in total loans in CEE countries in June 2018 (%)

Source: Own study based on NBP data, <https://www.nbp.pl/home.aspx?f=/systemfinansowy/stabilnosc.html> (figures for the report December 2018).

In the last decade, the quality of loan portfolios has deteriorated significantly in most countries around the world. This is result of the financial crisis, that hit the global economy in 2007—2009. Since then, the average quality level of bank assets has deteriorated rapidly due to the global economic recession. The fact, that the quality of credit exposures is closely related to the economic cycle is well known and is not surprising. However, the deterioration in the quality of loan exposures varied widely from country to country. In the countries of Central and Eastern Europe, particularly high values of the NPL index had Hungary, Latvia and Estonia, while very low (*Fig. 3.*)

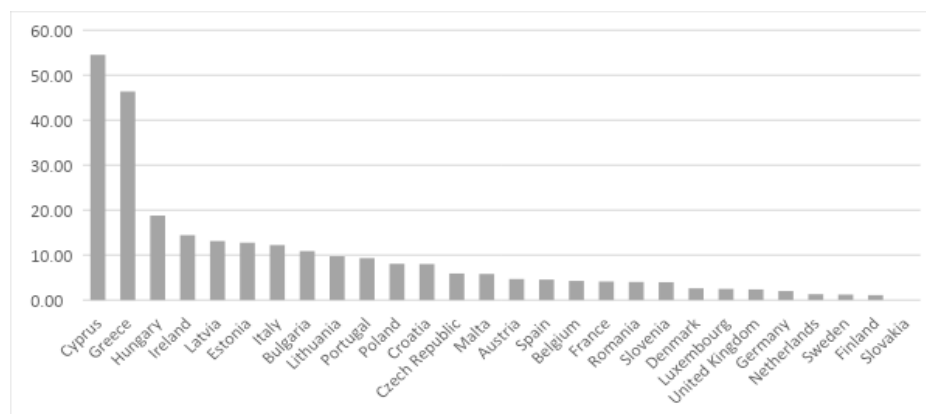


Fig. 3. Slovakia and Slovenia

Source: data from Banking Supervisors from Central and Eastern European Countries (BSCEE) Reviews (various issues), www.bscee.org.

In the examined group of countries, a strong differentiation of the NPL value is observed in the case of loans for households and for non-financial enterprises (Fig. 4 and 5). In particular, it should be emphasized that the average NPL level for loans granted to non-financial enterprises was almost 50% higher than in the case of loans to households (11.97% and 8.19% respectively). In the case of some countries, like Latvia, or Hungary, the deterioration in the quality of loan exposures was in 2010 and was very rapid, while for other countries, for example Croatia, Romania, Lithuania, Poland, the high NPL level is visible between 2012—2013.

Figure SEQ Figure * ARABIC 3: The level of the NPL ratio in European Union countries in 2017

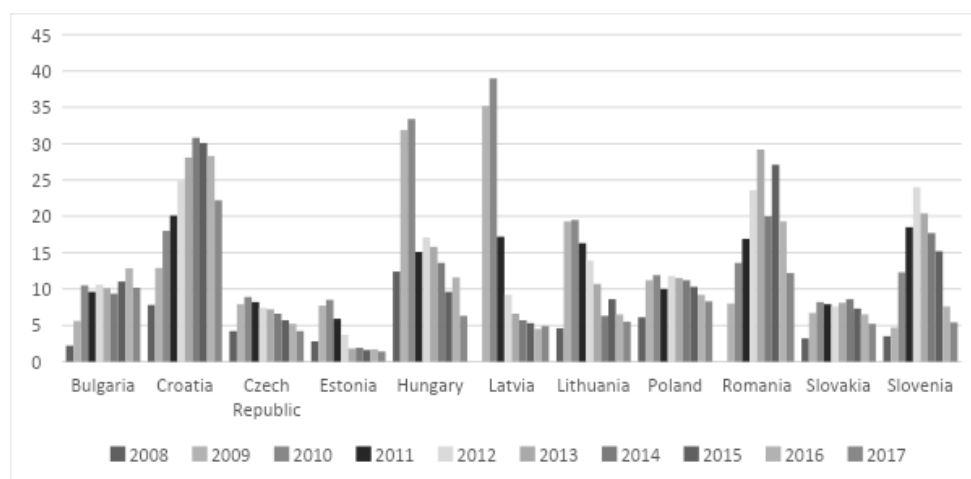


Fig. 4.

