

# ESG factors impact on non-performing loans in Poland

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## Abstract

This paper contributes to the discussion on the relationship between a bank's performance attributed to non-performing loans (NPL) and its ESG (environmental, social, and governance) performance. The study uses two-stage least squares (2SLS) regressions with instrumental variables to identify relationships between non-performing loans ratio and ESG scores, including separate scores for environmental, social, and governance pillars. The research is based on yearly data from the Polish commercial banking sector from 2013 to 2023. The following bank-specific variables were used in the model: ESG score (Environmental Pillar Score, Social Pillar Score, Governance Pillar Score) and ROA, CAPR1 (Capital Adequacy Ratio), NPL, loan dynamics, ALW (Loan Loss Allowance to Total Loans), as well as macroeconomic variables such as GDP, unemployment rate and inflation. We find that a banks' ESG score is negatively associated with its non-performing loans. Banks with higher ESG scores have lower non-performing loans ratios. The study enriches the ESG literature in the banking sector by concentrating on banks' loan quality. Moreover, it provides relevant evidence how improving ESG scores goes together with improving the quality of banks' portfolios.

**JEL classification:** C23, G21

## Introduction

ESG principles have been strongly articulated over the past few years by international and European authorities, such as the European Banking Authority (EBA). Banks are required to incorporate environmental (E), social (S), and governance (G) criteria into their credit rating process (EBA (2021)) and regard ESG disclosure as crucial for fostering market discipline. Simultaneously banks are required to report ESG risks (EBA (2022)). There are also recommendations to integrate ESG into the supervisory tools of regulatory authorities (Aevoae, Andries, Ongena, & Sprincean (2022)). Together with Corporate Sustainability Reporting Directive (CSRD) this will impact not only financial institutions and their clients, but all larger companies. With time even smaller companies will have to document how they deal with ESG and how they take into account sustainability in their day-to-day business.

The study investigates the relationship between the non-performing loans ratio for the commercial banking sector in Poland and ESG performance in all three pillars: environmental, social, and governance. Our study differs from other studies and contributes to the literature in four aspects.

Firstly, the paper most closely related to our research is Liu, Jin, & Nainar (2023). The authors, relying on the sample of US commercial banks from 2002 to 2021 and the Refinitiv ESG database, found that a bank's ESG score is negatively associated with its non-performing loans ratio. That is banks improving in terms of ESG compliance, also improve their business. The authors relied on data from the Refinitiv database, abandoning recodes with missing data. What distinguishes our research is the fact that, based on the Orbis and Bloomberg databases, for commercial banks in Poland we supplemented missing records in the Refinitiv database. Hence, despite having only a few banks in the sample, we have complete data on all those entities.

Second, so far, studies on the relation between ESG and NPL in commercial banks in Poland, have not been conducted. The complete sample, covering most of the commercial banking sector in Poland, lets us draw meaningful conclusions.

Finally, we analyse only banks from the commercial banking sector in Poland, avoiding comparisons between publicly traded commercial banks and cooperative banks or banks from different countries. For example, Bruno, Iacoviello, & Giannetti (2024) analyse 135 banks from 28 EU countries were without considering their specific traits on each of those markets. Moreover, the authors did not provide the names of the banks included in the study, and hence comparison with our study is impossible.

Our contribution to the research on impact of ESG compliance in financial sector is therefore twofold: we consider a homogenic set of banks with complete data with a scope comparable to other studies in the field, and hence we can reach quite sharp conclusions in the process, while controlling for differences between banks key characteristics.

## Literature review

The main stream of research on the consequences of banks' ESG strategies focuses on the value of bank shares (Alam, Banna, & Hassan (n.d.); Azmi, Hassan, Houston, & Karim (2021); Demir & Danisman (2021)), stability (Chiaramonte, Dreassi, Girardone, & Piserà (2022)), and financial stability deterioration (Citterio & King (2023)). There is also a line of research on efficiency (Alam et al. (n.d.); Ji, Sun, Liu, & Chiu (2023)), profitability (Chiaramonte et al. (2022); Yuen, Ngo, Le, & Ho (2022); Zhou (2021)) risk-taking behaviour (Tommaso & Thornton (2020); Chiaramonte et al. (2022)) credit (Zhou (2021)) and lending behavior (Basu, Vitanza, Wang, & Zhu (2022); Danisman & Tarazi (2024)).

The factors determining the quality of the loan portfolio have been classified as macro- and microeconomic factors – specific to the banking sector. The macroeconomic factors significantly associated with the quality of the loan portfolio include, among others: GDP growth (Głogowski (2008); Beck, Jakubík, & Piloju (2015); Donath, Cerna, & Oprea (2014); Wdowiński (2014); Murumba (2013); Dimitrios, Helen, & Mike (2016); Borsuk & Markiewicz (2020); Ciukaj & Kil (2020); Petkovski, Kjosevski, & Jovanovski (2021)) inflation (Beck et al. (2015); Ciukaj & Kil (2020)) and unemployment rate (Beck et al. (2015); Klein (2013); Dimitrios et al. (2016); Wan (2018); Wairimu & Gitundu (2017); Radivojević et al. (2019); Petkovski et al. (2021)).

In addition to macroeconomic factors, the quality of the loan portfolio is also influenced by microeconomic factors resulting from the specificity of the banking sector, including Tier-1 capital ratio, profitability, liquidity (Zeng (2012); Klein (2013); Makri, Tsagkanos, & Bellas (2014); Kjosevski & Petkovski (2017)), growth rate of total loans, (Kjosevski & Petkovski (2017)) loan loss allowance (Klein (2013); Messai & Jouini (2013); Firmansyah (2014); Ozili (2019)).

Only a limited number of studies have investigated the relationship between a bank's performance of non-performing loans and its ESG or corporate social responsibility (CSR) score. Wu and Shen (Wu & Shen (2013)) analysed 162 banks from 22 countries. The empirical results demonstrate that CSR negatively associates with non-performing loans (Wu & Shen (2013)). Liu et al. (2023) investigated U.S. commercial banks and found that ESG rating is negatively associated with banks' non-performing loans. However, Bruno et al. (2024) studied the impact of ESG scores on non-performing loans for a sample of European listed banks from 28 countries over the period 2002-2020 and found that banks with greater levels of ESG score have higher levels of NPLs.

