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Dominik Hirschbühl, Andrej Ceglar, Theodor Cojoianu, Tina Emambakhsh, Yifan Qi, Caterina Rho, Elsie Hu, Marco Petracco, Fabrizio Biganzoli, Alfred de Jager, Laura Garcia Herrero, Andrea Mandrici, Carlo Pasqua

The climate-biodiversity-pollution nexus: the pricing of environmental credit risks for European industrial polluters

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Abstract

This study examines how euro area banks factor pollution-induced biodiversity risks into lending decisions, using data from 832 banks and 5,000 major polluters. Our results show that banks are increasingly pricing these risks by adjusting loan-to-value ratios and interest rates. Banks adjust lending conditions in line with EU pollution and biodiversity protection legislation, particularly for companies with large pollution footprints near biodiversity-protected areas or those contributing to Environmental Quality Standards failures of downstream surface waters. The former is driven primarily by banks' adoption of biodiversity policies and public commitments to the Equator Principles, while the latter is a result of regulatory risks. Our findings inform financial supervisors on how banks manage risks associated with the EU's zero pollution ambition, shed light on the interplay between biodiversity protection legislation and banks' lending decisions, and offer actionable guidance on leveraging existing regulatory frameworks to address the climate-biodiversity-pollution nexus.

JEL Classification: G1, G21, Q53, Q57.

Keywords: Biodiversity loss, chemical pollution, loan pricing, EU Biodiversity Strategy, Natura 2000.

Non-technical summary

Chemical pollution has far-reaching consequences, contributing not only to climate change through its greenhouse gas emissions but also to biodiversity loss, as toxic pollutants inflict damage on species and ecosystems. This study aims to integrate these dual negative externalities into a loan pricing framework, investigating whether euro area banks consider the financial implications of environmental regulations when deciding on corporate loans. We use a regulatory dataset on 91 pollutant emissions and transfers at the plant level (*European Pollutant Release and Transfer Registry*) to derive measures for biodiversity and climate impacts for 5000 firms. Biodiversity impacts are proxied using the *freshwater ecotoxicity* impact potential, which reflects a chemical pollution-based pressure on biodiversity, while climate impacts are calculated from plant greenhouse gas emissions (*direct GHG emissions*). To investigate banks' commercial loan pricing of *freshwater ecotoxicity*, we employ a panel regression approach integrating the aforementioned sustainability indicators. These are constructed in accordance with European Union (EU) directives and sustainable finance legislation objectives, alongside other standard variables describing the financial characteristics of firms, such as profitability, leverage, and total assets.

This study provides evidence that euro area banks already mitigate risks in their loan portfolio related to biodiversity-relevant chemical pollution (*freshwater ecotoxicity*). Banks generally mitigate these risks by adjusting loan-to-value (LTV) ratios, meaning they provide fewer loan per collateral. In this context, we find evidence that the credit conditions of polluters that operate near biodiversity-sensitive (World Database of Protected Areas, Natura 2000) and drinking water protected areas are particularly affected. These developments are especially pertinent for banks that have adopted the Equator Principles and implemented pollution policies. Furthermore, we show that banks drastically reduce LTV ratios to firms that contribute to 'good chemical status' failures as defined by the *Environmental Quality Standards*, one of the major instruments to mitigate chemical pollution in European surface waters. Moreover, we identified various cases where banks charge interest rate premiums, such as for smaller polluters, loans to polluters with longer maturities, and banks with a pollution policy also charge premiums to polluters located in proximity to protected areas.

Our results suggest that banks consider chemical pollution aligned with regulatory efforts in their commercial loan pricing, indicating that biodiversity protection legislation is starting to influence financial decision-making in the banking system. Beyond its direct findings, this study provides several significant implications. Most importantly, the proposed framework facilitates both informing supervisory bodies about banks' awareness of emission-related biodiversity risks and the monitoring of credit conditions for large polluters, ultimately supporting the European Union's zero pollution ambition. In the context of simplifying sustainability reporting at the corporate entity level, we show that plant-level pollution information can allow for corporate entity climate and biodiversity impact exposure benchmarking. Introducing another dimension of chemical pollution-related externalities may help shed light on environmental impacts and study potential trade-offs. From a financial risk perspective, it is essential to comprehend the complexities of the EU's legal framework aimed at mitigating pollution, as stringent regulations - such as tightened emission limits to reduce chemical pollution - may lead to more conservative lending practices towards high-polluting entities, ultimately affecting their access to credit and potentially pollution-abating investment through the identified channels. The proposed approach enables biodiversity protection from chemical pollution via the financial sector worldwide, as pollution registries, protected areas and environmental quality standards have been established globally.

1 Introduction

Despite the alarming decline in biodiversity[1] and halt of recovery of ecosystems[2], public attention remains disproportionally focused on climate change, ignoring the intricate relationship between climate change, biodiversity loss and chemical pollution.[3] Yet biodiversity loss is not only undermining ecosystem health and resilience, but it is also found to have the potential to cause significant economic losses and financial instability.[4] To mitigate the environmental challenge, European policymakers have developed and strengthened legislation to reduce pollution, preserve areas of high biodiversity value, and maintain the chemical quality of freshwater ecosystems. At the same time, financial supervisors have expanded their scope, recognising the importance of mitigating environmental externalities beyond climate to ensure long-term financial resilience.[5] This study seeks to connect the dots between biodiversity, chemical pollution, and financial risk by examining how euro area banks factor the potential environmental impacts of chemical pollutant emissions into their lending decisions, with a view to mitigating their own exposure to environmental risks that may increasingly affect the direct operations of their borrowers.

Despite the *European Union's* (EU) stringent regulatory framework for chemical use, a significant knowledge gap persists regarding the far-reaching effects of these substances on living organisms, ecosystems, and biodiversity.[6] This is due to the vast array of chemicals, their complex effects and synergies, and compound risks like droughts reducing river run-off or indirect effects such as the disappearance of food sources.[7] Many pollutants show an extremely low degradability, leading to their accumulation in riverine sediments, groundwater, and oceans, as well as bioaccumulation in species.[8] Specifically, toxic compounds have been found to accumulate in the muscle tissue of European freshwater and marine fish, mussels, and amphibians, often exceeding background levels.[9] As key components of food webs, these species or emerging in-

[1] see Hochkirch et al. (2023), IPBES (2019) and Sayer et al. (2025).
[2] see Haase et al. (2023).
[3] see Hellweg et al. (2023), Sylvester et al. (2023) and Sigmund et al. (2023).
[4] see ECB (2024).
[5] see OECD (2023), ECB/ESRB (2023) and EC (2024).
[6] In Europe, over 144.000 chemicals and mixtures are registered, while there are more than 350.000 chemicals globally, see Wang et al. (2020).
[7] see Free et al. (2023) and González and Fariña (2013).
[8] These pollutants are often referred to as uPBT (ubiquitous, persistent, bioaccumulative, and toxic).
[9] see Gonkowski and Ochoa-Herrera (2024), Durrieu et al. (2005) and Bonsignore et al. (2018).

sects facilitate the bio-transfer of toxic chemicals to the terrestrial environment and its predators, including seabirds and forest animals, and potentially also humans.[10] This is of particular importance as laboratory studies have revealed that even when diluted to low concentrations, certain toxic chemical substances can significantly affect various bodily systems, including reproduction, hormone regulation, nervous function, cardiovascular health, and immune response posing a significant threat to life, particularly aquatic and semi-aquatic ones, like amphibians.[11] Simultaneously, as chemical pollution research lacks interdisciplinary integration (biodiversity impact assessments are commonly conducted with a sole focus or excluding this pressure), its relative impact on ecosystems and biodiversity loss may be underestimated, limiting conservation efforts' effectiveness.[12] The unsustainable nature of chemical pollution becomes even clearer when considering that current water purification and treatment methods are costly, energy-intensive, and ineffective, while recycling processes risk spreading pollutants more widely.[13]

To safeguard ecosystems, policymakers formulated ambitious plans to reduce pollution. These regulatory efforts may increase costs and constrain polluters, requiring banks to manage related risks. Banks are exposed to risks by lending to polluters that face increasingly stringent environmental regulations, potentially impairing their financial performance and leading them to default on their loans. This issue is particularly pressing given the increasing demand for chemicals in some clean and digital technologies needed for the twin transition.[14] Further, as key actors in capital allocation, banks' lending decisions can exacerbate or mitigate environmental harm. In this context, the EU's sustainable finance policies recognise the critical role of the financial sector and aim to harness its potential by promoting the "*do no significant harm*" (DNSH) principle and investing in business practices and technologies that promote a more circular economy.[15]

To investigate the issue of chemical pollution in a financial risk context, this study builds on previous studies using regulatory data on chemical pollutant emissions and transfer to develop a set of footprints aligned with regulatory objectives encompassing biodiversity, pollution and

[10] see Kraus et al. (2021), Brunn et al. (2023), Norris (2024), Koch et al. (2021) and Wu et al. (2022).
[11] see Guillette Jr et al. (1994), Matthiessen and Gibbs (1998), Norris (2024), Diamanti-Kandarakis et al. (2009), and Gonkowski and Ochoa-Herrera (2024).
[12] see Sylvester et al. (2023), Sigmund et al. (2023) and Posthuma et al. (2020).
[13] see Brunn et al. (2023).
[14] see Bălan et al. (2025) and EEA Managing the use of chemicals and CEFIC 2022 Facts and figures of the European Chemical Industry, accessed April 2025.
[15] see De Haas et al. (2024).

climate dimensions.[16] By evaluating this data in a loan pricing panel regression framework, we investigate whether banks consider pollution-related biodiversity risks in their loan decisions. Our research features several innovations. First, we build an extensive dataset combining firm-level pollutant emissions data with ownership and loan- and bank-level credit information to evaluate euro area banks' consideration of environmental risks in lending decisions. Second, we investigate the relevance of banks and their possible alignment with the objectives formulated in the EU's sustainable finance and broader EU biodiversity protection legislation. Ultimately, our study examines whether banks that committed to the Equator Principles or disclosed the adoption of biodiversity or pollution policies are more likely to factor pollution considerations into their lending decisions. The findings suggest that banks mitigate risks from *freshwater ecotoxicity* emitters by lending less per unit of collateral. We found evidence that particular pollution near biodiversity-sensitive areas and polluters contributing to *Environmental Quality Standards* (EQS) 'good chemical status' failures obtain less credit per collateral. Banks appear less engaged in charging spreads to polluters, whereas they do so for small-sized polluters, debt refinancing purposes, if the banks themselves have a pollution policy, and more recently, also to firms contributing to EQS failures.