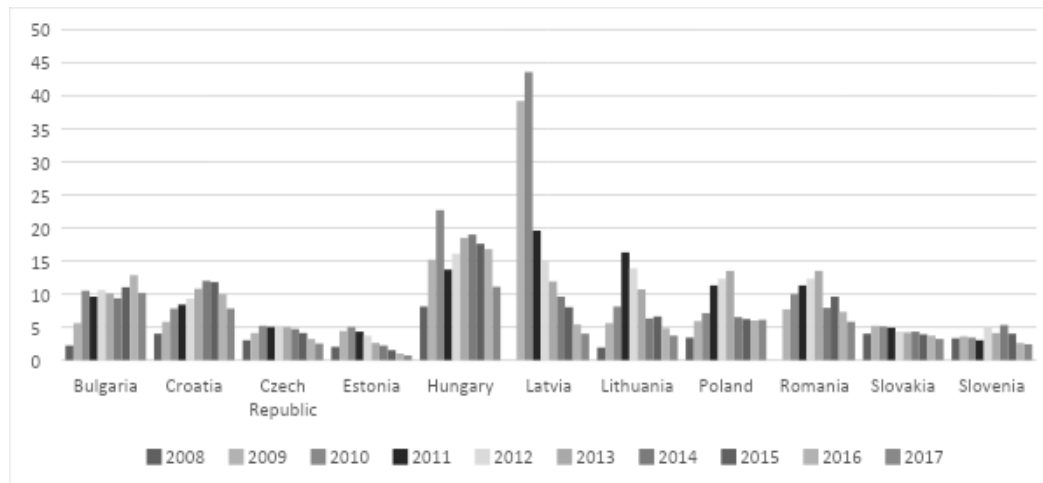


Fig. 5.

Source: data from Banking Supervisors from Central and Eastern European Countries (BSCEE) Reviews (various issues), www.bscee.org.

To carry out analyzes, the authors decided to use two types of panel models. In the first place, a dynamic panel model was used, estimated using the generalized method of moments (GMM), in the GMM-SYS version, introduced to the literature by Blundell and Bond [24]. The advantage of this method is the lack of assumptions about strict exogeneity of the regressors, thanks to which it is possible to take into account the delayed values of the dependent variable, which is not possible in the case of static panel models (with fixed effects and individual random effects) [25]. The GMM-SYS estimator gives more reliable and precise results in similar cases [26]. Statistical inference on the significance of model parameters was made on the basis of one-step

estimation, because basing the analysis on two-step method in the range of standard estimator errors may lead to incorrect conclusions, especially in the case of heteroskedasticity of a random component [23]. For diagnostic purposes, the Sargan test was used for the two-step method² and Arellano-Bond autocorrelation tests for the first differences: AR (1) and AR (2). These types of models are also used in the analysis of the credit exposures quality [27]. The final estimated dynamic regression model is given by the equation:

$$NPL_{it} = a_0 + a_1 * NPL_{it-1} + a_2 * MACRO.VAR_{it} + a_3 * MICRO.VAR_{it} + v_{it} \quad (1)$$

where: NPL is a measure of the credit exposures quality used in research; MACRO.VAR_{it} is a vector of country and sector macroeconomic variables values, affecting the quality of bank's credit exposures in period t; MICRO.VAR_{it} is a vector of control variables values, that characterize a specific bank; v_{it} is a random effect for the bank and in the t period.

The description of the variables used in the research and information on previous publications confirming their significance in the study of the NPL determinants are presented in Table 2.

Table 2

Characteristics of independent variables used in panel studies regarding NPL determinants in CEE countries in 2008—2017