## ESG pillars and non-performing loan measures

ESG scores are the aggregated variable derived from the weighted combination of several heterogeneous indicators. The Environmental (E) component encompasses sustainable resource use, emissions reduction, and minimizing environmental impact. The Social (S) component includes factors such as job satisfaction, occupational health and safety, diversity, equality, and human rights. The Governance (G) component involves adherence to best practices, equal treatment of shareholders, and the integration of non-financial goals into strategic and management decisions (Chiaramonte et al. (2022)).

Stakeholder theory emphasizes the importance of managing an organization in a way that considers the needs and expectations of all stakeholders group (Donaldson & Preston (1995)). The ESG score serves as a tool to measure how well an organization meets these expectations in the three key areas of sustainable development.

Given that banks with high ESG scores tend to have a low level of non-performing loans (Wu & Shen (2013); Basu et al. (2022)) and are also associated with a reduction in default risk (Tommaso & Thornton (2020)) and specific risks (Aeovae et al. (2022)) we propose the following hypothesis: *Banks' ESG scores, as well as the separate pillars, namely the Environmental score, Social score, and Governance score, are negatively associated with non-performing loans.* That means, improving ESG score has positive impact on bank's performance by lowering non-performing loans ratio.

**H1:** The ESG score has a positive impact on reducing the non-performing loans ratio

**H2:** The individual components of the ESG score – the environmental score, social score, and governance score – have a positive impact on reducing the non-performing loans ratio.

Banks with a high Environmental score are more likely to lend to companies that also take care of their environmental impact, such as those that reduce their carbon footprint, limit water usage or manage waste effectively. Such companies are usually more financially stable (Khan, Serafeim, & Yoon (2016)), and better managed, which translates to a lower risk of default and a lower NPL ratio. Additionally, banks with high Environmental scores often invest in projects related to renewable energy, energy efficiency, and other sustainable initiatives. These projects may be less risky in the long term because they are often supported by government and social policies, and they may be less susceptible to market fluctuations, which can lead to a lower number of NPLs.

Banks with a high Social score have excellent relationships with employees, shareholders, customers, consumers, and are valued members of the community. They care for all stakeholders by creating dignified working conditions and contributing to the community. Customers appreciate the transparency and ethical behavior of banks, and are more inclined to use their products, resulting in better performance for the bank. Incorporating social responsibility initiatives into bank's activities can potentially lead to financial benefits (Sindhu, Windijarto, Wong, & Maswadi (2024)).

According to the OECD, effective corporate governance enhances a company's reputation, mitigates risks, and strengthens shareholder confidence (OECD (2023)). Banks with a high Governance score are companies that operate in a transparent, responsible, and ethical manner, which in turn increases trust among investors, shareholders, and other stakeholders. Good corporate governance will be reflected in better bank performance (Komath, Doğan, & Sayılır (2023)). Such practices can contribute to better risk management, improved financial results, leading to lower non-performing loans ratios.

Table 1: Description of data in the dataset.

Variable	Description	Source
ESG	ESG Score (%)	Refinitiv
ESG_ENV	ESG environmental score (%)	Refinitiv
ESG_SOC	ESG social score (%)	Refinitiv
ESG_GOV	ESG governance score (%)	Refinitiv
LLA	Loan Loss Allowances (mln PLN)	Refinitiv
TGL	Total Gross Loans (mln PLN)	Refinitiv
PT_INC	Pre-tax income (mln PLN)	Financial statements
NPLA	Non-Performing Loans Actual (mln PLN)	Refinitiv
TAA	Total Assets (mln PLN)	Financial statements
CAPR1	Capital Adequacy Ratio (tier 1/risk-weighted assets) (%)	ORBIS
BESG	Bloomberg ESG Score	Bloomberg
UNPL	Unemployment rate	Central Statistical Office (GUS)
INFL	Inflation CPI	Central Statistical Office (GUS)
GDP	GDP in constant prices	Central Statistical Office (GUS)

Table 2: Additional variables.

Variable	Description
NPL	Non-performing loans ratio defined as non-performing assets deflated by total loans in previous year
LOAN	Total loans deflated by total assets in previous year
ALW	Loan loss allowance in year deflated by total loans in previous year
ROA	Return on assets defined as pre-tax income deflated by total assets in previous year

## Data

The study relies on annual data from the Polish commercial banking sector spanning from 2013 to 2023. Bank-specific data, including ESG scores, ROA, loan dynamics, and ALW, were obtained from the Refinitiv Database, CAPR1 from ORBIS (Bureau van Dijk), and macroeconomic data from the Macroeconomic Data Bank of Central Statistical Office (<https://dbm.stat.gov.pl>). Our sample includes all commercial banks in Poland from 2013 to 2023 for which the Refinitiv Database provides an ESG score. The starting point was the ESG score data. If other bank-specific variables available in the Refinitiv Database were missing, the Bloomberg database was used. The final sample prepared in this way includes 88 bank-year observations. The description of variables in this dataset is presented in Table 1.

There exist several studies using Refinitiv data. In most cases, these data are neither not supplemented with other sources, nor gaps in the data are filled with data from other sources consistent with Refinitiv. Moreover, sometimes market data come from several markets with slightly different factors impacting market behaviour. Our contribution in this paper is to focus on complete and consistent set of data coming from one market. Therefore, we believe that consistency adds weight and importance to our findings.

To continue analysis in terms comparable with other studies, we need to add four additional variables to the dataset. Those four variables are calculated with already existing data. Descriptions of those four additional variables are provided in Table 2.

We define new variables as:

Table 3: Summary statistics for relevant variables and economic factors.