The remainder of the study is structured as follows: Section 2 gives a primer on the EU legal landscape to mute pollution, providing the context for our analysis. Section 3 outlines the creation of firm-level biodiversity metrics from regulatory data and details the methodology. Section 4 presents the findings on biodiversity risk in bank loan pricing. The study concludes with Section 5, summarising the main takeaways.[17]

[16]see Sala et al. (2015), Erhart and Erhart (2023) and Erhart et al. (2025).

[17]For brevity, we delegated the literature review on asset pricing in the context of pollution and biodiversity to Appendix A.

2 A primer on the EU's zero pollution legislation and hypothesis building

The roots of today's EU legislation to safeguard biodiversity and ecosystems are based in the United Nations' *Convention on Biological Diversity* (CBD).[18] In 2022, at the 15th meeting of the parties to the CBD conference, the Kunming-Montreal *Global Biodiversity Framework* (GBF) was agreed upon.[19] To pave the way for the attainment of long-term biodiversity goals by 2050, a set of 23 actionable global targets has been defined that need to be initiated immediately and completed by 2030. Ratifying nations must pursue the targets in line with the CBD principles and other international commitments, considering national contexts and socioeconomic conditions. A target of particular interest is the one related to reducing pollution risks and the negative impact of pollution to levels that are not harmful to biodiversity and ecosystem functions and services, also taking into account cumulative effects. This shall be achieved by cutting pollution from excess nutrients, pesticides, and highly hazardous chemicals by at least half.[20]

The EU's GBF implementation efforts are anchored in the European Green Deal's *Biodiversity Strategy for 2030*.[21] It provides a long-term roadmap for protecting and conserving nature, reversing ecosystem degradation, and putting Europe's biodiversity on a path towards recovery by 2030. Core elements of the *Biodiversity Strategy* comprise the expansion of a Europe-wide network of protected areas on land and at sea, the roll-out of a far-reaching *Nature Restoration Law* (NRL) with legally binding restoration targets for specific habitats and species, and the introduction of pioneering measures to tackle the biodiversity crisis.[22] In fact, the EU operates a multifaceted legal framework to minimise pollution impacts and promote a sustainable and circular economy, with ambitions that align with and go beyond the *Biodiversity strategy's* ob-

[18] see United Nations (1992).

[19] see CBD (2022).

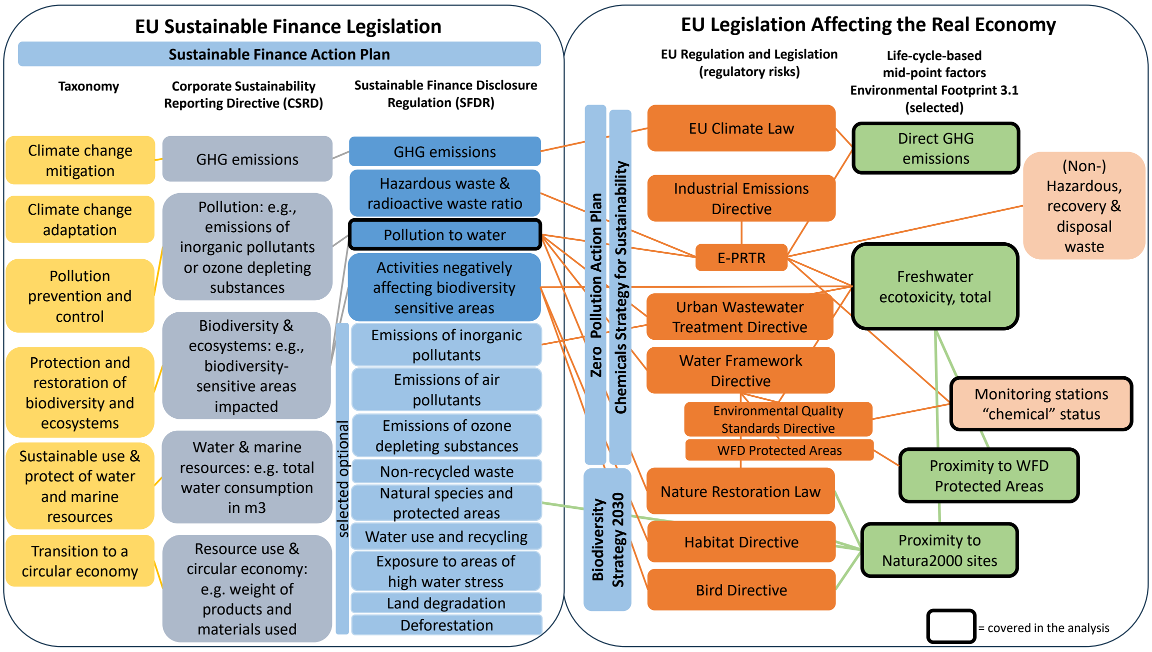
[20] see Kunming-Montreal Global Biodiversity Framework Targets for 2030, accessed on February 2025. Moreover, in 2022, the United Nations Environment Programme recognised chemical pollution as a planetary crisis equivalent to climate change and biodiversity loss, that requires the establishment of an independent intergovernmental science-policy panel on chemicals, waste and pollution prevention (see Ågerstrand et al., 2023) and UNEP Ad hoc open-ended working group on a science-policy panel on chemicals, waste and pollution prevention, accessed on 30 March 2025.

[21] see European Green Deal and Biodiversity Strategy for 2030.

[22] see Nature Restoration Law. In this context, 16 indicators have been proposed to guide swift and decisive action to effectively track progress, see Viti et al. (2024) and EU Biodiversity Strategy Action Tracker.

jectives (see Figure 1). Ultimately, the framework foresees emission and waste limits on the real economy, and any future tightening of these regulations may pose risks to the financial sector. In this context, the legislation on GHG emissions is the most stringent and the best documented evidence regarding the impact on financial markets.[23] Meanwhile, little is known about banks' financial risk perceptions of the non-GHG dimensions of the EU's zero pollution policies, to which we intend to contribute.

FIGURE 1 The EU's legal framework to mute pollution and protect biodiversity



Source: Own elaboration, lhs adapted from Popescu et al. (2024).

The financial system is indirectly exposed to environmental regulatory risks, primarily through its lending activities and holdings of assets of affected companies. To minimise potential losses, financial institutions must effectively manage these exposures. Therefore, the legal framework that impacts polluters is complemented by the EU's *Sustainable Finance Action Plan*, which utilises and supports the financial sector to promote sustainable practices, prevent greenwashing, and

[23] In the euro area, banks have started to reduce their exposure to high-carbon companies, with their loan share decreasing by around 3 percentage points, see Reghezza et al. (2022). For evidence on the US, see Ivanov et al. (2024). The authors find that high-emission private firms face less favourable financing conditions with shorter loan maturities, limited access to long-term bank credit, and a greater reliance on shadow banking institutions as participants in their loan syndicates. At the same time, research suggests that banks' pricing of environmental regulatory risks may be imperfect, especially in the early stages of policy implementation, as evidenced by the unexpected 25% decrease in loan spreads for firms participating in the EU ETS after 2013, see Antoniou et al. (2024). For information on policies, see EU Climate Law, EU Emission Trading System that regulates the trade of CO_2emission certificates and the Net-zero Industry Act to promote the net-zero economy.

raise awareness to mitigate sustainability transition-related risks.[24] The key concepts cover key environmental aspects, including GHG emissions, emissions to water, hazardous waste, and the protection of biodiversity-sensitive areas[25], which have counterparts in directives impacting the real economy.

In the following, we postulate three hypotheses that we are testing empirically in the main part of the paper. Each hypothesis is based on major EU strategies to mitigate pollution and protect biodiversity, detailed below.

