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IMPACT OF BANK-SPECIFIC AND MACRO DETERMINANTS ON NON-PERFORMING LOANS OF POLISH BANKING SECTOR[2]

The aim of this paper is to examine the determinants of non-performing loans (NPLs) in Poland. We investigate macroeconomic and bank-specific determinants of NPLs – for a panel of 18 banks from Poland, using annual data for the period 2005-2018. We apply two alternative estimation techniques: fixed-effects model and system Generalised Method of Moments. The results show the bank-specific determinants, with an impact on the amount of NPLs include return on equity and growth of gross loans,, while the most important macroeconomic factors influencing NPLs in Poland are GDP growth, domestic credit to the private sector, public debt and unemployment.
Keywords: Non-performing loans; Macroeconomic determinants; bank-specific determinants; Poland; Generalised Method of Moments
JEL: C23; C51; G21; G2

1. Introduction

In the last two decades, the deregulation, technological change and globalisation of goods and financial markets, have strengthened competition among banks. According to Jeong, Jung (2013), competition increased banks' credit risk, *i.e.* affected their loan portfolios in terms of their bad loan screening procedures and relaxing borrowing criteria. Moreover, the credit risk of the banks is very often linked to the ratio of NPLs, which can be generally defined as loans in default or close to being in default. Brownbridge (1998) points out that it was confirmed over the past decades that most of the banking failures or crises are caused by NPLs, e.g. the 1997 Asian financial crisis Yang (2003) and the 2008 global financial crisis Diwa (2010). Furthermore, according to Khemraj and Pasha (2009) the increase of NPLs has been associated with bank failures and financial crises in both developing and developed countries. This was confirmed during the global financial crisis in 2007-2008, when the levels of NPLs significantly increased across countries. While almost all countries in the world were faced with the rapid growth of NPLs, after 2007-2008, the growth varied significantly among

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different groups of countries, and among countries in the same group. For example, in 2008 the number of NPLs as a share of total loans in high-income countries from the Organization for Economic Co-operation and Development (OECD) was 3%, and increased to 8% in 2014, while in Central and Southeastern Europe, it was 4% in 2002, and reached almost 15% in 2014.

The Polish economy is one of the most advanced among the Central and Eastern European (CEE) countries. According to Eurostat and the European Commission, its economy has been one of the fastest-growing among the EU Member States (GDP grew by 4.6% in 2017). Furthermore, the financial system in Poland is dominated by the banking sector, which incorporates 80% privately owned banks and several state-owned ones. Also, the foreign capital is a common thing in Poland's banking sector, accounting to 60% of the total banking assets. At the end of 2017, the Polish financial landscape was made up of 35 commercial banks, 553 cooperative banks and 28 branches of credit institutions. In 2017, the ownership structure of the Polish banking sector changed. That year, the Polish banking sector's assets totalled €427.17 billion. The prudent credit policy and relatively good results of the Polish economy have allowed banks to maintain the NPL ratio at a relatively low level (6.8%), lower than at the end of 2016 The European Banking Federation (2018).

Considering the foregoing, the objective of this paper is to examine how bank-specific and macroeconomic determinants affect the level of NPLs in Polish commercial banks. There are many studies that explore the determinants of NPLs in many countries and regions, but a relatively small number of authors include the Polish banking sector in their research. To the best of the authors' knowledge, only one relevant study examines the determinants of NPLs in Poland, that of Głogowski (2008), but it covers the period before the global financial crisis (1996-2006). The determinants of NPLs of Polish banks were also analysed in the four-panel countries' studies conducted by Çifter (2012), Jakubík and Reininger (2013), Erdinc and Abazi (2014) Staehr and Uusküla (2017), but only as part of a group of countries of Central, Eastern, and South-Eastern Europe (CESEE) and never as a single country.

Keeping in mind the aforementioned studies, we offer a novel approach to the issue of NPLs in Poland. In this study, we employ an unbalanced panel, of 18 banks in Poland representing 80% of the total assets of Polish banks, using annual data, from 2005 to 2018. The selected period covers mainly the crisis and post-crisis times, as well as the last three years of the pre-crisis boom (2005-2007*).* According to Maddala (2001), the main advantage of panel data, as compared to other types of data, is the fact that the approach allows testing and adjustment of the assumptions that are implicit in cross-sectional analysis. Furthermore, in this study, we use the banks' public reports. Namely, our focus on the bank-level data eliminated the aggregation bias problem and enabled the researcher to disentangle the effects of various internal determinants (as controlled by the banks' management) on NPLs. In addition, to avoid the risk of providing inconsistent and biased results, by using only one estimation technique, in our study, we implement two alternative estimation models (fixed-effects model and system Generalised Method of Moments).

The structure of the paper is as follows. Following the introduction, Section 2 reviews the literature on empirical findings relevant for both the macroeconomic and bank-level determinants of NPLs. The methodology and the sources of the data employed are presented

in Section 3. Section 4 explains the analysis and empirical results of determinants of NPLs. Section 5 concludes the paper and offers policy recommendations.