	N	Mean	SD	Min	Max
ESG	88	0.5563	0.1617	0.1902	0.8739
BESG	72	2.5496	0.9660	0.8900	4.5500
ESG_ENV	88	0.5148	0.2514	0.0404	0.9501
ESG_SOC	88	0.5557	0.2087	0.0808	0.9119
ESG_GOV	88	0.6041	0.1993	0.1991	0.9513
NPL	80	0.0599	0.0319	0.0218	0.1587
LOAN	80	0.7114	0.1593	0.2979	1.2326
ALW	80	-0.0416	0.0176	-0.1019	-0.0105
$\Delta$ LOAN	80	0.0712	0.0920	-0.0750	0.5013
ROA	80	0.0144	0.0084	-0.0102	0.0410
CAPR1	88	0.1681	0.0270	0.0969	0.2360
GDP	88	0.0349	0.0262	-0.0200	0.0690
UNPL	88	0.0756	0.0269	0.0510	0.1340
INFL	88	0.0376	0.0463	-0.0060	0.1440

$$NPL_{i,t} = \frac{NPLA_{i,t}}{TGL_{i,t-1}}$$

$$LOAN_{i,t} = \frac{TGL_{i,t}}{TAA_{i,t-1}}$$

$$ALW_{i,t} = \frac{LLA}{TGL_{i,t-1}}$$

$$ROA_{i,t} = \frac{PT\_INC_{i,t}}{TAA_{i,t-1}}$$

Summary statistics for newly created variables and per period change in *LOAN* are presented in Table 3. In this table, we also present summary statistics for economic factors such as GDP growth in constant prices, unemployment, and inflation. Those variables are identical for each bank.

After extending the dataset with new variables and adding economy level data, we can proceed to model the relationship between non-performing loans ratio and bank and economy level variables.

Correlation data for relevant variables is presented in Figure 1. The lower triangle of the chart presents pairs of variables in data along with fitted linear regression with 95% confidence intervals. The upper triangle presents colour coded Pearson's correlation values. On the diagonal, we have non-parametric distributions for each variable. Several variables are uncorrelated. The strongest correlation is between ESG score variable and its distinctive environmental, social, and governance components. Another cluster of correlated variables consists of loan loss allowance, total gross loans, and pre-tax income.

We want to focus on the impact of ESG scores on non-performing loans in commercial banks. In the dataset, we have four variables related to ESG. First, we have Refinitiv ESG score (*ESG*) and its three pillars: environmental (*ESG\_ENV*), social (*ESG\_SOC*), and governance (*ESG\_GOV*). Independently, we also have Bloomberg ESG score (*BESG*). Note that ESG scores are, like any other scoring method, heavily dependent on how company level data are transformed into scoring for a given company. Given the proprietary nature of both Refinitiv

Figure 1: Correlogram for relevant variables in the dataset.

