CLIMATE POLICY RELEVANT SECTORS IN THE POLISH COMMERCIAL BANKS

Abstract
The aim of the study is to estimate credit exposures and their changes in commercial banks' portfolios in terms of sectors important for climate policy, which exposes them to the risk of transition in Poland in 2013-2022. The research concerned the analysis of changes in the structure of the loan portfolio in terms of sectors relevant to climate change (CPRS) broken down by groups (green, black, brown, dirty), industries (fossil fuels, utility-electricity, production, manufacturing, transportation, agriculture), and types of activity divided into sections. The CPRS methodology was applied (Battiston), which is used in EiOPA, ECB, EBA. The share of green exposures of the entire banking sector in 2013-2022 increased (to 49%) and the share of dirty exposures decreased (to 51%). Due to the link between the sections, the three pillars of industries with the greatest risk to transformation among the CPRS were: buildings, transportation and manufacturing.

Keywords: Credit portfolio, CPRS, transformation risk

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Introduction

Climate policy in the real sphere of enterprises and households is treated as a wide range of ESG (environmental, social and corporate governance, ESG) relations. The ESG risk in financial institutions, including the banking sector, is understood as the risk of negative financial effects of the impact of ESG factors on customers and counterparties or balance sheet positions of banks.

Directly exposed to ESG risks in banks are loan portfolios of enterprises operating in high-emission industries, i.e. emitting greenhouse gases (GHG). Climate risk management (climate-related risk) is supported by all committees functioning in a bank. The effect of banks' activities in the area of ESG is also the promotion of corporate social responsibility (CSR) activities.

The changes introduced in connection with the implementation of Basel IV in the EU (Regulation (EU) No 575/2013 of the European Parliament and of the Council, Directive 2013/36/EU of the European Parliament and of the Council) imposed on banks the obligation to proceed with climate risks in the risk management system. The ESG climate risk is also treated as a challenge for financial stability. The European Systemic Risk Board (ESRB) and the European Central Bank (ECB) are actively involved in analysing and monitoring the impact of climate risk on the financial system, identifying it as one of the main systemic risks in the European Union (EU). These risks also require banks to develop appropriate strategies and change business models to minimise climate risks.

The aim of the study is to estimate credit exposures and their changes in commercial banks' portfolios in terms of sectors important for climate policy in Poland in 2013-2022.

1. Review of literature

In view of the adoption of the Paris Agreement, which crowns the 21st UN Climate Change Conferences, and the commitment to achieve carbon neutrality by 2050, EU bodies are taking several legislative actions, including those addressed to banks (Council Decision (EU) 2016/1841 of 5 October 2016). The European Banking Authority (EBA) focuses...
on how risks related to climate change, legal regulations and reputational risks will affect and manage financial and non-financial risks at bank level.

Currently, legal regulations regarding the ESG can be found, among others, in the SFDR Regulation (Sustainable Finance Disclosure Resolution), the EU Taxonomy or the TCFD Guidelines (Task Force on Climate – Realated Financial Disclosures). Since May 2020, the European Central Bank (ECB) guidelines on climate-risk disclosures have been in force. In March 2021, the Regulation on sustainability-related disclosures in the financial services sector entered into force, and from June 2022, ESG risk disclosures are part of the so-called third pillar disclosures under CRR 2. As of 30 June 2021, the guidelines for granting and monitoring loans (EBA/GL/2020/06) became applicable to financial institutions.

In the case of the report and opinion published by the EBA on 1 March 2021, a methodology for calculating a new efficiency indicator in banks’ operations, i.e. the green asset ratio (GAR), was proposed. This measure is intended to determine whether the operations of a given bank qualify as environmentally sustainable within the meaning of the relevant provisions of Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment. The proposed ratio reflects the share of assets related to the financing of environmentally sustainable investments in the total balance sheet exposure of an institution (taking into account specific inclusions).