Hypothesis 1: *Banks adjust their lending to pollution-induced biodiversity risks.*

The *Zero Pollution Action Plan* is a key component of the Green Deal, aiming to reduce air, water, and soil pollution to levels that are no longer harmful to human health and the environment.[26] To achieve this, the *Industrial Emissions Directive* (IED) plays a crucial role, regulating and controlling pollution at its source.[27] Under this framework, large polluters are required to submit detailed reports on their chemical emissions to the *European Pollution Release and Transfer Registry* (E-PRTR), providing a transparent and publicly accessible record of their environmental performance and climate impacts. Reliable pollution levels can serve as a valuable input for banks' risk management, enabling them to better assess the sustainability characteristics associated with their clients or investments, and hence environmental risks stemming from legislative attempts to decarbonise and depollute.[28] At the same time, the IED also covers increasingly agroindustrial installations with freshwater eutrophication potential, another important driver of biodiversity loss.[29]

[24]see EC (2018). Key legislation includes the Taxonomy, which provides criteria for identifying sustainable economic activities, guiding investment decisions and reducing greenwashing. The Corporate Sustainability Reporting Directive (CSRD) mandates firms to disclose ESG performance data to improve transparency and inform stakeholders, particularly banks. The Sustainable Finance Disclosure Regulation (SFDR) requires financial institutions (particularly non-banks) to disclose ESG risks, "principal adverse impact indicators" and sustainability impacts of their products.

[25]see Popescu et al. (2024).

[26]The EU's zero pollution ambition also aligns with the United Nations' 2030 Agenda for Sustainable Development, supports the achievement of climate neutrality by 2050, and is closely tied to the goals of promoting a clean and circular economy, as well as restoring biodiversity. The EU has formulated Zero Pollution Targets for 2030.

[27]see Industrial and Livestock Rearing Emissions Directive (IED 2.0).

[28]see Q&A to Revised Industrial Emissions Directive.

[29]see Costa et al. (2021).

Hypothesis 2: *Credit conditions are likely to be more stringent for polluting firms operating in proximity to biodiversity-sensitive areas.*

In Europe, protected areas are organised within the *Natura 2000* network (N2000), which was established under the auspices of the *Birds* and the *Habitats* directives, and which are the cornerstone of the EU's biodiversity conservation strategy.[30] Therefore, we assume the *Natura 2000* network as a proxy for the Taxonomy objective to protect and restore biodiversity and ecosystems.[31] We hypothesise that firms polluting near protected areas are likely to have higher biodiversity impacts and, as a result, may face more stringent credit conditions. A more general notion at the global scale is the *World Database on Protected Areas* (WDPA), which also includes protected areas for Europe, with *Natura 2000* being a subset of European protected areas.

Hypothesis 3: *Banks amend their lending conditions to polluters contributing to a Environmental Quality Standards 'good chemical' status failure in downstream water monitoring stations and to polluters in proximity to Water Framework Directive drinking water protected areas.*

Another key instrument to mute pollution is the *Water Framework Directive* (WFD), which aims for "good chemical and ecological status" in water bodies by 2027, using quality indicators that assess chemical, biological, and physical-chemical parameters, requiring EU member states to identify pressures and create management plans to reduce pollution to meet environmental quality standards.[32] In the context of "good chemical status", particularly uPBT (ubiquitous, persistent, bioaccumulative, and toxic) pollutants play an important role as only 31% of EU water bodies meet the "good" condition status.[33] We hypothesise that credit to firms contributing via their pollutant emissions to a "good status" failure may be considered riskier; similarly, we expect credit conditions to firms that pollute near WFD *Drinking Water Protected Areas* to be considered more risky.

[30]see Birds Directive and Habitats Directive.

[31]This assumption has two caveats. First, chemical pollution is not the only pressure on biodiversity. Second, while the *Natura 2000* network serves as a biodiversity proxy at the political level, it has various limitations for actual biodiversity protection. It is not reflecting the most threatened species nor wider biodiversity (see Sánchez-Fernández et al. (2021)), lack of spatial prioritisation (see Carrizo et al. (2017)) and extensions to highly threatened (endemic) species (see Spiliopoulou et al. (2023)), and wasn't primarily designed for freshwater protection (see Sánchez-Fernández et al. (2021)).

[32]see Water Framework Directive.

[33]see EEA chemicals in European surface water and groundwater bodies, accessed 3 Dec 2024, and see Freshwater Information System for Europe, accessed 24 March 2025.

3 Data and methodology

This study integrates data from multiple sources to analyse environmental indicators in loan pricing. We draw on the European Environmental Agency's E-PRTR data and the European Commission's *Environmental Footprint* (EF) method to generate climate and freshwater biodiversity-related impact indicators at the plant and firm level. We use loan-level information from the European Central Bank's *AnaCredit*, the euro area's credit registry, and complement balance sheet information using Moody's *ORBIS* corporate database.

3.1 European pollutant release and transfer registry data

The E-PRTR regulation sets the framework for industrial facility reporting within the EU and associated countries.[34] We use version 11 of the dataset, which is compiled annually, covering 2015 to 2022, though it includes gaps that necessitate careful data handling.[35] Despite this, the regulatory data encompasses over 52,000 industrial entities, plants with ownership linkages and precise geographical information, covering both industrial operations and poultry and pig farming activities. Reporting obligations involve detailing pollutant emissions in kilograms, with information on 91 pollutants released into air, water and soil, and waste (pollutant) transfer.[36] In addition to the direct releases, we include the releases to wastewater treatment facilities as only parts of the pollutants accumulate in the sludge, with the remainder being discharged into the environment.[37]

3.2 Calculating the freshwater ecotoxicity and GHG impact potential

Evaluating almost a hundred pollutants in financial risk models is impractical as the complexity obscures meaningful insights. To reduce dimensionality, we utilise an impact potential assessment method, particularly the EF, version 3.1, to assess the potential impact associated with chem-

[34] see E-PRTR Regulation. It is succeeded by the Industrial Emissions Portal Regulation that provides data through the Industrial Emissions Portal. At the international level, the OECD is supporting the implementation of pollution registries, also assisting with Best Available Techniques.

[35] see E-PRTR v.11, which has improved ownership linkages compared to past iterations.

[36] for country-specifics, see Ricardo (2020).

[37] see Ricardo (2020), Karvelas et al. (2003), Feng et al. (2018), Jachimowicz et al. (2025) and Comber et al. (2021).

ical emissions, through impact assessment models and impact characterisation factors.[38] For instance, we derive a climate change (henceforth *direct GHG*) impact potential indicator that consolidates all gases, weighted by their respective global warming potentials, and a *freshwater ecotoxicity* metric that quantifies the potential ecotoxicity impact caused by emission releases to aquatic species, based on multimedia fate modelling and toxicological endpoints.[39] The EF is usually applied to quantify the potential environmental impacts of products and organisations through 16 so-called "mid-point" impact categories, including the two used in our analysis.[40] The "mid-point" *freshwater ecotoxicity* indicator refers to potential toxic impacts on an aquatic ecosystem, harming species and the functioning of the ecosystem. The comparability of harmful emissions, considering their distribution in the environment via a multimedia fate model, makes it a suitable tool for regulatory purposes.[41] To obtain the impact potential for each firm, *direct GHG emissions* (kg CO_2-equivalent over 100 years), which are direct plant emissions, and *freshwater ecotoxicity* (Comparative Toxic Units of (freshwater) ecotoxicity, CTUe)[42], we aggregate pollutant-specific characterisation factors (CF), used as coefficients to translate the emissions into potential impacts, weighted with annual emission release inventories across all pollutants (i), facilities (j) and release media (k):

$$Impact\ Potential^m = \sum_{ijk} P_{ijk} \times CF^m_{ik} \tag{1}$$

with P_{ijk} being pollutant i in kg emitted in facility j into release medium k, and CF^m_{ik} being the respective characterisation factor with $m \in$ {climate change, freshwater ecotoxicity}. To obtain CF, we manually match EF 3.1 and E-PRTR pollutant names, considering that chemical

[38]see Hellweg et al. (2023).

[39]see Sala et al. (2022). The toxicity impact assessment in the EF method (see Andreasi Bassi et al., 2023) builds on the USEtox model, which represents the scientific consensus (see Rosenbaum et al., 2008; Fantke et al., 2017). The EF3.1 method deviates from the original model as it adopts a broader underlying dataset available from the European Chemicals Agency (ECHA) repository and adopts a more conservative *freshwater ecotoxicity* assessment approach (see Sala et al., 2022). The EF can be downloaded here, accessed May 2024.

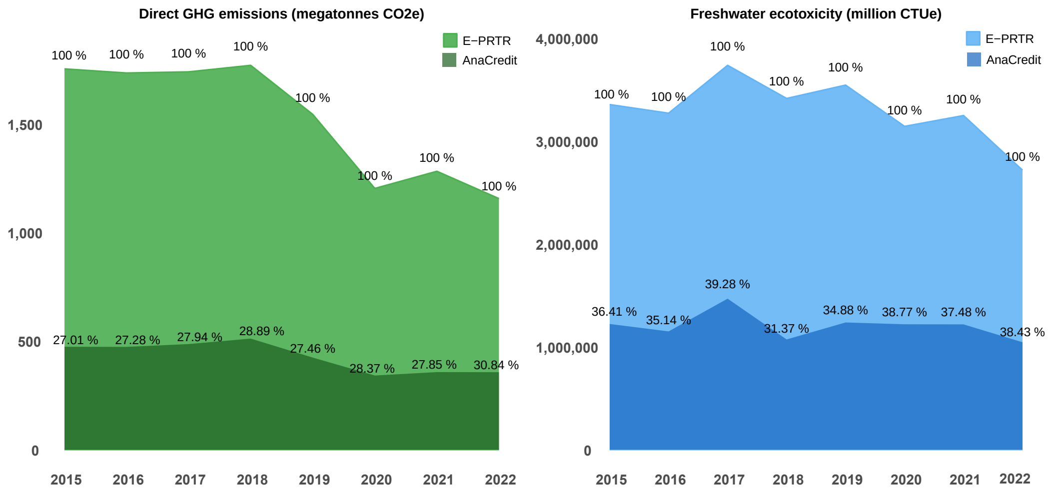
[40]Industrial wastewater emission release can cause substantial harm due to a decrease in pH levels (*acidification*), an overabundance of nutrients promoting algae bloom (*freshwater eutrophication*), increasing temperature disruptions, and the presence of toxic substances that can be harmful to exposed aquatic species (*freshwater ecotoxicity*), see Posthuma et al. (2020), and Schweizer et al. (2022). Other studies have also highlighted the importance of the *freshwater eutrophication* mid-point factor, see Erhart et al. (2025).