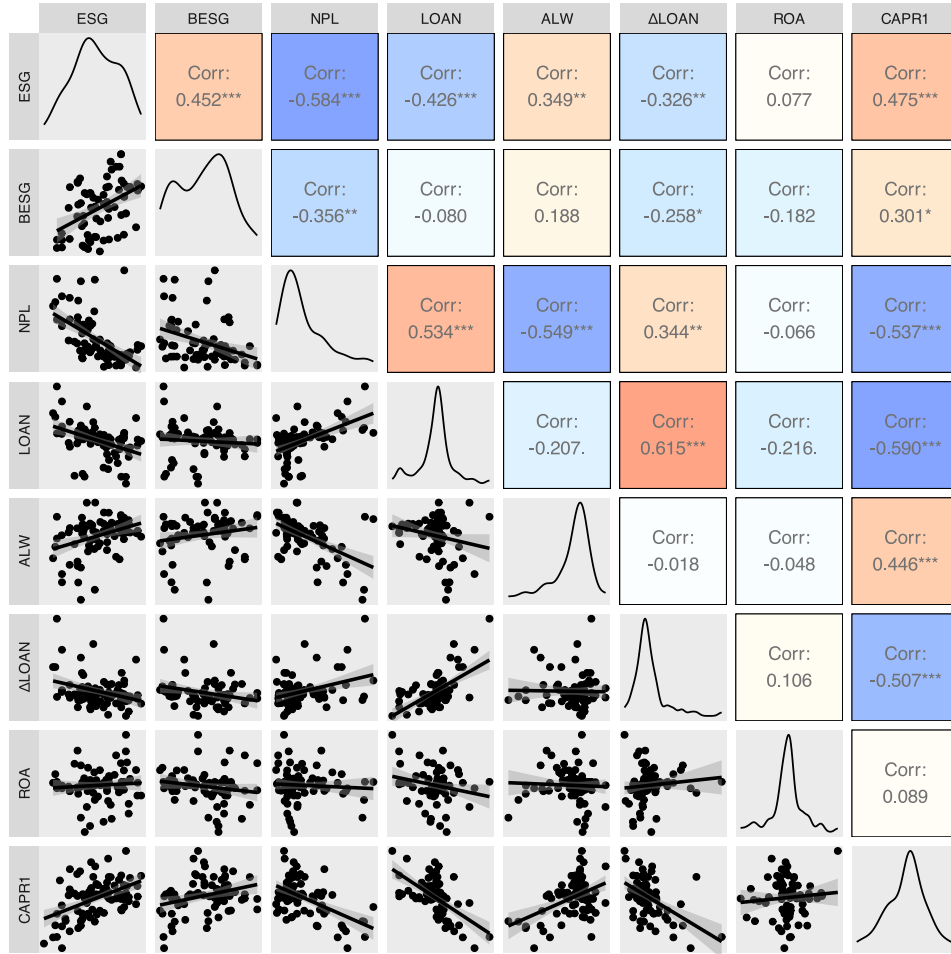
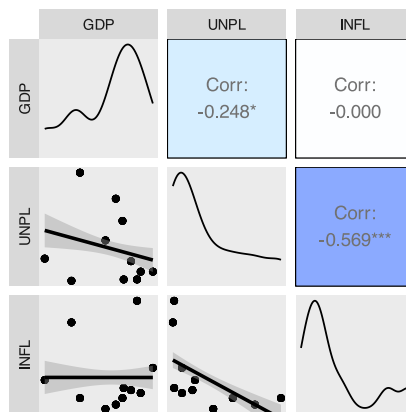
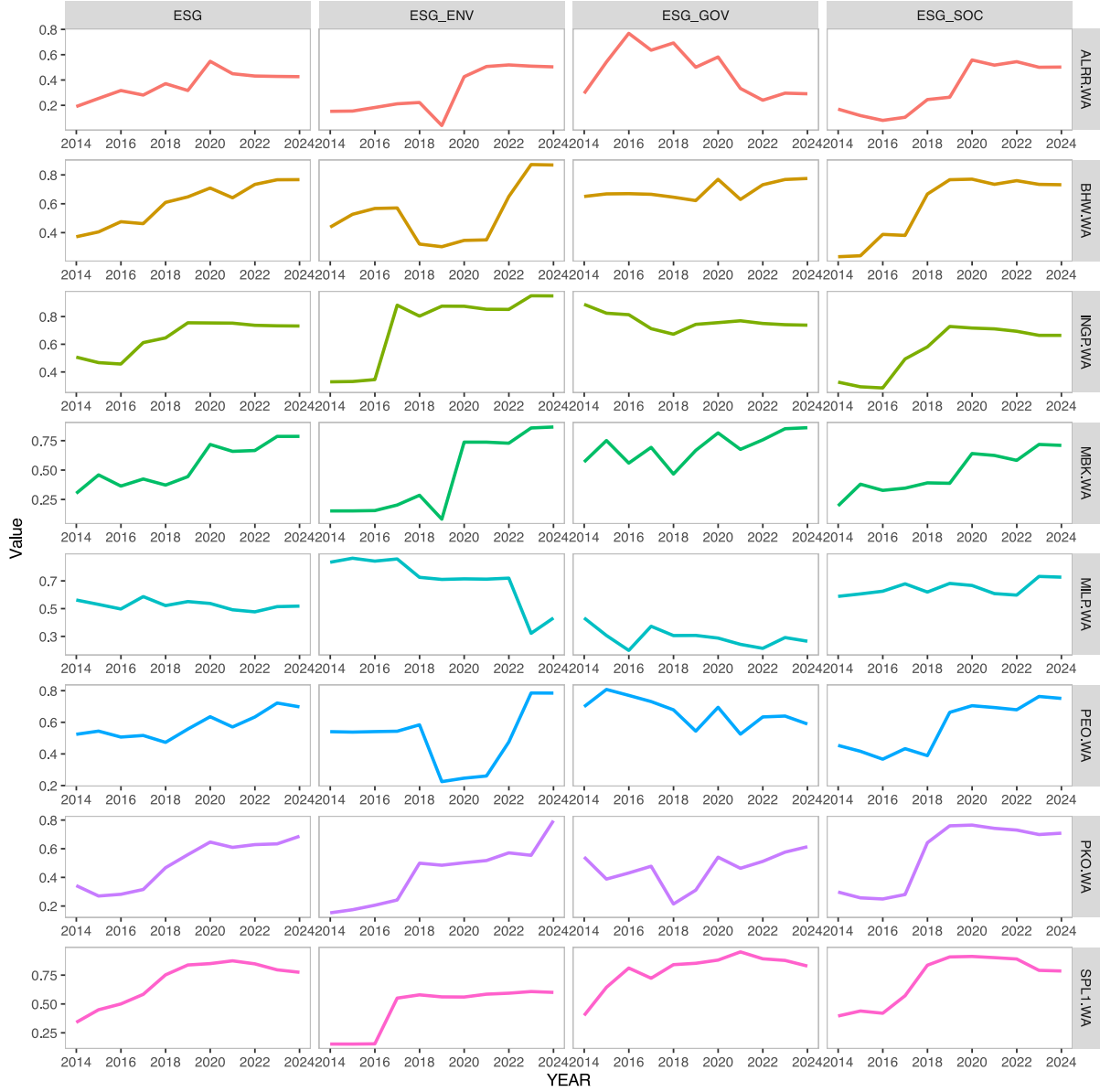


Figure 2: Correlogram for economy level variables in the dataset.



and Bloomberg scores, we have to take them for granted, without good understanding of the methodology used by each supplier. What is important is to note that those two measures are not correlated to the extent which would make us believe that they measure the same phenomenon. Figure 3 presents the graphical representation of ESG data for each bank in the sample.

Figure 3: Data on ESG scores and its components by bank.



Banks are named according to their symbols used on the Warsaw Stock Exchange. List of bank names is provided in Table 4. Most of commercial banks in Poland have foreign stakeholder and likely follow group guidelines for implementing ESG policies on local level. On the other hand, banks with local stakeholders have to develop their own standards and act accordingly. Part of the results section of this paper focuses on exploring the impact that this difference of ownership structure may have on ESG score impact on banks' activity.

ESG score is not a simple sum of scores per pillar. To make sure that there is a relevant relationship between pillar scores and summary ESG score in the sample, we consider model:

$$ESG_{i,t} = \beta_0 + \beta_1 ESG\_ENV_{i,t} + \beta_2 ESG\_SOC_{i,t} + \beta_3 ESG\_GOV_{i,t} + \varepsilon_{i,t}. \quad (1)$$

Table 4: Bank symbols and bank names.

Symbol	Name	Stakeholder
ALR.WA	Alior Bank	until 10/2015 foregin then local: PZU
BHW.WA	Bank Handlowy	Citibank
INGP.WA	ING Bank Polska	ING Groep
MBK.WA	mBank	Commerzbank
MLP.WA	Bank Millennium	Banco Comercial Português
PEO.WA	Bank Pekao	until 06/2017 foreign then local: PZU, PFR
PKO.WA	PKO Bank Polski	local: state
SPL1.WA	Santander Bank Polska	Santander Group

The estimation results are presented in Table 5. ESG scores for three ESG pillars are from Refinitiv database. Results clearly demonstrate that Bloomberg and Refinitiv ESG scores are not properly correlated. Likely approach to calculating the score by Bloomberg and Refinitiv differ substantially. On one hand, it is surprising because ESG scores are supposed to measure the same characteristic of each bank. On the other hand, SFDR directive guidelines do not provide solid basis for unequivocal rules for such calculations. Refinitiv ESG scores on per pillar level almost fully explain changes in total ESG score calculated by Refinitiv. Social pillar score has the strongest influence on the total final ESG score.