2. Literature Review

In the last few years, especially after the financial crisis of 2007-2008, the studies which investigated determinants of banks' credit risk gained in importance (Khemraj, Pasha, 2009). However, when it comes to modelling in this field, there is no universally accepted rule or principle to be used as a basic tool in all studies. The empirical results of studies differ, depending on the time periods and different specifics of each of the countries. There are, however, some common elements as well. Namely, NPLs are usually measured by the ratio of NPLs to total loans. The internal determinants usually consist of bank-specific variables, such as the size of the bank, equity to total assets ratio, return on equity, growth of gross loans. The macroeconomic determinants include GDP growth, inflation, unemployment, public debt. In the sequel of this paper, we give a short summary of the empirical literature that emphasises the NPLs determinants in Poland.

To our best knowledge, only one relevant study that of Glogowski (2008), has analysed determinants of NPLs, of 108 Polish banks in the period between 1996 to 2006, applying panel fixed and random effects models. In his study, Glogowski used only macroeconomic determinants (Real GDP growth, rate of loans issued to households and corporations, borrower debt burden, bank-level credit growth and share of real estate loans in loans to households) only.

The author finds evidence on the importance of the set of macroeconomic variables, consisted of real GDP growth, real interest rates and unemployment.

Out of the panel studies that have analysed CESEE countries, we focus on four-panel countries' studies (Çifter, 2012; Jakubík, Reininger, 2013; Erdinc, Abazi, 2014; Staehr, Uusküla, 2017).

Çifter (2012) examines the effect of concentration of banks on NPLs in ten Central and Eastern European (CEE) countries; the short-run effect of bank concentration is tested with the Generalised Method of Moments System and the instrumental variable approaches, and the long-run one is tested with the Fully Modified Ordinary Least SFquare (FMOLS) approach. The results show that the bank concentration is an insignificant factor on NPLs, either in the short or in the long run of the panel data set. On the other hand, individual FMOLS results reveal that the concentration of banks reduces the NPLs in Estonia, Latvia, and Slovakia, while decreasing those in Bulgaria, Croatia, Lithuania, Poland, and Slovenia in the long run.

Using the difference GMM and system GMM models, Jakubik and Reininger (2013) analysed determinants of NPLs in nine CESEE countries (Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine). In their paper, they used several macro determinants: real GDP, private sector, national stock exchange index, credit-to-GDP ratio, exchange rate. The empirical results show that real GDP growth is the main driver that is negatively correlated with the dynamics of NPLs.

Erdinc and Abazi (2014) analysed determinants of NPLs in 20 emerging European countries (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia FYR, Moldova, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Turkey, and Ukraine), using several panel methods (Fixed and Random Effect, Difference and System-GMM) and annual data from 2000 to 2011. Empirical results show that real GDP growth, inflation rate and bank profitability have a significant impact on NPLs. The results also suggest that higher lending rates may lead to adverse selection problems and hence reduce the loan quality.

Staehr and Uusküla (2017) estimated panel data models that use macroeconomic and macro-financial variables to forecast the ratio of NPLs in all EU countries, using quarterly data from 1997Q4 to 2017Q1. The results of their paper showed that the ratio of NPLs exhibits substantial persistence and higher GDP growth, lower inflation and lower debt are robust leading indicators of the ratio of lower NPLs. The current account balance and real house prices are important indicators for Western Europe, but are less relevant in the case of Central and Eastern Europe.

3. Data and Methodology

This section identifies the sources of our data, presents the data, and describes the regression models that we applied to investigate the effects of internal and external factors on NPLs.

3.1 Data Source and Sample Characteristics

In our study, we used an unbalanced panel of 18 banks in Poland. The data are based on the annual frequency for 2005-2018. According to Rinaldiand Sanchis-Arellano (2006), unbalanced panel data include more observations and their results are less dependent on a particular period.

The data used in the empirical analysis came from two main sources. The data for the bank-specific determinants (equity to total assets ratio, ROE and growth of gross loans) were obtained from the Bankscope database of Bureau van Dijk. The financial information was derived from balance sheets, income statements, and notes from the annual reports. Bankscope had up to 20 years worth of data available, covering the total sample period. The data for macroeconomic determinants – GDP growth (annual percentage), unemployment, inflation, consumer prices (annual percentage), domestic credit to the private sector (percentage of GDP) – public debt, and fiscal position (budget surplus deficit) as a percentage of GDP, were obtained from the World Development Indicators database. The selection of the variables included in the paper was inspired by the previously reviewed literature where selected determinants were usually used and the availability of data.

Within our presentation of the independent determinant, we considered both bank-specific determinants and macroeconomic characteristics. The factors that we used as control determinants, which may explain the NPLs of banks, are:

- Macroeconomic determinants: Real GDP growth – GDPG; Inflation – INF; Unemployment – UN; Domestic credit to private sector (% of GDP) – DCPS; Public debt-PD; fiscal position (budget surplus or the budget deficit) as a percentage of GDP-FISCALP.
- Bank-specific determinants: Ratio of equity to total assets – ETA; Return on equity – ROE; Growth of gross loans – GGL.