The EBA documents also propose performance indicators relating to environmental sustainability in the context of a bank’s off-balance sheet activities, its trading book and income from non-lending activities or asset management. The transitional period for banks’ adaptation to the new requirements should end in December 2022 or June 2024, depending on the type of indicator. During this time, starting from January 2022, banks are obliged to publish the information specified in the documents.

The literature on ESG and climate risk is extensive (Table 1). The climate risk can affect the financial system and the real economy through two risk channels (types). The physical risk includes the economic costs and financial losses resulting from the increasing severity and frequency of extreme weather events caused by the climate change. The transition risk is related to the costs generated by the need to adapt the economy to a more sustainable and low-carbon development path. In opinion Monasterrollo and Battiston (2020, pp. 52-72), there are several reasons why the risk of transfer is revealed, e.g. if the transition is late and sudden (ESRB, 2016) and thus "disordered" (NGFS, 2019).
Table 1. ESG and climate risks and interactions with other risks

<table>
<thead>
<tr>
<th>Risk type</th>
<th>Physical risk</th>
<th>Transition risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>– severe weather events and long-term changes in weather patterns can contribute to:</td>
<td>– new climate regulations, technologies and market sentiment can contribute to:</td>
</tr>
<tr>
<td>Credit</td>
<td>Decrease in the value of collateral, which in turn increases credit risk through higher LGD.</td>
<td>The emergence of the so-called &quot;stranded&quot; assets in industries with high CO₂ emissions, which in turn increases the probability of default (through lower debt sustainability) and LGD (through lower collateral value).</td>
</tr>
<tr>
<td>Market</td>
<td>Impairment of assets and growth in volatility of e.g., commodities and/or FOREX.</td>
<td>The emergence of &quot;stranded&quot; assets in industries with high CO₂ emissions, which cause a sudden need to reassess e.g., equity and/or the bond market.</td>
</tr>
<tr>
<td>Operating</td>
<td>Destruction of real estate (e.g., bank branches), data center and operations.</td>
<td>Increase operational risk, e.g., by outsourcing selected activities or processes.</td>
</tr>
<tr>
<td>Other</td>
<td>Macroeconomic shocks increasing liquidity risk.</td>
<td>Negative impact on the reputation of an institution, e.g., in connection with the so-called &quot;green washing&quot;.</td>
</tr>
</tbody>
</table>

Source: The author’s own compilation.

In view of the financial risk, including losses in assets and disruptions in the supply chain as a result of weather outbreaks (Adrian et al., 2022; NGFS, 2020; Oswald et al. 2020; Riksbank, 2019; Xu et al., 2018; Nordhaus, 2017), weather phenomena may also generate losses for insurance institutions, i.e. financial risk in terms of underestimated costs of paying compensation for losses caused by floods, storms and droughts, as well as lending institutions (banks) and asset managers related to asset impairment or bankruptcies of borrowers caused by climate change (IMF, 2022; Bank of England, 2021; Kalkuhl et al. 2020; Monasterolo, 2019; NGFS, 2019; Hsiang et al. 2017; OECD, 2015).

Research into estimating banks' exposure to climate risk mostly uses two identification approaches: carbon dioxide (CO₂) emitters and carbon-intensive industries (according to NACE), such as Battiston et al. (2017). The initial stage of assessing the level of climate risk often involves surveys addressed to financial institutions³. Battiston et al. (2022)

³ Empirical research on the ESG risk in the financial sector, including towards banks, is at its preliminary stage. These studies focus, inter alia, on transition risks for corporate clients (enterprises) in the face of difficulties in obtaining data from individual customers.
emphasize that low-carbon transition policies are expected to affect economic sectors in very different ways (IPCC, 2014, 2018, 2022). For instance, there is a consensus that achieving the Paris Agreement climate target requires the electricity sector to expand and the fossil fuel sector to shrink. However, differences are also expected within these sectors depending on specific climate mitigation scenarios and the technology used to produce energy and electricity.