[41]see Sala et al. (2021).

[42]The *freshwater ecotoxicity* metric at the endpoint would reflect $[PAF \times m^3 \times$ day per 1 kg emitted$]$. See Erhart and Erhart (2023) and Erhart et al. (2025).

FIGURE 2 *Direct GHG emissions* and *freshwater ecotoxicity*, euro area and sample

Notes: Percentages explain the total coverage of the E-PRTR variables for the euro area (E-PRTR, normalised to 100%) and the sample included in this study (AnaCredit).

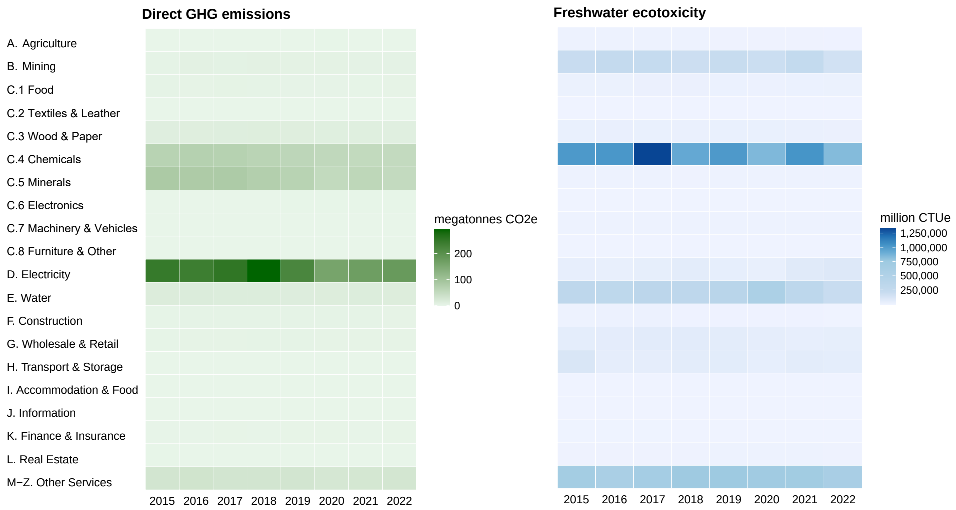


substance names may not be unique, and E-PRTR sometimes reports groups. The CFs of this matching are presented in Appendix C.5. Characterisation factors differ across release media for *freshwater ecotoxicity*, e.g., the toxicity of persistent pollutants remains unaffected when emitted to different release media, while the toxicity of non-persistent pollutants emitted to air is discounted as pollutants are expected to travel for longer periods, during which toxicity is assumed to degrade before they return via precipitation to the surface.[43]

Figure 2 shows the trends in *direct GHG emissions* and *freshwater ecotoxicity* impact potential in the euro area from 2015 to 2022. Notably, greenhouse gas emissions decreased substantially between 2018 and 2020, while *freshwater ecotoxicity* did not change much. Further analysis shows that about 34% (30%) of the total E-PRTR-covered euro area GHG (*freshwater ecotoxicity*) impacts are covered in our sample. Figure 3 provides a sectoral breakdown of *direct GHG* and *freshwater ecotoxicity* impact potential. As expected, the former can be found in the electricity, chemicals, and minerals sector, while the latter is predominantly a problem related to chemical production and the water treatment sector. While chemical producers are a source of pollution,

[43]Therefore, depending on the E-PRTR reported release medium x ∈ (air, water, soil), the FLOW class1 has to be chosen "Emissions to x", while the FLOW class2 was chosen to be "Emissions to x, unspecified". This assumption has been made for convenience, but it can potentially lead to an underestimation of impacts. Further, if pollutants were reported to be emitted to water with no reported climate change impact, but their emission to air is reported to have a climate change impact, we applied the CF of air. This concerns only a few observations, but we decided to impose this so as not to underestimate the climate change impact potential.

FIGURE 3 Covered *direct GHG emissions* and *freshwater ecotoxicity* potential by sector



wastewater treatment facilities contribute to the alleviation of pollution. Table C.3 shows the correlation between the variables. The correlation between *direct GHG emissions* and *freshwater ecotoxicity* is comparatively small (0.06). The same holds for most other variables. Interestingly, the LCA-based variable *freshwater ecotoxicity*, and the variable proposed to financial institutions by the SFDR, recommending aggregating pollutants to water by kg, not by toxicity per kg, are highly correlated (0.96).

3.3 Financial data

The analysis of banks' loan pricing relies on granular data on instrument-level exposures of banks to individual borrowers, which is mapped to bank- and firm-level balance sheet information. Our analysis focuses on corporate loans issued by euro area banks to non-financial corporations residing in the euro area. To this end, we construct a comprehensive data set by compiling instrument-, firm-, and bank-level information from different data sources.

Loan-level data is sourced from *AnaCredit*, the harmonised credit registry for the euro area managed by the European Central Bank.[44] *AnaCredit* covers loans above 25,000 Euro issued by commercial banks residing in the euro area, reporting approximately 80% of the total euro area corporate loan landscape. This database contains high-frequency and granular information on euro area banks' corporate loan portfolios, including information on loan size, interest rates,

[44] see Anacredit, accessed December 2024.

TABLE 1 Loan-level summary statistics

Notes: Loan-level information comprises monthly data and balance sheet information for firms refers to annual data, respectively. Loan-level variables are winsorized based on the 5th and 95th percentiles. Firms' total assets, profitability, leverage are winsorized based on the 1st and 99th percentiles. All variables are reported unorthogonalised.

	N	Mean	SD	Min	p25	Median	p75	Max
E-PRTR data								
Direct GHG emissions (in tonnes of COe)	4,461,354	144,890,215	693,896,099	0	0	0	0	2.3e+10
Freshwater ecotoxicity (in CTUe)	4,461,354	216,015,521	5214930330	0	0	0	1,425	2.7e+11
Freshwater ecotoxicity to water (in CTUe)	4,461,354	214,396,672	5213724065	0	0	0	0	2.7e+11
Pollution to water (tonnes)	4,461,354	722,050	17,288,626	0	0	0	0	890,565,312
Freshwater ecotoxicity WDPA $\leq$ 1km	4,461,354	62,676,045	3067677118	0	0	0	0	2.7e+11
Freshwater ecotoxicity N2000 $\leq$ 1km	4,461,354	60,035,801	3049215624	0	0	0	0	2.7e+11
Freshwater ecotoxicity WFD DWPA $\leq$ 1km	4,461,354	126,601,011	5019740426	0	0	0	0	2.7e+11
Firm-level data								
Profitability	4,461,354	.041	.072	-32	.012	.036	.066	.98
Leverage	4,461,354	.29	.19	0	.15	.29	.43	1.1
Total assets (mln EUR)	4,461,354	4,375	21,957	.047	31	117	494	152,130
Log-Total assets	4,461,354	4.9	2.2	-.3	3.4	4.8	6.2	12
Loan-level data								
Interest rate (pp)	4,461,354	2.4	2.4	0	1	1.9	3.3	65
Interest rate spread (bps)	4,461,354	196	164	-316	110	190	286	643
Loan-to-value ratio (bps)	1,564,908	12,069	10,213	746	6,079	10,000	12,487	40,364

collateral, as well as non-price loan characteristics such as loan type, purpose and loan maturities. We account for different types of corporate credits in our analysis. The three most common types are general loans, credit lines and trade receivables, followed by finance leases, revolving credits, overdrafts, reverse repurchase agreements, credit card debt, and deposits other than reverse repurchase agreements. The data is reported monthly and is available from September 2018 onwards. For our analysis, we take the entire monthly time series of corporate loan exposures from September 2018 until December 2023.

Balance sheet information of firms is sourced from *Moody's Orbis*, a comprehensive commercial database that includes in-depth information from various sources, such as official business registries, corporate annual reports, and company websites. It is methodologically standardised to ensure international comparability. We meticulously select variables that reflect a firm's financial performance, such as total assets, total debt, and operational profitability, to measure firms' financial positions and performance, as well as turnover to normalise emissions. We run an extensive cleaning procedure to exclude firms with erroneous, or unconventionally small or large total assets, profitability or leverage, and additionally winsorize firm-level balance sheet information at the 1st and 99th percentiles. Data in *Orbis* is available at yearly intervals with a lag of 2 years up until the year 2022. We map the monthly loan-level data with Orbis firm-level balance-sheet information from the previous year.