As discussed in the introductory part, the economic model that we used in the empirical analysis cover bank-specific and macroeconomic determinants and their potential impact on NPLs. Before attempting to identify potential bank-specific and macroeconomic determinants of NPLs, it is necessary to define the dependent determinant. In the literature, to date, there is no internationally harmonised definition that has been applied in all or most countries of the world for a considerable period of time. The most commonly used definition outlined by the Basel Committee on Banking Supervision, specifies that NPLs should include all loans that are 90 days overdue. In spite of that, countries report their statistics differently in such a way that some include all the loans which are 31 days past due, some countries take into account 61 or 30 days. According to Jakubík and Reininger (2013), efforts towards harmonising NPL definitions have been gathering steam only in recent years, in the wake of the financial and economic crisis. In this context, it is worth mentioning that Bankscope reports the level of "impaired loans", which may be different from the official classification of NPLs. "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 is specified in the loan agreement, while "NPL" is a regulatory concept, which primarily reflects loans that are more than 90 days past their due date Report of the Working Group on NPLs in CESEE (2012). Acknowledging these differences, we follow Klein (2013), Petkovski and Kjosevski (2018) and treat "impaired loans" as NPLs. In this analysis, our dependent variable will be the logit transformation of the ratio of impaired (NPLs) to total (gross) loans, as this transformation ensures that the dependent variable spans the interval (-∞;+∞) (as opposed to between 0 and 1) and is distributed symmetrically (Salas, Saurina 2002; Espinoza, Prasad, 2010).

Macroeconomic Determinants

In the literature (Babouček, Jančar, 2005; Jimenez, Saurina, 2005; Nkusu, 2011; Skarica, 2013; Klein, 2013; Beck et al., 2013; Us, 2016), the real GDP growth stands out as the main macroeconomic determinant of NPLs. Having this in mind, we include the annual growth rate of real GDP in our analysis. The literature notes that when there is a slowdown in the economy, a rise in the NPLs can be observed. Skarica (2013). According to Us (2016). the explanation behind this relationship is that when the economy is growing and the income of borrowers is increasing, the debt-servicing capacity improves, as does the overall financial stability as well. In other words, the growing economy associated with the growth of the general level of income and the reduced financial stress and, hence, GDP growth, should be negatively correlated with NPLs Nkusu (2011). Therefore, we anticipate a negative relationship between GDP growth and NPLs.

The inflation as the general consumer prices' rate is another macroeconomic factor that has been investigated, particularly because of the unclear and ambiguous evidence that generated this determinant. Thus, higher inflation can make debt servicing easier by reducing the real value of outstanding loans. On the other hand, inflation can be taken to decrease the real income in the long-run and therefore, leaving the debtors with a smaller amount of funds for repaying the debt. In the literature, many authors (Fofack, 2005; Rinaldi, Sanchis-Arellano, 2006; Gunsel, 2008; Skarica, 2013; Klein, 2015; Us, 2016), find a positive correlation between the inflation rate and NPLs On the other hand, the negative relationship between these two determinants was observed by Sofoklis and Nikolaidu (2011). Therefore, we do not expect precise results with regard to this relationship.

Similar to inflation, exchange rate depreciation may have a negative or a positive effect on NPLs. Thus, exchange rate depreciation in a country with flexible exchange rate regimes and a large amounts of lending in foreign currency, may have a positive effect on NPL accumulation (Klein, 2013; Beck, 2015). On the other hand, currency depreciation can improve the debt servicing capabilities of export-oriented firms and lower the NPL ratio. A significant proportion of loans extended by Polish banks is nominated in foreign currencies. Some of these loans were taken out by households without matching income.

Consequently, changes in the exchange rate can influence the cost of loan repayment and the burden it places on household incomes Głogowski (2008). A depreciation of the zloty can thus increase loan losses of banks that have a large proportion of loans in their portfolios. On the other hand, during the investigated period, the quality of loans was better than that of zloty loans, which suggests that the influence of exchange rate changes could have been minor.

The rate of export increase may provide additional information regarding the impact of economic conditions. A decline in exports should lead to a fall in company revenue, and therefore, companies face a lower ability to repay their credit. This contributes to a relatively higher NPL percentage to total loan (Clichici, Colesnicova, 2014)

In order to show the level of indebtedness of the private sector in the economy, we included the level of domestic credit to the private sector (% of GDP) in our model. According to (Pesola, 2005; Nkusu, 2011), high levels of debt make debtors much more vulnerable to adverse shocks because that directly affect their income and, therefore, their ability to service their obligations Pesola (2001), states that instability of the financial system becomes visible when the level of indebtedness is growing continuously, and unfavourable shocks are then more strongly experienced. Therefore with this variable, we expect a positive correlation with the NPLs.

The last macroeconomic determinant that we used in our model is unemployment, which is the control variable for the health of the economic environment and is also closely related with banks' performance. When it comes to unemployment, bank performance suffers when unemployment increases because there will be fewer individuals seeking to cooperate with banks, fewer bank accounts and services, which leads to increased NPLs. In other words, according to Messai and Jouini (2014), rise in the unemployment rate actually limits the current and future purchasing power of households and enterprises, also adversely affecting their cash flows and, therefore, increasing debt burden accompanies the increasing

unemployment rate Empirical studies that have investigated the relationship between unemployment and NPLs, found a positive correlation (Głogowski, 2008; Makri et al., 2014; Messai, Jouini, 2014; Kurumi and Bushpepa, 2017). Thus, based on the above arguments, there is a positive relationship between unemployment and NPLs.