## Research methodology

The focus of the study was to investigate the relationship between the non-performing loans ratio for the commercial banks in Poland and other factors considered relevant to non-performing loans ratio. Those factors can be either bank-specific or the same for each bank on market level. The dataset presented in the previous section consists of variables in both of those categories. The factor on which we will focus will be the impact of ESG score on non-performing loans.

In general, economic factors influence the current situation of bank customers, so those factors should correspond to the current level of non-performing loans ratio. Similar situation occurs on the bank side with *ROA* and capital adequacy ratio (*CAPR1*). Those two factors reflect upon current economic condition of a bank. All other factors are considered as influencing next period non-performing loans ratio. Therefore, the initial regression model we want to consider is:

$$\begin{aligned}
NPL_{i,t} = & \beta_0 + \beta_1 ESG_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 LOAN_{i,t-1} + \beta_4 ALW_{i,t-1} \\
& + \beta_5 \Delta LOAN_{i,t} + \beta_6 ROA_{i,t} + \beta_7 CAPR1_{i,t} \\
& + \beta_8 GDP_t + \beta_9 UNPL_t + \beta_{10} INFL_t + \epsilon_{i,t}
\end{aligned} \tag{2}$$

In this initial model, we include all variables and follow the assumption about time-structure of impact on non-performing loans ratio as presented above. This model is a starting point. Next step is verifying statistical relevance of included variables and possibly reducing the model to capture only those relationships that have meaningful impact on non-performing loans ratio. Therefore, we will explore several regressions pooling all data in the dataset. This leads to the reduced form model

$$NPL_{i,t} = \beta_0 + \beta_1 ESG_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 LOAN_{i,t-1} + \beta_4 ALW_{i,t-1} + \epsilon_{i,t} \tag{3}$$

for which we will investigate relevance of panel structure of the dataset. In particular, we will estimate random effects and fixed effects models and test their relevance.



Table 5: Results of regression of Refinitiv and Bloomberg ESG scores against ESG component scores.

	ESG	BESG	ESG vs BESG
(Intercept)	−0.028*** (0.004)	1.106* (0.418)	0.408*** (0.046)
ESG_ENV	0.142*** (0.005)	1.482** (0.475)	
ESG_SOC	0.549*** (0.007)	1.365* (0.600)	
ESG_GOV	0.341*** (0.006)	−0.324 (0.487)	
BESG			0.071*** (0.017)
Num.Obs.	88	72	72
R2	0.996	0.301	0.204
R2 Adj.	0.996	0.270	0.193
AIC	−548.7	182.6	−78.4
BIC	−536.3	193.9	−71.5
Log.Lik.	279.329	−86.277	42.176
F	7034.255	9.762	17.931
RMSE	0.01	0.80	0.13
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001			

As we previously stated, ESG scores are supposed to measure the quality of economic, social, and governance activities. Regulations introducing such reporting into the regulatory framework, such as Sustainable Finance Disclosure Regulation (SFDR) and Corporate Sustainability Reporting Directive (CSRD), do not provide specific measures that need to be applied. Therefore, one can assume that there may be substantial differences in calculations of ESG scores as presented in Table 5. The correlation between Refinitiv’s ESG score ( $ESG$ ) and Bloomberg’s ESG score  $BESG$  is surprisingly small, given those two variables are supposed to measure the same phenomenon. The simplest way of resolving this issue is to use 2SLS and estimate model with instrumental variable for  $ESG_{i,t-1}$ . We follow the approach adopted by Liu et al. (2023).

Final step is investigating impact of foreign stakeholders on importance of ESG in activities of commercial banks in Poland. This problem can be addressed in two ways – either estimating separate regressions for banks controlled by local and foreign stakeholders or by introducing dummy variable for banks controlled by foreign stakeholders. In the first case, we allow for variation of coefficients between two groups while in the second case, value of coefficient for the dummy variable measures difference between non-performing loans ratio between two groups.

## Results and discussion

Our starting point is the model stated in (2). Only a few variables in pooling regression for a wide set of data demonstrate statistical significance. Therefore, we may want to explore restricting the set of variables to increase statistical significance of obtained estimates. The summary of those estimations is provided in Table 6.

Clearly, dropping several variables had a very limited effect on  $R^2$ . We can think about it as lack of significance in explaining changes of  $NPL$  over time and across banks. That justifies settling

Table 6: Pooling regressions results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Intercept)	0.066 (0.055)	0.042 (0.034)	0.034 (0.031)	0.020 (0.023)	0.021 (0.023)	0.015 (0.021)	0.016 (0.022)
lag(ESG)	−0.043+ (0.024)	−0.044+ (0.024)	−0.040+ (0.023)	−0.036 (0.022)	−0.041+ (0.021)	−0.042* (0.021)	−0.047* (0.021)
lag(NPL)	0.233+ (0.125)	0.236+ (0.124)	0.235+ (0.123)	0.235+ (0.123)	0.246* (0.121)	0.245* (0.120)	0.242* (0.121)
lag(LOAN)	0.025 (0.024)	0.029 (0.023)	0.031 (0.022)	0.032 (0.022)	0.031 (0.022)	0.037+ (0.021)	0.045* (0.020)
lag(ALW)	−0.520* (0.207)	−0.561** (0.191)	−0.572** (0.189)	−0.562** (0.188)	−0.539** (0.183)	−0.507** (0.178)	−0.491** (0.179)
ΔLOAN	0.040 (0.039)	0.048 (0.036)	0.043 (0.034)	0.042 (0.034)	0.048 (0.033)	0.042 (0.032)	
ROA	−0.245 (0.351)	−0.273 (0.345)	−0.274 (0.344)	−0.274 (0.342)	−0.279 (0.340)		
CAPR1	−0.088 (0.163)						
GDP	−0.077 (0.108)	−0.067 (0.106)					
UNPL	−0.237 (0.255)	−0.199 (0.244)	−0.163 (0.237)				
INFL	−0.078 (0.081)	−0.065 (0.077)	−0.065 (0.077)	−0.038 (0.066)			
Num.Obs.	72	72	72	72	72	72	72
R2	0.568	0.565	0.563	0.559	0.557	0.552	0.540
R2 Adj.	0.497	0.502	0.507	0.511	0.516	0.519	0.513
AIC	−329.7	−331.3	−332.9	−334.3	−336.0	−337.2	−337.3
BIC	−302.4	−306.3	−310.1	−313.8	−317.7	−321.3	−323.6
RMSE	0.02	0.02	0.02	0.02	0.02	0.02	0.02