The slow process of upgrading the building infrastructure used by businesses and households to achieve lower energy intensity sustains increased transition risks, which over time culminate in an increase in financial risk (Battiston, et al. 2019; ESRB, 2016).

According to Monasterolo (2020), the climate transition risk refers to the risk associated with a disorderly low-carbon transition in which changes in the values of financial assets (respectively, negative for fossil fuels and positive for renewable energy technologies) cannot be fully anticipated or hedged by market players. There are several reasons for the lack of anticipation, including climate policy uncertainty; a late-and-sudden alignment to climate targets (e.g. 2 degrees C) due to the complexity of the policy process; incomplete markets (e.g. insurance); a deep uncertainty of future climate impacts on technological developments and social dynamics.

Moreover, Battiston et al. (2022) underline that, however, the same activity can be carried out with different technologies (e.g. coal-fired power plants or wind turbines). In the context of climate policies, the specific technologies used in the production process are very relevant because they are associated with very different levels of GHG emissions and transition risk. Financial institutions hold securities and loans associated with firms and these data typically come with the classification of firms in terms of their NACE codes or other similar economic classification systems. However, ISIC (International System of Industrial Classification), NACE (Statistical Classification of Economic Activities in the European Community) or NAICS (North American Industrial Classification System) economic classifications were not designed to disclose climate-relevant information and do not provide an identification of the activities that are exposed to the climate transition risk and could become "carbon stranded assets". Therefore, a specific use of NACE codes is required to identify sectors relevant to the climate policy. The main assumptions for mapping these sectors according to Battiston et al. (2022) are presented in Table 2-3.
Moreover, attempts to link economic activities with their emissivity can be found, among others, in process-based Integrated Assessment Models (IAM). According to Weyant (2017) and Krey (2014), these models are widely used to generate possible future trajectories of output of economic activities based on their energy technology (e.g., fossil fuels or renewables). Recently, IAM trajectories have been used to inform climate financial valuation adjustment and climate financial risk assessment in climate stress tests. The first approach to use the trajectories of IAM in the climate stress-tests of financial institutions was developed by Battiston et al. (2017). Since 2020, process-based IAM have been used by the NGFS to build climate mitigation scenarios (NGFS, 2020, 2021) which are recommended for use by the financial industry and by financial supervisors in their climate stress test exercises (Allen et al., 2020, Clerc et al., 2021, Alogoskoufis et al., 2021, Vermeulen et al., 2021).

The participation of banks in financing business activities through various types of loans and the management of assets of climate-sensitive customers identifies banks as participants in ESG issues. Therefore, banks’ lending policies require the financial supervision of ESG risks (EBA, 2021; NGFS, 2020a, 2020b, 2020c).

From the point of view of financial stability, the ESG risk can be assessed as part of management. The standard is insurance against fortuitous events, assets and fixed assets securing financial liabilities. This applies to mortgage loans for real estate placed against collateral to protect against a fall in the value of this pledge or to guarantee the payment of compensation (ECB, 2022; ESRB, 2020; Giuzio et al. 2019; ECB, 2019).

2. Sectors Relevant to Climate Policy (CPRS)
An important method for determining exposure by groups, sectors, and sections sensitive to climate change is the Climate Policy Relevant Sectors (CPRS) method developed by S. Battiston and I. Monasterelo (2017), improved at the turn of 2019-2022, and used in the studies of EiOPA (2018), ECB (2019), and EBA (2020).