Fiscal determinants

In some European countries, the 2008/2009 crisis from first affected fiscal indices and then extended to the banks. Taking this point into consideration, we included two public finance variables (DEBT and FISCALP) in our investigation. First, we used public debt, which is a form of financial obligation, incurred by the government or borrowings and repayments. With this determinant, we expect a positive relationship with NPLs, since an additional increase of public debt can influence the credit ratings of the government and consequently the liquidity of the banks. In other words, the banks tend to invest their liquidity reserves in government securities and with the deterioration of the government credit rating, the rating of government securities is also affected this way, the banks continue their operation under the pressure of liquidity. According to Reinhart and Rogoff (2010), the need of dealing with the liquidity pressure limits the banks' placement of loans and subsequently, the debtors cannot renew their loans which can cause an increasing trend in the level of NPLs. In other words, it has been posited that banking and sovereign crises are closely connected, and banking crises, in fact, can either precede or be the result of a sovereign crisis as in the case of Greece Louzis et al. (2012).

The second fiscal determinant that is employed in our model is the government's fiscal position (budget surplus or deficit) as a percentage of GDP. According to Hyde (2002), a surplus can indicate an increase in taxes or a decrease in government expenditures or both at the same time, while a deficit implies a decrease in tax revenues and a rise in government expenditure or both at the same time. According to Makri et al. (2014), since a variable FISCALP has by nature an adverse relationship with PD, it is expected to be negatively correlated with NPLs. In other words, this negative correlation is due to the fact that it can indicate a better fiscal position of the country, less expensive financing, and reduced risk, and expectations of a sustainable fiscal position are improved. Bearing this in mind, we expected a negative correlation with NPLs in the case of this determinant.

Bank-Specific Determinants

The first determinant that we used in our model is the profitability ratio (ROE) as a measure of banks' past performance, because banks' profitability is linked to their risk-taking behaviour. Swamy, 2012 points out that if the banks are more profitable that will lead to lower levels of NPLs. According to Boudrigaet al. (2009), inefficient banks with lower profitability are tempted to resort to less reliable and risky placements to increase their profitability and/or meet the demands of regulatory authorities The vast majority of the literature has observed a negative impact of the profitability ratios on the NPLs (Godlewski, 2004; Louzis et al. 2010; Makri et al., 2014; Selma, Jouini, 2013; Messai, Jouini, 2014). According to Makri et al. (2014), this relationship is due to the poor performance of the banks

decreased profitability which further motivates managers to lend to riskier borrowers, in order to rise profitability, which, in the end, leads to the growth of NPLs. Therefore, we expect a negative sign before this explanatory variable.

The share of equity in total assets is the next determinant that is included in our model. In most of the studies (Berger, De Young, 1997; Salas, Saurina, 2002; Klein, 2013), there is a negative relationship between equity in total assets and NPLs. But on the other hand, there are studies where this connection can be positive (Rajan, Dahl, 2003; Boudriga et al., 2009; Espinoza, Prasad, 2010). According to Quagliarello (2007), the positive relationship is due to the fact that the higher the risk appetite of a bank, the greater the share of capital to existing shareholders invested in the bank, in order to convince other shareholders to invest in and support the bank. Having these facts in mind in the case of this determinant, we expected an ambiguous correlation with NPLs.

According to Petkovski et al. (2018), the credit policy of the bank plays an essential role in determining the subsequent levels of NPLs. In order to maximise the short-run benefits, managers seek to rapidly expand the credit activities and may, hence, take inadequate credit exposures (Castro, 2012; Beck et al., 2013; Klein,2013). In the literature, the results based on this determinant are mixed. For example, in the study of Dash and Kabra (2010), they indicate the presence of a positive correlation between credit growth and NPLs, while other studies (Salas, Saurina, 2002; Quagliarello, 2007; Boudriga et al. 2009; Dash, Kabra, 2010; Swamy, 2012) found a negative correlation. Therefore, the effect of individual credit growth can go in both directions and we expected an ambiguous correlation with NPLs.

Table 1 presents descriptive statistics for the determinants involved in the regression model. Key figures, including mean, standard deviation, and minimum and maximum values, are reported. This table gives an overall description of the data used in the model and serves as a data screening tool to spot unreasonable figures. According to Table 1, there were observations missing regarding bank-specific determinants. This is mainly due to unreported figures in annual financial reports from some banks. Also, from Table 1, we can see that the NPLs variable has a mean value of 7.62, which goes up to a maximum of 40 and down to a minimum of 0.19. The high maximum value is due to the period when the data is collected, which covers the years of the world economic and financial crisis, the effects of which spilt over the Polish banking system, with some banks being affected more than others. Furthermore, we can see from Table 1 that ROE and GGL have negative values. Based on the data, we can say that there are significant differences among the banks in Poland in terms of all variables selected. Namely, in the case of ROE, there are banks where this determinant has a negative value of -25.2, but it can also go up to as much as 38.1. It is similar to the other variables. It is thus similar in the case of macroeconomic variables, where we have large oscillations in the analysed period, especially UN, which has the largest variations between the minimum and the maximum values.