Variable	Description	Data source	Previous research
Macroeconomic characteristics			
ΔGDP	Real GDP growth rate - measure of the rate of economic growth and impact of the business cycle.	Eurostat: http://ec.europa.eu/eurostat/web/gdp/data/database (17.01.2019)	Messai and Jouni (2013); Beck et al. (2015); Espinoza and Parad (2010); Jakubik and Reininger (2013); Marki et al. (2014);
HICP	Harmonized Index of Consumer Prices – measure of inflation	Eurostat, http://ec.europa.eu/eurostat/web/hicp/data/database (20.01.2019)	Klein (2013)]; Dimitrios et al. (2016);
UN	Unemployment rate defined as the ratio of the unemployed to the employed (BAEL)	Eurostat, http://ec.europa.eu/eurostat/web/hicp/data/database (20.01.2019)	Dimitrios et al. (2016); Skarica (2014); Marki et al. (2014); Messai and Jouini (2013).
HHI	Herfindahl-Hirschman Index - a measure of concentration of the banking sector	ECB: Banking Structural Financial Indicators	Cifter (2015);
L_GDP	Relation of loans to the non-financial sector / GDP - measure of the development of the banking market in individual countries.	World Bank: http://data.worldbank.org/indicator/FS.AST.DOMS.GD.ZS (10.01.2019)	-
Microeconomic characteristics			
Lg_A	The logarithm of the bank's total assets a measure of the size of the bank	Own calculations based on data from Orbis	Salas and Saurina (2002); Gosh (2015);
C_I	Cost-to-income ratio - measure of cost effectiveness	Data from Orbis	Jose Bercoff et al. (2002); Podpiera and Weill (2008);
L_A	Share of loans in total assets - a measure of the bank's credit exposure	Own calculations based on data from Orbis	Keeton (1999); Klein (2013); Messai (2013);

² For the one-step method, the Sargan test is not heteroscedastically compatible.

ROE	Average return on equity - a measure of profitability	Data from, Orbis	Salasa and Saurinę (2002); Klein (2013); Marki et al. (2014); Espinoza and Prasad (2010);
D_A	The share of non-financial sector deposits in total sources of financing - a measure of the bank's business model	Own calculations based on data from Orbis	Marki et al. (2014); Gosh (2015); Dimitrios et al. (2016);
TCR	Total Capital Ratio- bank's stability measure based on the bank's solvency in a broad sense	Data from Orbis	Bertrand Rime (2001); Espinoza and Prasad (2010); Marki et al. (2014)

Source: Own study.

Descriptive statistics of the control variables are presented in the *Table 3*.

Table 3

Descriptive statistics of variables used in models

Characteristic	NPL	GDP	HICP	UN	HHI	L_GDP	Lg_A	TCR	L_A	ROE	C_I	D_A
mean	13.98	1.73	2.30	9.42	0.11	68.36	14.53	18.48	64.02	5.15	75.24	77.96
median	9.88	2.34	1.90	8.95	0.09	67.02	14.39	16.00	65.58	5.84	64.29	81.52
standard deviation	13.48	3.83	2.74	3.79	0.06	17.70	2.76	11.82	23.82	51.45	66.54	20.23
minimum	0.06	-29.6	-1.60	2.90	0.06	13.40	9.19	-20.27	0.01	-328.78	-30.05	0.14
maximum	95.51	19.20	22.20	35.60	0.62	207.04	34.11	178.50	99.89	1140.34	810.71	98.21

Source: Own study.

The results of the research using the dynamic panel model are presented in *Tabl. 4*.

Table 4

Results of panel research (1-step GMM-SYS dynamic model) of NPL determinants in Central and Eastern Europe in 2008—2017

Control variable	2008—2017
NPL(-1)	0.506*** (0.126)
const	7.871** (3.15)
ΔGDP	-0.121 (0.109)
HICP	0.267 (0.257)
UN	0.359** (0.163)
HHI	-7.468 (7.42)
L_PKB	0.042** (0.021)
Lg_A	-0.369* (0.215)
TCR	-0.023 (0.053)
L_A	0.006 (0.033)
ROE	-0.135*** (0.03)
C_I	0.017** (0.008)
D_A	0.007 (0.022)
Number of observations	771
Number of banks	138

Test AR(1)	-3.112***
Test AR(2)	1.491
Sargan Test (two-step)	48.511

Note: *** significance at the level of 1%, ** significance at the level of 5%, *significance at the level of 10%. The heteroscedastically consistent error standard is given in brackets.

Source: Own study.

The conducted research confirmed that the current level of NPL is influenced by the level of this indicator in the bank in the previous year. Among the significant macroeconomic determinants of the NPL, the positive impact of the unemployment rate was confirmed. This result remains consistent with previous analyzes presented in part 2 of the article. The strong decline in the unemployment rate in recent years in the CEE countries has significantly affected the reduction of the NPL level in the banks in this region. At the significance level of 5%, the influence of the development of the banking market (L_GDP index) on the NPL level was confirmed, and the direction of the impact was positive. It means, that in countries characterized by higher credit saturation for the non-financial enterprises, the banking sector is characterized by a worse quality of loan exposures.