To identify the CPRS, guidelines have been prepared for the qualification of various operations according to the economic activity codes (NACE) (at the level of classes and subclasses), covering some different levels of disaggregation (Table 2).
Table 2. Levels of disaggregation for CPRS

<table>
<thead>
<tr>
<th>Groups (four)</th>
<th>CPRS Main</th>
<th>Individual sections</th>
<th>CPRS (dis-aggregation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• black (fossil fuels); • brown (electricity + manufacturing + transportation), • brownish (agriculture + buildings), • dirty (black + brown + brownish), • green</td>
<td>CPRS1-fossil-fuel, CPRS2-utility-electricity, CPRS3-manufacturing, CPRS4-buildings, CPRS5-transportation, CPRS6-agriculture</td>
<td>CPRS2 (NACE Rev2 level)</td>
<td>Granular</td>
</tr>
</tbody>
</table>

Source: Battiston et al. (2022)

The CPRS classification is widely used by practitioners and policymakers, based on the use of a classification of economic activities that is reproducible and comparable across portfolios and jurisdictions (Table 3).

Table 3. The list of sectors relevant for climate policy by code classification

<table>
<thead>
<tr>
<th>CPRS sectors</th>
<th>NACE rev. 2, 4 codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fossil-fuel</td>
<td>05, 06, 08.92, 09.10, 19, 35.2, 46.71, 47.3, 49.5</td>
</tr>
<tr>
<td>2 Utility-electricity</td>
<td>35.11, 35.12, 35.13</td>
</tr>
<tr>
<td>4 Buildings</td>
<td>23.6, 41.1, 41.2, 43.3, 43.9, 55, 68, 71.1</td>
</tr>
<tr>
<td>5 Transportation</td>
<td>29, 30, 33.15, 33.16, 33.17, 42.1, 45, 49.1, 49.2, 49.3, 49.4, 50, 51, 52, 53, 77.1, 77.35</td>
</tr>
<tr>
<td>6 Agriculture</td>
<td>01, 02, 03</td>
</tr>
</tbody>
</table>

Explanation: The table illustrates selected NACE codes for the first 6 CPRS Main categories. Note that when a 2-digit (or 3-digit) NACE code is indicated, it means that all 4-digit NACE codes contained in that code are mapped to the same CPRS. Source: Battiston et al. (2022).

The CPRS can be applied to all types of financial assets (e.g., stocks, loans, bonds) and geographic jurisdictions, thus making possible
comparisons across investors. The CPRS is also fully in line with the EU taxonomy for sustainable activities. Moreover, the CPRS shall provide a standardised and practical classification of activities (at NACE Rev2 level, 4-digit) on which revenues may have a positive or negative impact in a disorderly low-carbon transition, based on their energy technology (e.g., based on fossil fuels or renewable energy). For this reason, the CPRS classification is considered a benchmark for assessing the financial risks associated with climate change and has been used by several international financial institutions to assess investors’ exposure to climate transition risks. The use of CPRS methodology can be found in several reports, among other places.

- The European Central Bank (2019) provided in its June 2019 Financial Stability Report some preliminary estimates of financial institutions’ aggregate exposures to the CPRS, relative to their total shares in debt securities, ranging from 1% for banks to around 9% for mutual funds.
- The European Insurance and Occupational Pensions Authority, (EIOPA, 2018, pp. 1-88) reported the aggregated CPRS exposures of EU insurance companies of approximately 13% of their total securities shares.
- The European Banking Authority (EBA, 2020), in its assessment of the financial risk of the banking system of December 2020, used the CPRS methodology to analyse the temporary risk associated with €2.4 trillion of EU bank loans.

According to the results of the studies by Battiston et al. (2022) and Alessi et al. (2019) for the EU countries and non-financial corporations in 2013, 2015 and 2018, based on the CPRS methodology for the equity and bond portfolio, the highest degree of the transition risk was shown by the following sectors: industry, followed by transportation and fossil fuels; electricity and buildings were exposed to the risk to a lower degree.

It is worth emphasizing that by identifying credit exposures by groups, sectors and sections (CPRS), banks can estimate their exposure to ESG risks and make decisions regarding capital requirements and reserves.

3. Empirical framework for Polish banking sectors

3.1. Data

In this study of loan portfolio exposure, the methodology developed by Battiston et al. (2022), that is, a mapping from the NACE codes of economic activities into Climate Policy Relevant Sectors (CPRS) and into
the variables of the process-based Integrated Assessment Models (IAM), is used by the Network for Greening the Financial System (NGFS) to provide its climate scenarios (according to Table 2) standards ISIC, NACE or NAICS and refers to a production process, e.g., electric power generation.