Table 2 Loans, firms and facilities by firm size

Category	Loan observations	Firms	Facilities
Micro	95,547	659	745
Small	641,373	1,576	1,951
Medium	1,453,779	1,607	2,254
Large	2,270,655	1,136	2,472
Total	4,461,354	4,978	7,422

Table 1 lists all variables used in our loan-level empirical analysis along with their summary statistics for the final dataset that combines all data sources. Overall, our sample comprises almost 4.5 million loan observations (credit spread, 1.5 million for LTV), issued by around 832 banks to around 5000 IED firms. A total of 438 firms report *direct GHG emissions*, 1406 firms report pollutants having *freshwater ecotoxicity* potential. The other firms in the sample report so-called pollutant off-site transfer (waste) or other pollutant emissions without GHG or *freshwater ecotoxicity* potential. For clarity, Table C.4, which includes descriptive statistics on both metrics used in the regressions that are particularly relevant for understanding the economic significance of the observed effects, has been moved to the appendix. Furthermore, as shown in Table 2, we can classify the 4978 firms into 659 micro, 1576 small, 1607 medium-sized and 1136 large firms.[45] In reality, some of the firms may not be classical SMEs, but subsidiaries owned by larger firms that outsource activities. Overall, the dataset shows a coverage of around 8% of all *Anacredit* loan exposures, and of around 15% of all E-PRTR facilities.

[45]based on the European Commission's definition of SMEs. For a sectoral and size breakdown, see Table C.2 in the Appendix C.2. In this analysis, we treat wastewater treatment plants similarly to other polluters, acknowledging that they play a critical role in mitigating the problem. Still, they have to report pollutants due to imperfect removal of upstream urban and industrial inflows, see Ricardo (2020), Karvelas et al. (2003), Feng et al. (2018), Jachimowicz et al. (2025) and Comber et al. (2021).

3.4 Loan-level panel regression

We specify a panel regression model, where a loan is issued by bank j to firm i in month m of year t:

$$Y_{ijm} = \alpha + \beta_1 Z_{i,t-1} + \beta_2 log\ direct\ GHG\ emissions_i + \gamma_1 X_{i,t-1} + \lambda_{ij} + \tau_{jm} + \theta_{ulsm} + \epsilon_{ijm} \tag{2}$$

The dependent variable Y denotes a loan's intensive margin (either the loan-to-value ratio or the interest rate spreads). Z is the main independent variable of interest. It corresponds to E-PRTR-based variables such as *freshwater ecotoxicity*, in log-levels (or intensity, which are log-(levels-revenue ratio)). β_1 identifies whether banks price the respective factor into their lending decisions. We add *log direct GHG emissions*, which refers to greenhouse gases (GHG) emitted by plants aggregated at the firm level in a given year, in log-levels, to control for a climate-related factor.[46]

X denotes a vector of other firm-specific control variables, which include firms' one-year lagged (log) total assets, profitability (operating profits-over-total assets), and leverage (total debt-over-total assets). These variables are commonly used in the literature to control for firm size, financial performance, and capital structure, and are included to ensure that our estimates are robust to these potential confounding factors (see Appendix C.1 for a description of all variables). We use the 1-year lag for firms' balance sheet variables because it is assumed that banks receive information on these components only with a delay (e.g. after firms publish their annual financial statements). For the E-PRTR variables, we use the time-series dimension of exposure variables, acknowledging the existence of missing values due to data gaps or plants being shut down for revision, and apply a transformation *log(1+x)*. We orthogonalise *freshwater ecotoxicity* emissions to account for possible collinearity due to the overlap in firms' *direct GHG* (see Appendix C.3). We further include a series of fixed effects in the model. λ corresponds to time-invariant loan-level controls, namely, the type and purpose of the loan. We include bank-month-level fixed effects, τ, to control for bank-specific factors and heterogeneity in the credit supply over time that could affect the dependent variables. To identify changes in credit demand across firms, we include θ, which corresponds to the interaction of industry-, location-, size- and

[46] Although it is also an important emission-related driver of biodiversity loss, the increasing stringency of climate legislation creates a need for a separate examination of this factor in the financial risk analysis.

month-fixed effects (thereafter called ILS-time fixed effects).[47] Firms' location corresponds to the country of the legal entity, and their industry corresponds to their NACE level 2 classification. The size of firms is a categorical variable, indicating whether a firm is a micro, small, medium-sized or large firm. All standard errors are clustered at the firm level. Before presenting our findings, we would like to emphasise that our estimates should be understood as revealing associations between biodiversity-relevant chemical pollution and loan conditions, rather than establishing causal relationships.

4 The pricing of emission-related biodiversity risks in loans: Results with discussion

This section examines the extent to which banks consider a firm's emission-related biodiversity potential impact when setting loan terms. By integrating the *freshwater ecotoxicity* impact potential into a loan pricing model, we explore how this factor may influence a bank's risk evaluation of a firm. Our analysis focuses on two risk-mitigating strategies: offering lower loan-to-value (LTV) ratios and charging an interest rate premium (Spread).

4.1 Introducing freshwater ecotoxicity and firm size heterogeneity

We initiate our investigation by testing the first hypothesis, which suggests that banks consider chemical pollution a potential financial risk when making loan decisions. Particularly, we introduce the orthogonalised *freshwater ecotoxicity* measure in addition to *direct GHG emissions* into the loan panel regression as specified in Equation 2, considering the total corporate loan portfolio of banks. All other subsequent analyses are variations that investigate subcategories or incorporate new variables from other data sources.

Table 3 presents the results for the LTV ratio, which indicates the amount of collateral banks require from borrowers when issuing a loan. Columns (1) and (2) insert *direct GHG emissions* and *freshwater ecotoxicity* in log-levels and log-levels orthogonalised next to a set of balance

[47] We could have included firm-time-level fixed effects to capture the time-varying heterogeneity in firms' credit demand, however, this would absorb the impact of our main variables of interest, i.e. factors related to emissions and biodiversity, as they are measured at the firm level. We therefore use the combination of firms' location, industry, size and month of credit issuance as an alternative.

sheet controls in total and newly originated loans. *Direct GHG emissions*, in line with theory, displays a highly negative and statistically significant impact on LTVs. A 1-unit increase in firms' log-*direct GHG emissions* leads to a decrease in LTVs between 19.2 basis points (bps), which accounts for a difference of up to 4.6 percentage points less credit per collateral for the difference between the biggest and a zero GHG emitter. A 1-unit increase in log-*freshwater ecotoxicity (orthog, level)* leads to a decrease in LTVs of 16.9 bps (27.9 bps) in total (new) loans, which implies that the biggest emitter obtains 3.6 pp (6 pp) less loan per collateral as compared to a firm reporting no freshwater ecotoxicity releases. At the same time, we would like to highlight that the statistical significance of 10% in total loans, given the high number of observations, requires a careful interpretation of the results, while the significance at the 5% level in new loans proves more reliable. The analysis in columns (5) and (7) further unveils no significant pricing of spreads related to *freshwater ecotoxicity (orthog, level)*. At the same time, the findings for *direct GHG emissions* are in line with the literature. Due to the strict legislation to cut GHG emissions by 2050, and the increased costs for emission reductions and possible penalties, highly exposed firms become more vulnerable and lending to them becomes riskier, leading to a carbon premium in loan interest rates and a reduced LTV ratio.[48] Similarly, albeit not at the centre of our analysis, we also assess the implications of *freshwater eutrophication* potential of pollutant emissions on credit conditions. Eutrophication reflects nutrient pollution, which is often considered a major stressor to biodiversity. The results are similar to *freshwater ecotoxicity* (Table B.10 and B.11) in terms of pricing of the LTV ratio (-22.8 bps (level) to -26 bps (intensity) per unit value increase both at 5% statistical significance level) and no pricing of the spread (see Table B.27 in Appendix B.3).

[48]see Ehlers et al. (2022).

TABLE 3 Freshwater ecotoxicity and firm size heterogeneity

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals. Small, Medium and Large are dummy variables referring to the firm's size. Regressions that include firm-size related regressors are expressed relative to micro firms and do not include size-related fixed effects.

	LTV				Spread			
	Total loans		New loans		Total loans		New loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	982.508	586.787	3001.491***	1155.676	−58.039***	−67.830***	35.036	14.268
	(666.307)	(706.589)	(996.097)	(838.405)	(18.697)	(19.636)	(37.135)	(35.635)
Leverage	46.010	−744.870	453.495	−633.238	73.506***	66.493***	117.047***	101.798***
	(388.423)	(618.149)	(376.152)	(468.563)	(12.610)	(12.662)	(26.160)	(23.802)
Log-Total assets	224.938***	196.597**	−46.204	−145.956	−7.048***	−6.453***	−11.153***	−13.506***
	(86.346)	(79.952)	(93.083)	(91.652)	(2.065)	(1.950)	(3.820)	(3.662)
Log-Direct GHG emissions (level)	−19.184**	−32.741***	−6.482	2.886	1.018***	0.884***	0.804**	1.031***
	(9.274)	(11.545)	(6.685)	(6.814)	(0.271)	(0.307)	(0.341)	(0.379)
Log-Freshwater ecotoxicity (orthog, level)	−16.928*	20.285	−27.926**	−25.840	0.279	−1.282*	0.010	−2.032*
	(8.832)	(16.052)	(13.544)	(28.037)	(0.311)	(0.727)	(0.388)	(1.216)
Small		974.719***		1205.206***		−61.960***		−75.794***
		(268.271)		(321.656)		(10.474)		(14.276)
Medium		769.146**		1328.205***		−67.980***		−68.409***
		(324.581)		(415.323)		(11.224)		(17.575)
Large		1114.332**		1977.417***		−63.870***		−51.397**
		(470.152)		(594.952)		(13.623)		(21.662)
Small × Log-Freshwater ecotoxicity (orthog, level)		−57.694***		−43.082		2.338**		3.354**
		(21.739)		(31.473)		(0.945)		(1.368)
Medium × Log-Freshwater ecotoxicity (orthog, level)		−16.697		−21.493		1.749**		2.468*
		(21.843)		(34.666)		(0.878)		(1.426)
Large × Log-Freshwater ecotoxicity (orthog, level)		−63.473**		35.183		1.297		1.939
		(28.816)		(30.378)		(0.837)		(1.251)
Constant	11058.071***	10503.310***	9451.170***	8699.425***	209.017***	272.542***	240.975***	315.914***
	(348.869)	(250.961)	(426.564)	(304.868)	(10.101)	(11.215)	(19.790)	(13.067)
Observations	1564908	1564908	80684	81979	4461354	4461354	500002	501698
R_a^2	0.831	0.810	0.882	0.847	0.579	0.554	0.636	0.583
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	No	No	No	Yes	No	No	No
IL-Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