+ p &lt; 0.1, \* p &lt; 0.05, \*\* p &lt; 0.01, \*\*\* p &lt; 0.001

Table 7: Regression results for random and fixed effects models.

	Pooling	Pooling	Fixed	Fixed	Random	Random
(Intercept)	0.066 (0.055)	0.016 (0.022)			0.018 (0.065)	0.013 (0.028)
lag(ESG)	−0.043+ (0.024)	−0.047* (0.021)	−0.002 (0.035)	−0.037 (0.025)	−0.019 (0.031)	−0.040+ (0.022)
lag(NPL)	0.233+ (0.125)	0.242* (0.121)	0.054 (0.136)	0.123 (0.127)	0.120 (0.128)	0.179 (0.121)
lag(LOAN)	0.025 (0.024)	0.045* (0.020)	0.024 (0.046)	0.046 (0.039)	0.041 (0.036)	0.053* (0.026)
lag(ALW)	−0.520* (0.207)	−0.491** (0.179)	−0.173 (0.333)	−0.189 (0.301)	−0.421 (0.265)	−0.423+ (0.213)
ΔLOAN	0.040 (0.039)		0.009 (0.040)		0.023 (0.038)	
ROA	−0.245 (0.351)		−0.077 (0.422)		−0.138 (0.388)	
CAPR1	−0.088 (0.163)		0.015 (0.200)		0.006 (0.185)	
GDP	−0.077 (0.108)		0.040 (0.113)		−0.006 (0.108)	
UNPL	−0.237 (0.255)		0.166 (0.285)		−0.010 (0.262)	
INFL	−0.078 (0.081)		−0.122 (0.088)		−0.096 (0.083)	
Num.Obs.	72	72	72	72	72	72
R2	0.568	0.540	0.216	0.149	0.281	0.343
R2 Adj.	0.497	0.513	−0.031	−0.007	0.163	0.304
AIC	−329.7	−337.3	−343.7	−349.8	−336.7	−342.5
BIC	−302.4	−323.6	−318.6	−338.4	−309.4	−328.8
RMSE	0.02	0.02	0.02	0.02	0.02	0.02

+  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

for the reduced form model stated in formula (3). All variables in the reduced form model are statistically significant. Observe also, that in all estimated pooling regression models coefficients for  $ESG$  are negative. That is, higher ESG score reduces non-performing loans ratio.

Dataset has panel structure. Therefore, a natural next step is to explore whether fixed or random effects model could provide better insight into the relationship between non-performing loans ratio and other variables. In this case, we will focus on the reduced form model (3).

Random effects model requires transformation of variables in the estimation process. Amemiya method (**source**) is time-consuming and requires estimation of several GMM models. Nevertheless, we use as it is efficient.

The key takeaway from results presented in Table 6 and Table 7 is consistently negative sign of  $ESG_{i,t-1}$  coefficient, that is  $lag(ESG)$ . We have no basis for rejecting hypothesis  $H1$ . To further support it, we can consider 2SLS estimation with various instruments for  $ESG$ .

Table 8: Comparison of 2SLS instrumental variable regressions and pooling regression.

	Pooling	lag(lag(ESG))	lag(ESG_SOC)	lag(BESG)
(Intercept)	0.016 (0.022)	0.019 (0.024)	0.032 (0.024)	0.061 (0.054)
lag(ESG)	−0.047* (0.021)	−0.051* (0.025)	−0.067** (0.025)	−0.107+ (0.063)
lag(NPL)	0.242* (0.121)	0.234+ (0.125)	0.197 (0.126)	0.077 (0.180)
lag(LOAN)	0.045* (0.020)	0.045* (0.020)	0.042* (0.020)	0.042+ (0.024)
lag(ALW)	−0.491** (0.179)	−0.489** (0.179)	−0.481** (0.180)	−0.532* (0.201)
Num.Obs.	72	72	72	64
R2	0.540	0.540	0.534	0.490
R2 Adj.	0.513	0.513	0.507	0.455
AIC	−337.3	−337.3	−336.2	−289.2
BIC	−323.6	−323.6	−322.6	−276.3
RMSE	0.02	0.02	0.02	0.02

+  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

## Instrumental variables and 2SLS

In this section, we extend analysis using instrumental variables for  $ESG_{i,t-1}$  and 2SLS estimation. Liu et al. (2023) in their research decided to use  $ESG_{i,t-2}$  as the instrument. In Table 5, we demonstrated that the social component is the most relevant part of the ESG score. That will be the second instrument we want to consider. Finally, we also use Bloomberg ESG score as instrument. In all three cases, we have to be aware of limitations of those instruments. We attempt to measure very complex changes in the way companies operate with a single measure. Moreover, this measure is standardized with the scoring process.

Plotted confidence intervals for parameter estimates demonstrate that, all three approaches to the estimation provide quite similar results. What is more important, again estimates for  $ESG_{i,t-1}$  remain negative. Only in case of Bloomberg ESG score used as the instrument for ESG, 95% confidence interval presented in Figure 4, includes positive numbers.

## Components of ESG score

Our second hypothesis is related to impact of components of ESG score – environmental, social, and governance. Note that regressions presented in Table 5 demonstrates that all statistically relevant coefficients for components of ESG are positive. That leads us to regressing non-performing loans ratio against individual ESG components. Results are presented in Table 9.