Data on credit exposures come from the databases of the National Bank of Poland (NBP, 2023; NBP300). The empirical analysis uses NBP reporting data, including the NBP300 database, i.e. banks' reports on loans to non-financial corporations. The time series included quarterly data for Q4 2013 to Q2 2022 (35 quarters). The Stata statistical package was used to calculate individual CPRS disaggregation's. Data descriptive statistics are provided in the Table 4-5 and Figure 1.

Table 4: Summary Statistics, using the observations Q4 2013 – Q2 2022

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPRR</td>
<td>362.88</td>
<td>367.25</td>
<td>287.14</td>
<td>414.94</td>
</tr>
<tr>
<td>Dirty</td>
<td>192.21</td>
<td>195.25</td>
<td>157.88</td>
<td>212.01</td>
</tr>
<tr>
<td>Black</td>
<td>8.4387</td>
<td>7.5896</td>
<td>4.5084</td>
<td>15.970</td>
</tr>
<tr>
<td>Brown</td>
<td>79.369</td>
<td>82.194</td>
<td>58.877</td>
<td>90.414</td>
</tr>
<tr>
<td>Green</td>
<td>170.68</td>
<td>174.07</td>
<td>129.26</td>
<td>204.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Std. Dev.</th>
<th>C.V.</th>
<th>Skewness</th>
<th>Ex. kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPRR</td>
<td>35.563</td>
<td>0.09800</td>
<td>-0.47263</td>
<td>-0.94217</td>
</tr>
<tr>
<td>Dirty</td>
<td>13.267</td>
<td>0.06902</td>
<td>-1.04640</td>
<td>0.36113</td>
</tr>
<tr>
<td>Black</td>
<td>3.0440</td>
<td>0.36071</td>
<td>0.97019</td>
<td>0.37596</td>
</tr>
<tr>
<td>Brown</td>
<td>8.9961</td>
<td>0.11335</td>
<td>-0.94281</td>
<td>-0.17412</td>
</tr>
<tr>
<td>Green</td>
<td>23.558</td>
<td>0.13802</td>
<td>-0.13584</td>
<td>-1.42020</td>
</tr>
</tbody>
</table>

Source(s): Own calculations used StataSE 16.

Table 5: Correlation coefficients, using the observations Q4 2013 – Q2 2022, 5% critical value (two-tailed) = 0.3338 for n = 35

<table>
<thead>
<tr>
<th>CPRR</th>
<th>Dirty</th>
<th>Black</th>
<th>Brown</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0000</td>
<td>0.9387</td>
<td>-0.2294</td>
<td>0.9316</td>
<td>0.9810</td>
</tr>
<tr>
<td>1.0000</td>
<td>-0.1488</td>
<td>0.9754</td>
<td>0.8540</td>
<td>Dirty</td>
</tr>
<tr>
<td>1.0000</td>
<td>-0.2931</td>
<td>-0.2626</td>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>1.0000</td>
<td>0.8571</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0000</td>
<td>Green</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source(s): Own calculations used StataSE 16.
3.2. Changes in Climate Policy Relevant Sectors (CPRS)

The total value of CPRS exposures increased from PLN 287.1 billion in 2013 to PLN 414.9 billion in 2022, i.e. by 45%. Nearly 50% of these exposures belonged to the group of the so-called dirty exhibitions, mostly including manufacturing, buildings and transportation. The value of dirty exposures in the years under review increased from PLN 157.9 billion to PLN 212.0 billion, i.e. 34%. In turn green exposures rose from PLN 129.3 billion to PLN 202.9 billion, i.e. by 57.0%, which had a positive impact on reducing the risk of transformation. The lowest exposure value (almost throughout the study years) corresponded to the group of blacks (fossil-fuels). However, in recent years, this group has shown a strong rebound after the Covid-19 pandemic and the war in Ukraine, exposures jump to nearly PLN 16.0 billion in Q2 2022.