To better understand conventional pricing mechanisms, we investigate the role of firm size heterogeneity and whether it plays a role in pricing our chemical pollution externality. This is particularly so as smaller firms are often disadvantaged in lending conditions, and polluting activities can expose these firms to higher risks. We introduce an interaction term for log-*freshwater ecotoxicity (orthog, level)* with firm size dummies for the LTV ratio (2) and (4) and the interest rate spread (6) and (8), leaving micro-sized companies as a baseline. The findings highlight that banks mitigate emission-related credit risks to small and large polluters by reducing, on average, LTV by 58 to 63.5 bps per unit of log-*freshwater ecotoxicity (orthog, level)*. Surprisingly, there is no significant effect for medium-sized polluters. At the same time, small and medium-sized *freshwater ecotoxicity* polluters have to pay statistically significantly higher interest rate spreads than their large peers, 2.3 and 1.75 bps per unit value increase of log-*freshwater ecotoxicity (orthog, level)*. This effect increases substantially in newly originated loans, while the impact on LTVs in newly originated loans remains lower and statistically insignificant. Although we didn't control for ownership, the findings reflect increased caution of banks towards smaller polluters, an issue that could be related cleanup costs and discussions that takes place in the broader context of the *Environmental Liability Directive* and the *Polluter Pays principle*.[49]

4.2 Refinancing loans and maturity

While the previous analyses suggest that banks reduce potential risks to *freshwater ecotoxicity* emitters predominantly by granting less loan per collateral and charging a spread to smaller polluters, Table 4 investigates the extent to which debt refinancing and loan maturity channels could play a role. As total loans cover many activities, e.g. trade credit, we run the regression on the specific subcategory of debt refinancing loans. The results indicate that banks are charging a spread of 4.3 bps per unit value increase of log-*freshwater ecotoxicity (orthog, level)* at a 1% statistical significance level, which becomes statistically insignificant in new loans. Furthermore, while the interaction term of refinancing loans and freshwater ecotoxicity is negative but non-significant, the significance level for all other loan purposes of this variable increases to 5% level, making it a more reliable estimate with still -19.4 bps, which increases to -28.3 bps in new loans.

[49] see Environmental Liability Directive and European Commission Ensuring that Polluters Pay, accessed on 12 October 2025.

Table 4 Freshwater ecotoxicity, refinancing loans and maturity

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	LTV				Spread			
	Total loans		New loans		Total loans		New loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	811.006	1005.021	3098.873***	3003.850***	−59.490***	−57.810***	35.611	35.331
	(657.190)	(667.706)	(969.344)	(999.824)	(19.128)	(18.636)	(37.097)	(37.128)
Leverage	106.004	153.530	500.485	443.478	76.429***	73.729***	116.801***	116.870***
	(385.952)	(389.972)	(382.953)	(374.707)	(12.668)	(12.600)	(26.086)	(26.152)
Log-Total assets	228.971***	223.227**	−65.902	−43.543	−6.813***	−7.074***	−11.128***	−11.176***
	(86.431)	(86.706)	(93.394)	(93.797)	(2.087)	(2.076)	(3.807)	(3.825)
Log-Direct GHG emissions (level)	−18.953**	−15.007	−5.963	−6.658	0.994***	1.037***	0.818**	0.807**
	(9.304)	(9.148)	(6.774)	(6.692)	(0.282)	(0.271)	(0.340)	(0.341)
Log-Freshwater ecotoxicity (orthog, level)	−19.361**	−29.490*	−28.351**	−21.713	0.208	0.019	0.001	−0.017
	(8.971)	(16.093)	(13.938)	(23.154)	(0.316)	(0.370)	(0.387)	(0.581)
Refinancing loan	−190.199		211.990		18.870***		38.567***	
	(267.415)		(452.658)		(5.050)		(9.800)	
Log-Freshwater ecotoxicity (orthog, level) x Refinancing loan	−65.879		50.017		4.326***		1.733	
	(40.616)		(74.904)		(0.868)		(1.303)	
Maturity (years)		−157.620***		97.628***		−0.997***		−1.677***
		(20.923)		(34.124)		(0.135)		(0.506)
Log-Freshwater ecotoxicity (orthog, level) x Maturity (years)		2.276		−1.804		0.052**		0.009
		(2.075)		(4.266)		(0.026)		(0.087)
Constant	11032.380***	11861.365***	9527.151***	9128.267***	206.981***	213.654***	240.806***	246.313***
	(349.793)	(367.094)	(426.595)	(448.484)	(10.204)	(10.162)	(19.679)	(20.024)
Observations	1564908	1564908	80684	80684	4461354	4461354	500002	500002
R^2_a	0.829	0.833	0.881	0.883	0.577	0.579	0.636	0.636
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

On the maturity side, although the loan-to-value (LTV) ratio and spread both decline as maturity increases, the interaction between *freshwater ecotoxicity* and maturity has a positive and significant effect on the spread, suggesting that banks consider longer maturities for polluter riskier. This signal, however, is not present in newly originated loans. Overall, new loan origination suggests significant changes in lending patterns that are potentially due to various crises, although reducing efforts to mitigate risks from *freshwater ecotoxicity* polluters. Another reason could be heterogeneity in bank lending patterns, or loans to *freshwater ecotoxicity* polluters are only considered risky under certain circumstances.

4.3 Dissecting the role of bank commitments, policies and EU legislation

In this subsection, we explore possible mechanisms in the pricing of *freshwater ecotoxicity* tied to bank commitments, pollution near biodiversity-sensitive areas (hypothesis 2), bank and EU policies and firms contributing to downstream failures in *Environmental Quality Standards* (EQS), the EU's main instrument to ensure 'good status' in surface waters (hypothesis 3).

4.3.1 Equator Principles Financial Institutions (EPFIs)

The Equator Principles were launched in 2003 with the goal of integrating more robust environmental and social risk management processes in the financing of large infrastructure projects. Signatory financial institutions (EPFIs) incorporate the 10 Equator Principles into their environmental and social risk management policies to ensure alignment.[50] to sound environmental practices. This approach aims to avoid negative impacts on ecosystems, workers, and communities, and if unavoidable, to reduce, mitigate, or compensate for such impacts appropriately. Given our analysis is focused on the environmental impact of polluting facilities, this initiative is particularly noteworthy as it reflects banks' commitments to environmental protection in financing infrastructure projects through self-declaration. As shown in Table 5, it is particularly banks committed to the Equator Principles that tend to price *freshwater ecotoxicity* into their loan-to-value ratios (-33.1 bps). Notably, the effect is particularly pronounced for newly originated loans, where a one-unit increase in log-*freshwater ecotoxicity (orthog, level)* is associated with a 114.6 basis point reduction in the LTV ratio, a response three and a half times as

[50] see https://equator-principles.com/, accessed on 10 August 2025.

Table 5 Freshwater ecotoxicity and Equator Principles for Financial Institutions

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios are expressed in basis points. Profitability and leverage are expressed in decimals.

	LTV		
	Total loans		New loans
	(1)	(2)	(3)
Profitability	982.508	966.467	2496.499***
	(666.307)	(667.262)	(966.868)
Leverage	46.010	40.439	198.290
	(388.423)	(387.738)	(347.279)
Log-Total assets	224.938***	223.454***	−91.235
	(86.346)	(86.519)	(87.415)
Log-Direct GHG emissions (level)	−19.184**	−18.871**	0.190
	(9.274)	(9.412)	(5.875)
Log-Freshwater ecotoxicity (orthog, level)	−16.928*	−6.741	−1.019
	(8.832)	(11.053)	(10.104)
Log-Freshwater ecotoxicity (orthog, level) x signed		−33.084**	−114.563***
		(15.417)	(27.735)
Constant	11058.071***	11072.891***	9769.708***
	(348.869)	(350.374)	(399.488)
Observations	1564908	1564908	80684
R^2_a	0.831	0.831	0.883
Bank-Time FE	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes

strong as in total loans providing important insight into the relevance of public commitment to biodiversity-relevant principles for the pricing of *freshwater ecotoxicity*.[51]