All coefficients of reduced form model remain statistically significant. Moreover, all estimates for individual ESG factor are also negative, but not statistically significant in all cases. We have no basis to reject hypothesis **H2**. Statistical significance of social component of ESG is in line of estimation of relationship between ESG and its components.

## Splitting the set of banks – local vs foreign stakeholders

In this section, we want to run an experiment and split the set of banks into two subsets. One subset will consist of banks controlled by Polish stakeholders and the other group will consist of

Figure 4: Graphical summary of IV models.

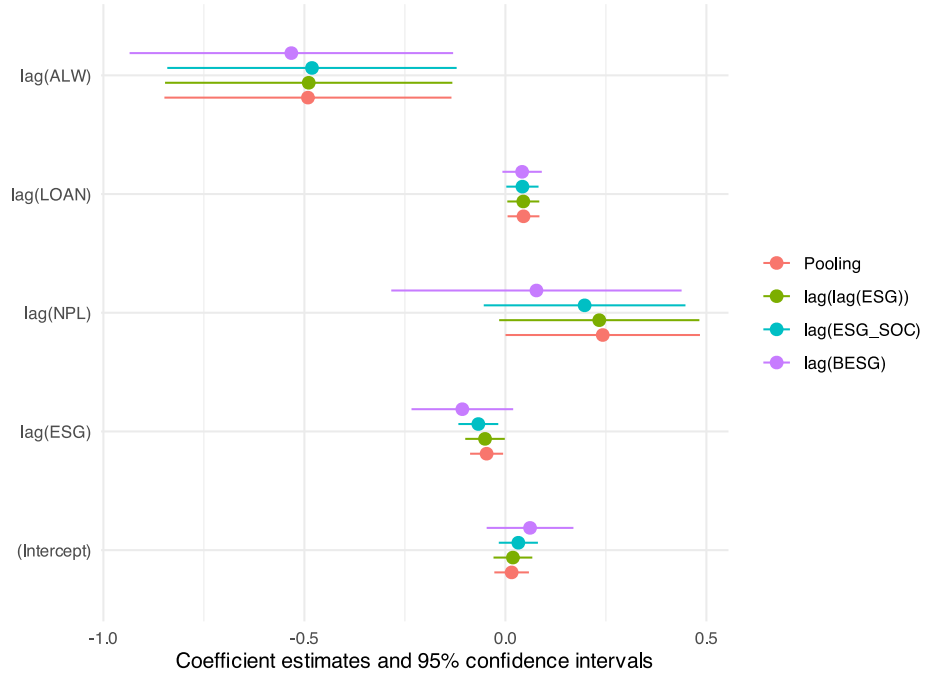


Table 9: Pooling regressions including component ESG factors.

	ESG	Environment	Social	Governance
(Intercept)	0.016 (0.022)	−0.011 (0.017)	0.012 (0.018)	−0.020 (0.018)
lag(ESG)	−0.047* (0.021)			
lag(NPL)	0.242* (0.121)	0.335** (0.116)	0.225+ (0.119)	0.340** (0.118)
lag(LOAN)	0.045* (0.020)	0.050* (0.020)	0.046* (0.019)	0.051* (0.021)
lag(ALW)	−0.491** (0.179)	−0.446* (0.193)	−0.504** (0.176)	−0.516** (0.186)
lag(ESG_ENV)		−0.014 (0.012)		
lag(ESG_SOC)			−0.041** (0.015)	
lag(ESG_GOV)				−0.003 (0.014)
Num.Obs.	72	72	72	72
R2	0.540	0.515	0.556	0.505
R2 Adj.	0.513	0.486	0.530	0.476
AIC	−337.3	−333.4	−339.8	−332.0
BIC	−323.6	−319.7	−326.2	−318.4
RMSE	0.02	0.02	0.02	0.02

+  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Table 10: Regression results for ESG split between banks controlled by local and foreign stakeholders.

	Local	Foreign
(Intercept)	−0.020* (0.008)	−0.033*** (0.006)
ESG_ENV	0.127*** (0.011)	0.148*** (0.007)
ESG_SOC	0.555*** (0.011)	0.547*** (0.009)
ESG_GOV	0.336*** (0.011)	0.344*** (0.007)
Num.Obs.	27	61
R2	0.997	0.996
R2 Adj.	0.996	0.995
AIC	−174.3	−371.3
BIC	−167.9	−360.7
Log.Lik.	92.165	190.644
F	2453.189	4297.629
RMSE	0.01	0.01
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001		

banks controlled by foreign stakeholders. The first group is ALRR.WA, PEO.WA, and PKO.WA. Note that those banks were not controlled by local stakeholder in all periods in the sample. All other banks belong to the second group.

First, we run regression on ESG indicators data.

Components of ESG behave similarly in both groups, and therefore we can believe that the relationship has the same properties in both groups. Then we repeat the exercise with pooling regression on data for banks with polish stakeholders and foreign stakeholders.

Again, estimates for  $ESG|_{i,t-1}$  remain negative. Graphical representation of confidence intervals for those estimates is presented in Figure 5. It further confirms our inability to falsify hypothesis **H1**. Interestingly,  $R^2$  for the group of banks controlled for foreign stakeholders is much lower than for banks controller by local stakeholders. One can think that international banking groups have to focus on all-around ESG measures that fit all markets and therefore their non-performing loans ratios are far less dependent on ESG measures on local level. On the other hand, locally controlled banks are more concerned with their non-performing loans ratios and therefore the relationship between non-performing loans ratios and ESG scores is stronger.

Now we have some differentiation between two groups of banks, but other than Loan Loss Allowance the differences are minimal. The natural next step is to introduce a dummy variable for banks controlled by foregin stakeholders, but the effect is statistically not relevant.

The last exercis we conduct is running pooling regrssions with a dummy variable for foreign stakeholders.

The results, presented in Table 12, confirm all observations presented earlier in the paper. We can conlude that we have no basis for rejecting **H1** hypothesis. It implies that ESG scores are relevant to determining non-performing loans ratios. The social component is the most important here. We can interpret is as impact of how employees of a bank interact with its environment and how they are willing to cooperate with banks' clients in resolving and addressing their problems.