Table 1

Descriptive statistics

	NPL	ROE	ETA	GGL	GDPG	DCPS	INF	EXPORT	EXR	UN	PD	FISCALP
Mean	7.62	10.0	11.0	15.7	3.96	47.1	1.96	44.2	4.11	9.10	50.3	-3.62
Median	6.67	10.4	10.4	10.1	3.72	50.5	2.12	44.5	4.16	9.29	50.4	-3.65
Max	40.0	38.1	42.2	157.7	7.03	54.5	4.23	52.1	4.48	17.7	55.7	-0.4
Min	0.19	-25.2	0.71	-87.2	1.39	27.1	-0.87	35.9	3.61	3.8	44.2	-7.3
Std. Dev.	5.29	7.61	4.91	26.41	1.52	8.4	1.62	4.28	0.22	3.41	3.42	1.88
Observ	182	211	225	202	252	252	252	252	252	252	252	252

Source:Author's calculations.

3.2. Methodology

In the main objective of this study is to examine the impact of bank-specific and macroeconomic factors on the volume of NPLs, using panel data for a sample of 18 banks from 2005 to 2018. Hsiao (1986) listed several advantages of panel data compared to other types of data. First of all, panel data provide more information, more variability, less collinearity among other variables, a greater degree of freedom, and higher efficiency. Second, panel data can not only capture and measure effects that are not detectable in cross-section time-series analysis but also provide a platform on which to test more complicated behavioural models. For that reason, a precise econometric model is developed incorporating all the widely recognised variables mentioned above. Also, the model is summarised in accordance with the existing models in the vast literature and the variables involved are also supported by substantial empirical evidence.

In general, the following econometric model is developed:

$$y_{it} = \alpha_0 + \beta_i BANK_{i,t} + \beta_i MAC_{i,t} + \varepsilon_{it} \quad (1)$$

where y_{it} denotes the NPLs to total gross loans, α_0 is the intercept, BANK denotes the bank-specific variables, and MAC denotes the macroeconomic factors. Note that i corresponds to the examined bank of the sample and *t* to the year, while ε denotes the error term.

In order to obtain deeper insight into the relevance of the explanatory variables, their coefficients are estimated by employing two estimation techniques: Fixed Effects Model (without the variable NPLt-1 from equation (1), since it can lead to inconsistent results), and System GMM, as well as the necessary relevant tests which will be explained more specifically further in the paper.

The starting point in each panel model is the assessment of fixed and random effects. They are well documented in the literature, such as, for example, in Wooldridge (2002, 2007). In short, the analysis of fixed effects assumes that the units of interest (in our case, the banks) are fixed and that the differences between them are not of interest. The random-effects model, on the other hand, provides a lock to the population from which the sample was extracted. For our analysis of the banks, the model of fixed effects would be adequate. Namely, in short panels, the estimates obtained can differ considerably and the fixed effects should therefore be employed when we strongly believe that the units in the model are not random drawings

from a larger sample, in which case the RE is preferred (Judge et al., 1988). In addition to this, we also conducted the Hausman test (1978) for distinguishing between the models of fixed and random effects. Moreover, the suitable equation for estimation through fixed effects model becomes:

$$NPLi,t= \alpha0 + \beta1ETA,t + \beta2ROEi,t + \beta3GGLi,t + \beta4GDPGi,t + \beta5DCPS\ i,t + \beta6INFi,t\ \beta7EXPORTi,t\ \beta8EXRi,t + \beta9UNi,t + \beta10PDi,t + \beta11FISCALPi,t + \varepsilon i,t \quad (2)$$

The models of fixed and random effects imply that all the variables on the right side of the model (1) are exogenous. However, for some of them, it can be argued that there is a reciprocal causation, as part of them arise from the balance sheets of the banks themselves. Such feedback may cause inconsistency in the assessment of the model of fixed or incidental effects. In order to overcome it, the model can be evaluated by means of the so-called instrumental variables technique, in which potentially endogenous variables are instrumented with variables that are highly correlated with the particular regressor but are not correlated with the error member Wooldridge (2007). In particular, the panel data prepared for this study is a linear functional relationship, a dynamic left-handed variable, not strictly exogenous as some of the variables and fixed effects that were observed with the first estimation technique. Accordingly, the structured model for the determinants of NPLs is a perfect match for GMM estimation and therefore, we decided to proceed with the aforementioned technique to obtain more relevant and unbiased results. Additionally, following the past papers with dynamic panel data Makri et al. (2014), Us (2016), Klein (2013), Beck and Levine (2004), Cheng and Kwan (2000) and many others that are similar to this one, focused on the objectives alike and handling an equivalent panel data set, utilised the System GMM.

With System GMM we avoid the dynamic panel bias" in the fixed effects model by transforming the data to first differences to remove the fixed effects and uses the lagged levels of the right-handed independent variables as instruments. But, still, in panel datasets with limited time dimension or lower T (such as in our case), this estimation can be less precise Blundell and Bond (1998). As a result, the System GMM is applied in order to avoid this concern. This approach actually involves two equations: one in levels in which the instruments are presented by the lagged first differences, and the other in the first differences with lagged levels as instruments Arellano and Bover (1995). Under this approach, the lagged bank-level variables were modelled as pre-determined (thus instrumented GMM-style in the same way as the lagged dependent variable) while the country-level and the global variables were treated as strictly exogenous (instrumented by itself as an "IV style" instrument, Roodman (2009).