The upward trend of CPRS (according to the notation of the function $y = 3.2232x + 304.87$) depended mainly on the increase in the trend of green exposures ($y = 2.1327x + 132.29$) and dirty exposures ($y = 1.0905x + 172.58$), with the slow decline of black exposures ($y = -0.0425x + 9.2031$) (Figure 2).
Figure 2. The groups of CPRS credit exposures in Poland in Q4 2013- Q2 2022 (PLN billion)

Change trends of two key exposures: dirty and green, indicate that green exposures grew faster than dirty. Consequently, in several periods their values were equal, and in several periods the green values were higher.

If the current upward trend of green exposures is maintained \((y = 1.0905x + 172.58, \ R^2 = 0.7094)\), then, according to the forecast, in 2023 the share of dirty groups will exceed \((y = 2.1327x + 132.29, \ R^2 = 0.8606)\) (without further shocks) (Figure 3).
Figure 3. Dirty and green exposures in the years Q1 2013-Q2 2022 and their forecasts for Q3 2022-Q4 2035 (PLN billion)

Source(s): The author’s own calculations: NBP (2022), NB300 (2023).

A significant increase in the dynamics of the black exposure group amounted to 254% in Q4 2021 compared to Q4 2020 (y/y; with a negative base effect related to the Covid-19 pandemic) and fell slightly, to 230%, in Q2 2022 (y/y). After the calming of the macroeconomic situation and the reduction in energy commodity prices in the global economy, a decrease in the financing of this group of black exposures and negative dynamics (2016, 2018 or 2020) should be expected. On the other hand, the dynamics of brown and dirty exposures showed relatively stable fluctuations, with a rise in the green group (Figure 4).
In the years 2013–2022, dirty exposures gradually shrunk (from 55% to 51%), compared to an increase in green exposures (from 45% to 49%). Their average shares in the exposures of the banking sector were 53% and 47%, respectively. In contrast, the proportion of non-performing loans (NPLs) showed a slow decline from 11% to 7% and from 10% to 6%, respectively. The reduction in NPL exposure indicated an improvement in the ability to service loans, especially in the area of green exposure (a decrease by 4 pp), compared to a weaker one in dirty exposures (by 1 pp). These data therefore confirm a gradual increase in the share of green exposures against a fall in dirty exposures, with an improvement in their handling capacity. With continued growth, the share of green exposures in the banking sector may, according to the forecast \( y = 0.0017x + 0.4375, \ R^2 = 0.6768 \), reach a higher share than dirty exposures showing a weak but negative trend \( y = -0.0017x + 0.5625, \ R^2 = 0.6768 \) in 2023. In the case of these two exposures, but including non-performing loans (NPL), both groups showed similar downward trends (2013-2022). These changes were beneficial and showed an improvement in the quality of the banks’ loan portfolio. According to the forecasts for the dirty group (NPL), the function takes the form \( y = -0.009x + 0.1131, \ R^2 = 0.790 \), and for the green group (NPL) \( y = -0.009x + 0.0982, \ R^2 = 0.7462 \) (Figure 5).

\(^4\) Of course, for a clear reduction in the risk of transition, it will be necessary to achieve a clear surplus of green over dirty exposures.
4. The involvement of banks in CPRS industries