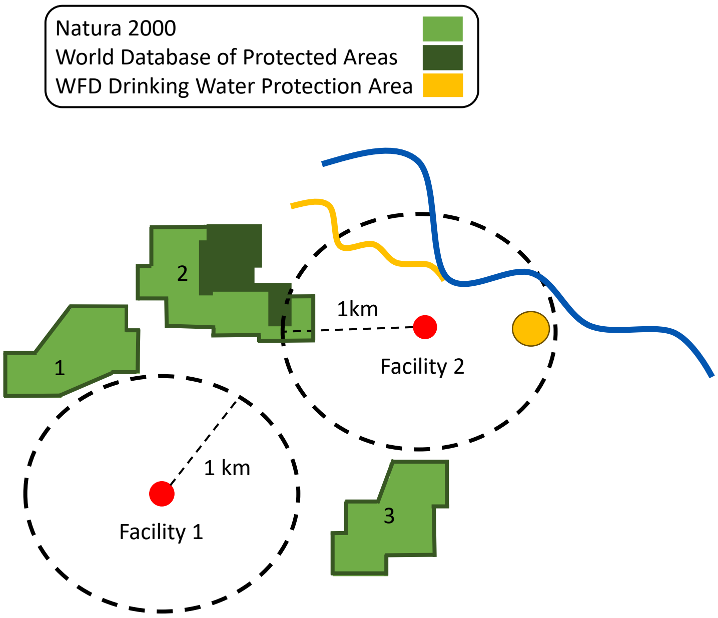
4.3.2 Proximity to biodiversity-sensitive areas

Expanding on our initial findings, we examine the second hypothesis: that banks may account for financial risks tied to lending for projects near biodiversity-sensitive areas, where pollution could do significant harm to ecosystems. The "do no significant harm" principle and the protection of biodiversity and ecosystems are declared objectives of the EU taxonomy supporting the EU's environmental goals. Chemical pollution, and its proxy *freshwater ecotoxicity*, can be relevant as it can flow directly into protected sites or be biotransferred via the food chain, hindering biodiversity conservation.[52] In fact, indirect evidence for the United States suggests increased regulatory scrutiny led industrial facilities near protected areas to scale back production and workforce to reduce pollution rather than investing in pollution control.[53]

To examine whether banks perceive polluters near protected areas as more risky borrowers,

[51] Results on spreads have been delegated to Appendix B.12 due to insignificance.
[52] see Acreman et al. (2020); Adams et al. (2015); van Rees et al. (2021); Koch et al. (2021).
[53] see Akbari et al. (2025).

FIGURE 4 Linking IED facility emissions with protected areas



we make use of the location information of each facility (see Figure 4) and split the *freshwater ecotoxicity* variable into two components: one that is emitted within a range (1km, 2km, 3km or 4km) of biodiversity protected areas, and one that is emitted outside that range.[54] In the following analysis, we focus on the *Natura 2000* network, which serves as the political framework for biodiversity conservation in the EU.[55]

Splitting freshwater ecotoxicity by distance to Natura 2000 areas (Tables 6) reveals substantial and statistically significant reductions in loan-to-value (LTV) ratios for the pollution happening near biodiversity protected areas. For Natura 2000 (and WDPA, s, statistically significant responses across all distances, with the response intensity declining as , with the intensity of the response declining as the distance increases, however, reductions are most pronounced within 1km (-32.9 bps) and 2km (-25.2 bps) distances. Overall, the findings suggest that banks, on average, adhere to the objective of proximity to protected areas proposed in the sustainable finance legislation. To investigate further on this, we refine the proximity of pollution by the respective bank's status as an EPFI signatory (Table 7). The results suggest that EPFI banks,

[54]see Erhart et al. (2025), who proposed this concept. A detailed technical description of this procedure and the data sources used can be found in Appendix C.4.1.

[55]Results on the textitWorld Database of Protected Areas (WDPA), the global overarching framework, are provided in the Appendix, noting that Natura 2000 is a subset within Europe.

Table 6 Freshwater ecotoxicity and (Natura 2000) biodiversity-sensitive areas

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	976.619	984.475	973.819	971.838	−58.639***	−57.142***	−57.452***	−58.009***
	(666.030)	(666.528)	(666.396)	(666.319)	(18.742)	(18.676)	(18.689)	(18.710)
Leverage	36.969	25.855	35.883	37.119	73.321***	72.806***	72.936***	73.628***
	(388.497)	(389.851)	(389.682)	(389.013)	(12.615)	(12.637)	(12.639)	(12.632)
Log-Total assets	228.507***	229.682***	224.048***	223.832***	−6.958***	−6.845***	−6.851***	−6.862***
	(86.957)	(87.067)	(86.650)	(86.852)	(2.082)	(2.077)	(2.084)	(2.086)
Log-Direct GHG emissions (level)	−21.124**	−18.430*	−19.050*	−20.157**	0.992***	1.099***	1.071***	0.991***
	(9.426)	(10.209)	(9.787)	(9.893)	(0.273)	(0.308)	(0.303)	(0.288)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	−32.854***				−0.594			
	(11.010)				(0.419)			
Log-Freshwater ecotoxicity N2000 > 1km (orthog, level)	−8.350				0.441			
	(8.880)				(0.298)			
Log-Freshwater ecotoxicity N2000 $\leq$ 2km (orthog, level)		−25.224**				−0.403		
		(9.823)				(0.360)		
Log-Freshwater ecotoxicity N2000 > 2km (orthog, level)		−8.922				0.349		
		(8.481)				(0.292)		
Log-Freshwater ecotoxicity N2000 $\leq$ 3km (orthog, level)			−13.179				−0.273	
			(9.501)				(0.335)	
Log-Freshwater ecotoxicity N2000 > 3km (orthog, level)			−10.295				0.266	
			(8.619)				(0.293)	
Log-Freshwater ecotoxicity N2000 $\leq$ 4km (orthog, level)				−11.689				0.095
				(9.205)				(0.335)
Log-Freshwater ecotoxicity N2000 > 4km (orthog, level)				−8.981				0.033
				(8.714)				(0.292)
Constant	11045.855***	11041.991***	11064.306***	11065.683***	208.686***	207.995***	208.070***	208.145***
	(351.689)	(351.879)	(350.104)	(350.959)	(10.176)	(10.138)	(10.157)	(10.149)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

particularly in new loans, are the drivers behind this pricing, as evidenced by their reduction of the LTV ratio by 98 bps for each unit increase in pollution within a 1 km radius. This translates to a 21 percentage point reduction in the LTV ratio for large polluters within a 1km distance to N2000, relative to non-polluters.

To test the robustness of our results, we also investigated other metrics related to chemical and nutrient pollution, like freshwater ecotoxicity to water, *pollution to water* and *freshwater eutrophication* (Tables in Appendix B.1.3.1). *Freshwater ecotoxicity* released directly into water is associated with significant and substantial reductions in loan-to-value (LTV) ratios for proximity to WDPA, persisting across all distances (1-4km). In contrast, similar to the results for Natura 2000 sites, significant reductions in LTV ratios are only observed at shorter distances, namely 1km and 2km. The *pollution to water* metric yields qualitatively consistent results. Furthermore, *freshwater eutrophication* is found to have a significant impact on LTV ratios within 1-2 km distances from WDPA. These results reinforce and complement the preceding findings, providing

Table 7 Freshwater ecotoxicity, Natura 2000 sites and Equator Principles

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	LTV							
	Total loans				New loans			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	977.732 (665.713)	985.466 (666.508)	972.065 (666.706)	965.524 (667.380)	3018.471*** (998.378)	3030.905*** (1025.779)	2924.067*** (1007.942)	2986.753*** (999.220)
Leverage	37.463 (388.763)	28.491 (390.521)	39.337 (390.486)	43.428 (390.718)	413.545 (365.574)	324.610 (381.171)	343.498 (383.443)	341.504 (391.039)
Log-Total assets	228.522*** (86.952)	228.953*** (87.173)	223.325** (86.733)	223.932*** (86.857)	−35.667 (90.565)	−35.178 (89.556)	−56.258 (87.878)	−64.551 (88.168)
Log-Direct GHG emissions (level)	−21.041** (9.492)	−19.246* (10.058)	−19.973** (9.727)	−20.043** (9.837)	−8.729 (6.794)	−5.601 (8.937)	−5.209 (8.568)	−7.700 (8.604)
Log-Freshwater ecotoxicity N2000≤1km (orthog, level) x signed	−34.677** (15.407)				−97.605*** (24.195)			
Log-Freshwater ecotoxicity N2000≤1km (orthog, level) x not signed	−31.480** (14.353)				−17.438 (18.304)			
Log-Freshwater ecotoxicity N2000>1km (orthog, level)	−8.326 (8.897)				−20.726* (11.602)			
Log-Freshwater ecotoxicity N2000≤2km (orthog, level) x signed		−40.181*** (13.745)				−72.995*** (23.080)		
Log-Freshwater ecotoxicity N2000≤2km (orthog, level) x not signed		−15.932 (13.094)				−30.650** (13.673)		
Log-Freshwater ecotoxicity N2000>2km (orthog, level)		−8.144 (8.534)				−20.783* (11.196)		
Log-Freshwater ecotoxicity N2000≤3km (orthog, level) x signed			−29.479** (13.077)				−63.121*** (23.625)	
Log-Freshwater ecotoxicity N2000≤3km (orthog, level) x not signed			−2.937 (12.649)				−22.467 (13.998)	
Log-Freshwater ecotoxicity N2000>3km (orthog, level)			−9.423 (8.654)				−17.462 (11.070)	
Log-Freshwater ecotoxicity N2000≤4km (orthog, level) x signed				−23.839* (12.720)				−49.669* (26.974)
Log-Freshwater ecotoxicity N2000≤4km (orthog, level) x not signed				−3.821 (12.310)				−28.534** (13.903)
Log-Freshwater ecotoxicity N2000>4km (orthog, level)				−8.287 (8.768)				−17.710 (11.067)
Constant	11045.884*** (351.713)	11047.256*** (352.547)	11070.482*** (350.734)	11067.541*** (351.296)	9419.680*** (419.765)	9439.273*** (411.955)	9535.858*** (401.830)	9572.105*** (402.898)
Observations	1564908	1564908	1564908	1564908	80684	80684	80684	80684
R^2_a	0.831	0.831	0.831	0.831	0.883	0.883	0.883	0.883
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

further support for our conclusions and failing to provide evidence that would allow us to reject hypothesis 2. Financial incentives to move polluting activities have redistributive costs and don't solve the negative externality problem. Therefore, the *Chemicals Strategy for Sustainability* and the REACH regulation remain important complementary measures to reduce the use of harmful chemicals.[56]

[56] see Chemicals Strategy for Sustainability and REACH regulation, accessed on 12 October 2025.