Among the microeconomic factors, that are significant determinants of the banks' NPL level in the CEE region, profitability measures (ROE) and cost effectiveness (C_I) were are the most important ones, and their direction was consistent with the previous analyzes presented in the literature on the subject. Banks, which were characterized by better profitability (higher ROA) and better cost-effectiveness ratio (lower C/I index) were have better quality of credit exposure. However, the study did not confirm the impact of the solvency ratio and D_A ratio (measure of the bank's business model) on the NPL level in the examined group of banks.

Due to the relatively short time series, analyzes were also carried out using a static panel model. The Hausman test was used to select the right model, which allows to answer the question: which individual effects occurred in the analyzed population — fixed effects (FE) or random effects (RE). The RE estimator is consistent and no less effective than the FE estimator, if the assumption of independence of variables observed from individual effects is fulfilled. Due to the insignificance of Hausman's statistics for all models, models with random individual effects were used, whose general notation takes the form:

$$NPL_{it} = a_0 + a_1 \times MACRO.VAR_{i(t,t-1)} + a_2 \times MICRO.VAR_{i,t} + v_{it} \quad (2)$$

where: NPL is a measure of the credit exposures quality used in research; MACRO.VAR_{i(t,t-1)} is a vector of country and sector macroeconomic variables values, affecting the quality of bank's credit exposures in period t or t-1; MICRO.VAR_{i,t} is a vector of control variables values, that characterize a specific bank; v_{it} is a random effect for the bank and in the t period.

The results of the research using the static panel model are presented in *Tabl. 5*.

Table 5

Results of panel research (static model, random effects) of NPL determinants in the countries of Central and Eastern Europe in 2008—2017

Control variables	2008—2017
const	3.614 (4.849)
ΔGDP	0.152* (0.089)
HICP	-0.536 *** (0.129)
UN	1.006 *** (0.147)
HHI	35.266 (23.265)
L_GDP	0.053 (0.046)
Lg_A	-0.380 (0.403)

TCR	-0.193 *** (0.056)
L_A	0.000 (0.039)
ROE	-0.024 ** (0.01)
C_I	0.029 *** (0.006)
D_A	0.009 (0.027)
Number of observations	771
Number of banks	138
Hausman Test Relevance	0.256

Note: *** significance at the level of 1%, ** significance at the level of 5%, *significance at the level of 10%. The heteroscedastically consistent error standard is given in brackets.

Source: Own study.

The results of the study, performed with the static model, remain broadly in line with the results obtained in the dynamic model. Also in this case, a significant positive impact of the unemployment rate on the NPL level was confirmed (with a confidence level of 99%). The inflation level, whose increase is an important factor limiting the share of impaired loans in the loan portfolio of banks, is also important for the quality of credit exposure. Similarly to the static model, the impact of market concentration on the NPL level has not been confirmed. Among the microeconomic factors, profitability and cost effectiveness were also significant determinants, and the direction of their impact is similar to the results obtained in the static model. The difference between the dynamic and the static model was the result of the impact of the bank's solvency level (measured by the TCR ratio) on the quality of the credit exposure. The study showed the significant impact of the bank's equity level on its NPL index (negative direction of dependence). There is no evidence for the impact of the L_A ratio (a measure of the bank's credit exposure) on the NPL level in the analyzed group of banks.

Conclusions. The considerations, presented in this article, regarding the quality of credit exposures of banks operating in the European Union countries, constitute a significant contribution to the discussion on the possibility of solving the problem of a significant increase in the value of impaired loans in the post-crisis period. Very favorable macroeconomic situation in the CEE countries in 2015—2017, in particular a significant decrease in the unemployment rate (in many countries to the historical lows of the post-transformation period), contributed to the improvement of the NPL level, without however completely eliminating the negative effects of the financial crisis 2007—2009. This means that in the event of a deterioration in the economic situation, the quality of the credit exposure may deteriorate again and, consequently, the profitability and solvency of the region's banks may also deteriorate. This risk is magnified by the fact, that banks in many countries have significant value of loans denominated in foreign currencies in their portfolios (in particular in CHF and EUR). This situation, accompanied by a strong depreciation of the domestic currency, may lead to a reduction in the debt repayment capacity of borrowers. The results of carried out panel research show that the value of the NPL ratio of the analyzed banks is statistically significantly affected by both macroeconomic factors, such as GDP, the unemployment rate and inflation, as well as bank-specific factors such as the ROE or C/I ratio.

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