The credit exposures results of the Polish banking sector for the next degree of disaggregation, i.e. for the level of industries, prove that three industries (pillars) of CPRS, i.e. buildings, transportation and manufacturing, were of major importance in the years 2013-2022. The largest share of exposure was concentrated in the construction industry, despite its reduction by 7 pp (from 49% to 43%). The second pillar was the transportation industry, for which the exposure climbed by 4 pp (from 17% to 21%), while the third pillar of manufacturing maintained a stable share of 17% in the total CPRS (Figure 6). It is worth noting here that the three industries in Poland were also key to CPRS exposures according to the results of research for the EU countries in 2013, 2015 and 2018 (Battiston et al., 2022 and Allesi et al., 2019).
Referring CPRS exposures to the exposures of the entire banking sector in Poland, it appears nearly 60% of the exposures relate to the transition risk. What this means is that the majority portfolio is sensitive to changes in ESG transformation risk and requires careful monitoring and supervision. Between 2013 and 2022, the buildings sector accounted for the largest share of this exposure, despite showing a contraction of 5 pp (from 27% to 22%), against an increase of 1 pp. in the transportation sector (from 10% to 11%) and a stable 9% share of the manufacturing sector (Figure 7).

In the analysis of ESG transition risks, their concentration is an important issue. One of the ways to identify it is the value of credit exposure for 1 contract. In Poland, the utilities (utility-electricity) industry maintained
the highest average exposure value for 1 contract in Q2 2022 (approx. PLN 9.4 million). Other unit exposures under a contract corresponded to manufacturing sector (approx. PLN 6.0 million) and buildings (approx. PLN 5 million), respectively, compared to the lowest in the agricultural sector (below PLN 1 million) (Figure 8).

Figure 8. Average exposure by CPRS group and number of contracts for Q2 2022 (PLN million, number)

Source(s): The author's own calculations: NBP (2022), NB300 (2023).

5. Concluding remarks
The use of the CPRS methodology to analyze the loan portfolio of the Polish banking sector in 2013-2022 allowed the identification of industries with a high risk of transformation. These industries turned out to be construction, transport and industrial processing, similarly to the results of Battiston et al. (2022) for market capitalization (stocks and bonds) of non-financial companies in EU countries.

Detailed results for Poland allowed us to estimate that the portfolio of credit exposures according to CPRS showed an increase of 45% in the analyzed period. The greatest increase in absolute values was recorded by dirty and green exposures, which reached comparable values in the second quarter of 2022. In the involvement of the entire banking sector in 2013-2022, the share of green groups increased (from 45% to 49%) while the dirty group decreased (from 55% to 51%). This indicates a positive trend towards the potential to reduce the risks of the transformation if it continues in the coming years. At the same time, these results confirm that in Poland there are slow changes in improving the structure of the loan portfolio in sectors important for climate policy, which are in the initial period of transformation in this area. Per loan agreement, the utility sector (electricity) is responsible for the highest concentration of exposure, which is also confirmed by EU-wide results (Battiston et al., 2022). There are connections between sectors (spillovers effects), which
indicate that three industries have a significant impact on other sections, i.e.: construction (on activities in sections C, F, I, J, K, L, M, N), transport (on activities in sections C, F, I, J, K, L, M, N), C, F, G, H, N) and industrial processing (for C and B).

Limitations
The limitations of assessing the impact of climate transformation on the portfolio of banks’ credit exposures include: the fact that large enterprises conduct various activities, i.e. both green and dirty at the same time, which makes the classification of their liabilities in banks’ portfolios difficult and e.g. limitations in access to statistical data from the financial and non-financial sectors, taking into account the impact of climate change.

Future research areas
Future research should address two areas. Firstly, analyzes at the level of microdata, i.e. more disaggregated data, would be important for Poland. The results of this research would allow for precise identification of which types of activities in the section/sector are responsible for the so-called green investments or, on the contrary, escalate dirty investments.

Secondly, interesting research would be analyzes of climate scenarios regarding the correct paths of climate transformation towards zero emission as well as negative paths, including difficulties with the transformation by 2030. Analyzes of the comparative results of such transformation paths for Poland and other EU countries, including the euro zone (e.g. for France, Germany) could also reveal time, area and, of course, financial differences.

References


25. IPCC (2018), "Global Warming of 1.5°C", An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.


Climate policy relevant sectors in the Polish commercial banks