However, the equation that we aim to estimate in this research paper in order to observe the impact of the bank-specific and macroeconomic variables on NPLs is the following

$$NPLi,t= \alpha0 + \gamma0NPLt\text{-}1 + \beta1ETA,t + \beta2ROEi,t + \beta3GGLi,t + \beta4GDPGi,t + \beta5DCPS\ i,t + \beta6INFi,t\ \beta7EXPORTi,t\ \beta8EXRi,t + \beta9UNi,t + \beta10PDi,t + \beta11FISCALPi,t + \varepsilon i,t \quad (3)$$

This equation also incorporates the lagged dependant variable that was excluded earlier from the fixed effects estimation since the first one can result in "dynamic panel bias", and the

latter will be absorbed by the model's intercept. Nevertheless, the reasons behind the choice of Arellano-Bond GMM Estimator are elaborated above.

Based on all of the above, the further analysis evaluates the economic model (1) through 2-panel methods: the method of fixed effects and the system-GMM method. The choice between the fixed and random effects will be made based on the Hausman test (1978). The validity of instruments selected for parametric evaluation can be tested using the Sargan test. The second group of tests refers to tests of serial correlations in different residuals (first-order **AR (1)** and second-order **AR (2)** serial correlation). The first-order autocorrelation in the differed residuals does not imply that the estimates are inconsistent (Arellano, Bond, 1991, p. 282). However, the second-order autocorrelation would imply that the estimates are inconsistent.

4. Results and Discussion

In this section, we begin with an analysis of the results of multicollinearity. One of the assumptions of the linear regression model is that there is no multicollinearity among the independent (explanatory) determinants. If the correlation between explanatory determinants is high, estimation of the regression coefficients is possible, but with large standard errors and, as a result, the population values of the coefficients cannot be estimated precisely. According to Kennedy (2008), multicollinearity is a problem when the correlation is above 0.80, which was not the case here. The correlation among the variables selected is broadly in line with the economic theory. The matrix shows that, in general, the correlation between the selected determinants was not strong, suggesting that multicollinearity problems were either not severe or non-existent.

Table 2

Correlation matrix

	NPL	ROE	GGL	ETA	GDPG	INF	EXR	EXPORT	DCPS	UN	PD	FISCALP
NPL	1											
ROE	-0.2	1										
GGL	-0.26	0.05	1									
ETA	0.34	0.01	-0.18	1								
GDPG	-0.09	0.21	0.2	-0.06	1							
INF	-0.09	0.18	0.09	-0.01	0.11	1						
EXR	0.03	-0.35	-0.14	-0.005	-0.37	-0.21	1					
EXPORT	-0.03	-0.25	-0.11	0.03	0.06	-0.41	0.56	1				
DCPS	0.003	-0.42	-0.14	0.03	-0.38	-0.26	0.8	0.74	1			
UN	0.08	0.35	0.06	-0.005	-0.07	0.14	-0.54	-0.78	-0.79	1		
PD	0.1	-0.3	-0.16	0.03	-0.67	-0.18	0.67	0.31	0.65	-0.16	1	
FISCALP	-0.1	0.06	-0.04	0.02	0.38	-0.42	0.09	0.7	0.13	-0.4	-0.24	1

Source: Author's calculations.

The results of the unit root test are presented in Table 3. The unit root analysis, according to ADF Fisher-type tests, can not be rejected in three determinants (UN, INF and DEFI), while the results of PP Fisher-type tests indicate that the null hypothesis of non-stationarity can be rejected for all our determinants. The results of the Breitung test indicates that the hypothesis

of non-stationarity cannot be rejected for three of the determinants (NPL, DCPS and ETA). However, bearing in mind that the other two unit tests (ADF and PP Fisher-type) show that these determinants are stationary at their levels, we include PD, DCPS and ETA in our models, and we treat them as non-stationary variables at their levels.

Table 3

Panel unit root tests

Test variables	ADF-Fisher Chi-square		PP-Fisher Chi-square		Breitung	
	Level	First Difference	Level	First Difference	Level	First Difference
NPLs	45.19***		61.96***		-1.534*	
PD	0.793**		0.784*		0.782	-3.727***
UN	30.61	91.98***	66.07***		-6.715***	
GDPG	88.57***		51.69**		-7.578***	
INF	32.94	93.80***	14.5055*		-4.756***	
DCPS	162.3***		443.6***		3.624	-13.02**
EXPORT	64.05***		72.24***		-4.98***	
EXR	43.05***		57.09**		-9.68***	
ROE	59.66***		98.56***		-2.895***	
ETA	46.70*		82.21***		0.558	-0.462*
GGL	64.10***		82.76***		-2.537**	
DEFI	0.595	158.90***	0.985*		-4.190***	

***, **, * denote statistical significance at the 1, 5, 10 percent level, respectively

Source: Author's calculations.

In Table 4, we report the empirical results of the fixed effects model and system GMM. Despite their differences, all approaches arrive at essentially similar results as to the sign and the statistical significance of most determinants in the regression specification. This confirms that our results are robust to different specifications, although the precision of the estimated coefficients differs across different methods that we have used in our study.