Table 11: Pooling regressions split by stakeholders.

	All	Local	Local	Foreign	Foreign
(Intercept)	0.066 (0.055)	0.195 (0.116)	−0.022 (0.046)	−0.005 (0.069)	0.045+ (0.026)
lag(ESG)	−0.043+ (0.024)	−0.152** (0.044)	−0.073+ (0.039)	−0.005 (0.032)	−0.029 (0.024)
lag(NPL)	0.233+ (0.125)	0.235 (0.194)	0.197 (0.201)	−0.004 (0.166)	0.053 (0.154)
lag(LOAN)	0.025 (0.024)	0.008 (0.065)	0.091+ (0.047)	0.026 (0.029)	0.021 (0.023)
lag(ALW)	−0.520* (0.207)	−0.464 (0.290)	−0.753** (0.216)	0.006 (0.429)	−0.125 (0.324)
ΔLOAN	0.040 (0.039)	0.075 (0.043)		−0.013 (0.064)	
ROA	−0.245 (0.351)	−1.125* (0.460)		0.044 (0.494)	
CAPR1	−0.088 (0.163)	−0.162 (0.326)		0.125 (0.201)	
GDP	−0.077 (0.108)	−0.283* (0.118)		0.125 (0.154)	
UNPL	−0.237 (0.255)	−0.820* (0.378)		0.229 (0.392)	
INFL	−0.078 (0.081)	−0.018 (0.084)		−0.080 (0.116)	
Num.Obs.	72	24	24	47	47
R2	0.568	0.928	0.855	0.133	0.074
R2 Adj.	0.497	0.872	0.825	−0.108	−0.014
AIC	−329.7	−128.1	−123.5	−207.1	−216.0
BIC	−302.4	−114.0	−116.4	−184.9	−204.9
RMSE	0.02	0.01	0.01	0.02	0.02

+ p &lt; 0.1, \* p &lt; 0.05, \*\* p &lt; 0.01, \*\*\* p &lt; 0.001

Figure 5: Graphical summary of estimation for local and foreign stakeholders.

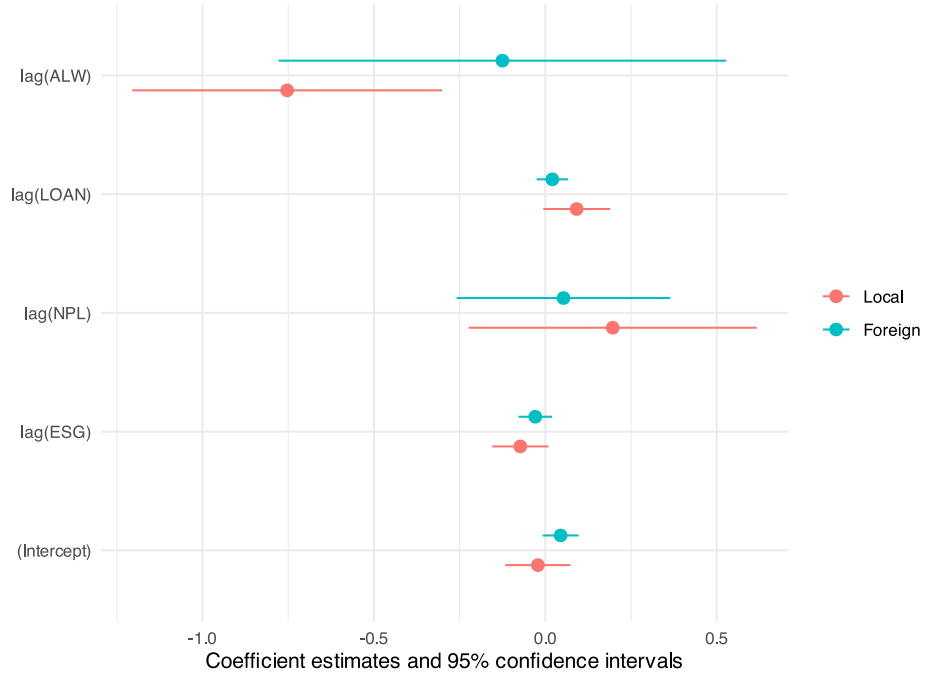


Table 12: Regressions with dummy variable for foreign stakeholders.

	Pooling	Fixed	Random
(Intercept)	0.013 (0.023)		0.003 (0.039)
lag(ESG)	-0.048* (0.021)	-0.036 (0.024)	-0.037 (0.023)
lag(NPL)	0.241+ (0.122)	0.052 (0.129)	0.111 (0.122)
lag(LOAN)	0.046* (0.020)	0.052 (0.038)	0.059+ (0.033)
lag(ALW)	-0.522* (0.201)	-0.214 (0.294)	-0.356 (0.263)
FOREIGN	0.002 (0.007)	0.035+ (0.018)	0.015 (0.013)
Num.Obs.	72	72	72
R2	0.541	0.202	0.213
R2 Adj.	0.506	0.040	0.153
AIC	-335.4	-352.4	-345.7
BIC	-319.5	-338.8	-329.8
RMSE	0.02	0.02	0.02
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001			



Companies with high environmental score pay attention to limiting their carbon footprint and general awareness to environmental issues. Companies with high governance score follow rules of proper governance structure. In both cases, it may help improve their business conduct, but the social score has the more direct relationship. Paying more attention to social interaction within a bank also improves relationships with banks' customers.

## Conclusions

This study investigated the relationship between the non-performing loans (NPL) ratio for the commercial banking sector in Poland. We investigated the influence of ESG score on non-performing loans ratio. Independently of a method used for estimation of the relationship, we found that improving ESG score also lowers non-performing loans ratio. Therefore, we can conclude that we have no basis for rejecting both hypothesis that we stated at the beginning of this paper – ESG score ultimately improves non-performing loans ratio and all ESG components have the same improving effect. One has to keep in mind that the impact of the social component is the strongest. Therefore, focusing on social score may improve performance of a credit portfolio.

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