The results presented in Table 4 broadly confirm that both bank-level and macroeconomic factors play a role in affecting the banks' asset quality. The models seem to fit the panel data reasonably well, having fairly stable coefficients. First, the Hausman test (with a *p*-value of 0.012) shows that we can reject the null hypothesis that the random effect model is preferred and proceed with the estimation employing the fixed effects model. Thus, the Hausman test indicates to us that it is the fixed effects model that should be used during the estimation. Furthermore, the Hansen test shows that the chosen instruments are valid in the system GMM (with a*p*-value of 0.697). Also, the results under both models (difference and system GMM) show that the residuals demonstrate no serial correlation of order two, although a first-order autocorrelation is present in both models, yet, this does not imply that the estimates are inconsistent. According to Arellano and Bond (1991), inconsistency would be implied if a second-order autocorrelation was present, but this is rejected in our case by the test for AR(2) errors.

The results for the lagged dependent variable have a positive and statistical significance in both of the models that estimated its coefficient, which is confirmed by the dynamic character of the model's specification. The value of the lagged NPLs is 0.23 suggest that a shock to NPLs would be likely to have a prolonged effect on the Polish banking system. These results

are similar to those obtained by previous studies, as in Beck et al. (2005) where the lagged NPLs' value was between 0.19 and 0.29 and in Otasevic (2014), where the values of lagged NPLs were between 0.12 and 0.27.

Table 4

Estimation Results

Variables	Fixed Effects (FE) regressions	System GMM
NPL(-1)		0.23*** (0.45)
Const	15.06** (7.35)	10.06*** (5.43)
ETA	-0.086 (0.05)	-0.216 (0.26)
ROE	-0.024* (0.01)	-0.074 (0.11)
GGL	-0.034*** (0.01)	-0.016* (0.01)
GDPG	-0.675*** (0.27)	-0.943*** (0.23)
DCPS	-0.387*** (0.12)	-0.313*** (0.07)
INF	-0.038 (0.19)	0.240 (0.18)
EXPORT	0.038 (0.03)	0.059 (0.05)
EXR	0.35** (0.11)	0.40* (0.15)
UN	0.413 (0.25)	0.645*** (0.21)
PD	0.360** (0.16)	0.363*** (0.12)
DEFI	-0.212 (0.19)	-0.021 (0.11)
Number of Banks	18	18
Hausman test (p-value)	0.012	
Number of instruments		13
Hansen test (p-value)		0.697
Test for AR(1) errors		0.053
Test for AR(2) errors		0.338

1. Arellano-Bond test shows that the average autocovariance in residuals of order 1 is 0 (HB0B: No autocorrelation).
2. Arellano-Bond test indicates that the average autocovariance in residuals of order 2 is 0 (HB0B: No autocorrelation).
Standard errors are in parenthesis
*,** and *** show that the null hypothesis can be rejected at 10%, 5% and 1% significance levels, respectively

Source: Author's calculation

Starting with bank-specific determinants, only individual credit growth in three models (FE, difference and system GMM) has a statistically significant and negative relationship with NPLs. Despite the theoretical justification of the positive relationship as we mentioned before, there are also studies such as (Swamy, 2012; Boudriga at al., 2009; Sukrishnalall, Pasha, 2009), who establish a negative link between these two variables. These results probably reflect the conservative lending stance adopted by commercial banks after 2002-2014 due to their bad lending experience with the real sector and the general decline in the

real economy. In that period, the amount of NPLs in Poland reached a record high of 22.6% in June 2003. This is in line with Quagliarello (2007), who argued that a positive result of GGL may be the result of certain specifics, regulations and history in the separate banking systems that they have and the banks are more conservative and more careful in the dissemination of the credit offer.

The ROE related results indicate that profitability has a significant and negative impact on NPLs, but only in the first model with a fixed effect with a value of (-0.24). This result confirms the hypothesis that less profitable banks, in general, take higher credit risk and demonstrate the validity of the hypothesis of "bad management", reflected in the reduced profitability, which, in turn, motivates managers to go for increased risk exposure, therefore creating the growth of bad loans. The result is in line with the study of Klein (2013), where ROE was also statistically significant only under the fixed model, while being not significant under the difference and system GMM. So, the results are compatible with the economic intuition and the theoretical arguments discussed previously in this study. Again, the result reinforces the theoretical argument of bad management in the bank, which will eventually lead to a weakening of the efficiency in the procedure for underwriting bank loans. However, this result does not hold when the endogeneity of return on assets is controlled for in the GMM-IV estimation.

We found that GDP growth has a significant and negative impact on NPLs, which means that an increase in the domestic product causes a decrease of NPLs in both models. The results support the negative correlation with the non-performing loans in the CEE region aligned with the results from Makri et al. (2014), Skarica (2013), Us (2016), Fofack (2005) and Salas and Saurina (2002). The sign of these variables fulfil our expectations as well and one unit change in the GDP will lead to 0.943 units change in the opposite direction in the NPL ratio. This means that when the economy is booming, the income of the people is also increasing and they have more cash flows to repay their outstanding debts. Conversely, in times of economic recession, when the GDP falls, the wages are as well disrupted and the people are left with less income needed for meeting their loan obligations. Consequently, it influences the level of the non-performing loans and they increase substantially (Makri et al., 2014). The fact that economic growth is statistically significant (at the level of significance of 1%) in all models is confirmed by the robustness of the results obtained.

The results of DCPS indicate a statistically significant explanation power with a negative sign of the NPLs. If we considered this determinant in the context of one of the bank-specific determinants (credit growth), we could conclude that rapid credit growth would lead to faster growth of NPLs. Namely, they both had positive signs in line with the literature (Dash, Kabra, 2010), which condemned unsustainable lending booms as a factor that led to increased financial fragility. This result may also justify the central bank's actions to limit excessive lending growth to ensure financial stability.

With respect to the impact of the exchange rate, our results are in line with the results of other macro-studies on NPLs De Bock and Demyanets (2012) and Beck, Jakubík and Piloiu (2013) 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. 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 some 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. Apart from methodological issues, there are economic explanations why foreign currency loans may not show higher NPL ratios than local currency loans (Jakubík, Reininger, 2013). (1) The materialisation 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 materialisation 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 materialisation 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. (2) Another explanation may be borrower selection as a result of prudent behaviour 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 annexe 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).

As we expected, unemployment has a positive and statistical significance at 1%. As was anticipated, it is found a strong positive relationship between the unemployment rate and the non-performing loans in Poland. This sign alludes to the assumption that when unemployment between people increases, it limits their cash flows and resources since they are not working and consequently constrains their ability to repay the outstanding loans and therefore, that increase contributes to the raising of the NPLs in the loan portfolios. This justification and the obtained results are aligned with Makri et al. (2014), Messai and Jouini (2014), Louzis et al. (2010) and Bofondi and Ropele (2011), who represented evidence of the unemployment rate significantly and positively related to the NPLs. Thus, the estimated value of the coefficient suggests enlargement of the non-performing loans of 0.65 units in a case when the unemployment rate will go up by one unit, all else equal. Also, the p-value reveals the statistical significance at a level of 1%.

The last macroeconomic variable that is statistically significant is public debt. The public debt of the country also confirms the predictions for a positive relationship with the non-performing loans corroborated by many research studies such as Makri et al. (2014) and Reinhart and Rogoff (2010). In particular, the fixed effects model estimates coefficient with a value of 0.066, which implies that if the government debt increases by one unit, under all else equal, the non-performing loans will be positively affected by 0.36 units. Besides, it demonstrates statistical significance at a level of 5%. Thus, the justification of this relationship is that increase in the public debt can deteriorate the rating of the government securities and subsequently, it can influence banks' liquidity since they are usually inclined to invest their liquidity reserves in government securities. Consequently, the banks limit the issuing of new loans and since borrowers cannot renew their loans, the non-performing loans might increase (Reinhart, Rogoff, 2010).

We may conclude that the estimations for the overall period suggest that the selection of the independent variables is plausible and most of the regressors yield statistically significant coefficients, which also have the expected signs.

The main conclusion of this paper is that the NPLs in Poland are generally shaped by the macroeconomic factors in the period analysed. Second, the factors that demonstrate a statistically significant and positive correlation with the NPLs ratio are the following: the lagged non-performing loans ratio, the GGL, and ROE of bank-specific factors, as well as the GDPG, DCPS, UN and PD from the group of macroeconomic factors. Also, the signs of these variables are in line with the initial expectations.

In summary, we may conclude that in the period between 2005 to 2018, the NPLs were mostly influenced by macroeconomic factors. This paper found that bank-specific factors also have an impact, although a relatively smaller one, on the level of NPLs. Bearing this in mind, the banking sector in Poland should continue to further improve the quality of their management, as despite the theoretical justification of the positive relationship between credit growth and NPLs, in our case, this relationship has a negative value which confirms that banks in Poland are well-managed in terms of approving and collecting loans again.

Conclusion

In this paper, we examined the macroeconomic and bank-specific and determinants of NPLs for a panel of 18 banks from Poland, using annual data for the period 2005-2018. We employ two alternative estimation techniques: the fixed effects model and the System Generalised Method of Moments. During our research, we could not find another empirical paper that is focused entirely on the issue of macroeconomic and bank-specific determinants of NPLs in Poland, with the exception of only one, but which covers the period before the global financial crisis (1996-2006).

Based on the empirical results, we can see that relatively different results are shown through the four alternative estimation techniques. The general conclusion that can be drawn is that in the period under consideration, the NPLs in Poland were mostly shaped by macroeconomic factors. Specifically, we found that, from among the macroeconomic determinants, GDP

growth and domestic credit to the private sector have a strong negative effect on the level of NPLs, while public debt and unemployment have a positive one. This paper also finds that out of the bank-specific factors, individual credit growth in the case of three models (FE, difference and system GMM) demonstrates the most significant and negative relationship with NPLs statistically.

We have several suggestions for further research. First, it would be possibly interesting for future authors to extend the sample and comparatively analyse certain countries, similar to Poland (the Czech Republic, for example), in order to elucidate the determinants that affect NPLs. Second, as a measure of credit risk, it would be beneficial to also apply changes in the status of NPLs, or bad debt reserves, along with the ratio of NPLs over total loans. Third, future studies could provide a breakdown of all NPLs to NPLs to enterprises and to households and then apply such a breakdown of NPLs to enterprises by type of activity and to households by type of loan. Such findings could help the policymakers to identify the loan categories that are mostly exposed to NPLs and, consequently, to concentrate on those categories in order to mitigate the credit risk and strengthen the financial stability of the country.

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