4.3.3 Bank and EU policies

In recent years, the European Union has demonstrated its dedication to environmental conservation through significant legislative initiatives aimed at reducing pollution and implementing the Kunming-Montreal Global Biodiversity Framework. This commitment to safeguarding biodiversity and ecosystems at the European and global level has, in turn, prompted certain financial institutions to establish and enforce their own biodiversity and pollution mitigation policies. To capture the presence of these policies, we employ a novel approach, utilising Large Language Models (LLMs) to analyse bank-level annual reports and other documents. This enables us to construct bank-level dummy variables that align with the biodiversity policy principles outlined by the United Nations Environment Programme Finance Initiative (UNEPFI) and the pollution policy guidelines set by the E-PRTR.[57]

In Table 8, we try to refine the previous sections result, by introducing interactions of the LLM-generated biodiversity and pollution policy dummy variables (bank policies) and dummy variables for the post Biodiversity Strategy 2030 and post Kunming-Montreal Agreement periods (EU and global policies) with log-*freshwater ecotoxicity N2000* $\leq$ *1km (orthog, level)*. As we do not have data on all banks in our sample, we constrain the sample to banks that have at least one report that we could evaluate. The analysis unveils that banks with biodiversity and pollution policies are the ones driving the reduction of LTV ratios of polluters (-5.9 pp and -1.3 pp per unit value increase in log-*freshwater ecotoxicity N2000* $\leq$ *1km (orthog, level)*). Banks with a pollution policy appear to price a premium to those of 6.2 bps per unit value increase in log-*freshwater ecotoxicity N2000* $\leq$ *1km (orthog, level)*. Furthermore, to examine the impact of these international agreements on lending practice within this set of banks, we have introduced interaction terms between post-Biodiversity Strategy 2030 and post-Kunming-Montreal Agreement (KM) dummies and pollution within a 1km distance to N2000. In the aftermath of KM, banks have charged a premium to *freshwater ecotoxicity* polluters (1.2 bps in total loans, and 2.6 bps in new loans), while LTV ratios have been reduced by 5.3 pp for these polluters in newly originated loans since the announcement of the Biodiversity Strategy.

[57] see UNEPFI (2023). Please refer to Appendix C.7 for details on the method.

TABLE 8 Freshwater ecotoxicity near Natura 2000, bank and EU policies

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals. The sample consists of banks providing at least one report throughout the sample.

	LTV							
	Total loans				New loans			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	2034.618	1977.558	2004.439	2002.081	7667.230***	7806.729***	8203.083***	7469.326***
	(1629.472)	(1630.023)	(1631.086)	(1631.374)	(2460.395)	(2437.630)	(2433.816)	(2555.158)
Leverage	1091.676	1097.533	1100.632	1095.446	2673.674*	2735.649**	2826.533**	2709.804**
	(747.874)	(748.507)	(748.442)	(748.065)	(1373.426)	(1378.873)	(1395.600)	(1355.576)
Log-Total assets	489.248	491.026	494.156	496.453	−1427.973**	−1430.805**	−1421.893**	−1448.406**
	(388.163)	(388.339)	(388.433)	(389.303)	(648.264)	(648.225)	(652.351)	(648.057)
Log-Direct GHG emissions (level)	−80.280*	−81.103*	−78.283*	−81.134*	58.554	50.296	61.481*	59.427
	(41.480)	(41.547)	(41.629)	(41.487)	(36.828)	(40.030)	(33.328)	(36.370)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	533.045***	57.964	48.288	−30.712	−36.885	98.979	486.764**	−61.363
	(87.421)	(45.738)	(93.427)	(38.662)	(82.997)	(94.876)	(204.942)	(99.540)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Biodiversity policy	−593.303***				N/A			
	(92.679)							
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Pollution policy		−113.687*				−138.284		
		(59.280)				(84.777)		
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Post Biodiversity Strategy 2030			−115.438				−527.598**	
			(96.404)				(238.684)	
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Post Kunming-Montreal Agreement				−57.773				47.134
				(52.185)				(77.376)
Constant	7205.565***	7211.760***	7198.561***	7189.961***	14364.252***	14374.073***	14312.337***	14470.221***
	(1652.632)	(1653.471)	(1653.809)	(1656.952)	(3138.571)	(3140.122)	(3166.655)	(3149.826)
Observations	110059	110059	110059	110059	5926	5926	5926	5926
R^2_a	0.353	0.352	0.352	0.352	0.870	0.870	0.871	0.871
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	*Yes*
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

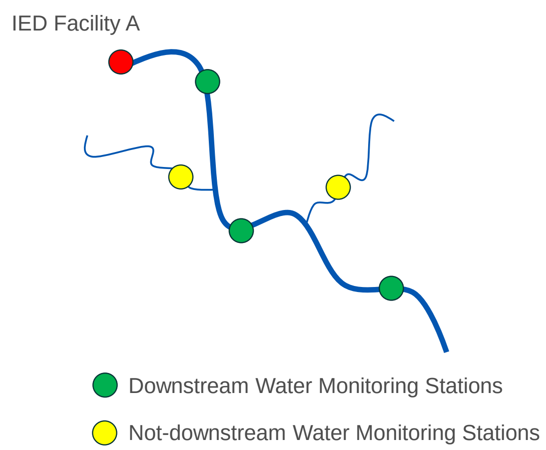
	Spread							
	Total loans				New loans			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Profitability	29.482	27.934	29.911	29.449	204.501**	204.662**	204.782**	205.212**
	(40.313)	(40.222)	(40.321)	(40.544)	(89.052)	(89.151)	(89.530)	(88.565)
Leverage	91.157***	90.958***	91.236***	91.278***	112.129***	112.134***	112.213***	111.736***
	(18.700)	(18.675)	(18.710)	(18.683)	(28.843)	(28.846)	(28.891)	(28.648)
Log-Total assets	−14.353***	−14.373***	−14.348***	−14.505***	−20.092***	−20.093***	−20.088***	−20.848***
	(4.530)	(4.529)	(4.535)	(4.513)	(6.932)	(6.932)	(6.935)	(6.876)
Log-Direct GHG emissions (level)	1.801***	1.802***	1.804***	1.763***	1.349**	1.348**	1.355**	1.256**
	(0.556)	(0.557)	(0.554)	(0.554)	(0.583)	(0.582)	(0.597)	(0.572)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	−0.068	−5.807	1.180	−0.140	0.326	1.686	1.677	0.059
	(1.038)	(3.704)	(0.822)	(0.711)	(1.436)	(1.032)	(2.538)	(0.679)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Biodiversity policy	0.397				0.693			
	(1.198)				(1.738)			
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Pollution policy		6.192*				−0.669		
		(3.706)				(1.325)		
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Post Biodiversity Strategy 2030			−0.927				−0.664	
			(1.118)				(2.794)	
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level) x Post Kunming-Montreal Agreement				1.183***				2.624***
				(0.432)				(0.537)
Constant	238.449***	238.517***	238.420***	239.128***	296.471***	296.508***	296.453***	300.500***
	(23.737)	(23.738)	(23.734)	(23.682)	(35.839)	(35.830)	(35.878)	(35.621)
Observations	590825	590825	590825	590825	104280	104280	104280	104280
R^2_a	0.615	0.616	0.615	0.616	0.738	0.738	0.738	0.741
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4.3.4 Environmental Quality Standards and "good status" of surface waters

Finally, we investigate the third hypothesis, which assumes that loans to firms that contribute to a "failed good chemical status" in downstream water bodies and pollution in proximity to *Drinking Water Protected Areas* may be considered more risky.

First, we investigate on the loan pricing of pollution in the context of the Water Framework Directive, enacted in 2000, which provides the foundation for Europe's water protection policy. In particular, its daughter's directive related to *Environmental Quality Standards* seeks to achieve 'good chemical status' for surface waters by 2027. This is because legacy chemical pollution, as well as the uncontrolled introduction of new substances, are intensifying threats to the long-term health and sustainability of freshwater ecosystems.[58] As shown by the plateauing of European freshwater biodiversity and river quality since the 2010s, with many rivers remaining in a poor state.[59] In practice, the EQSD sets short- and long-term concentration limits for

FIGURE 5 Linking IED facility emissions with downstream water monitoring stations



45 priority hazardous substances, which are monitored by monitoring stations. Though priority substances represent only a small fraction of chemicals in European surface waters - potentially underestimating the biodiversity impact - their legal regulation poses significant operational risks to companies (and hence financial risks to their lenders) as competent authorities are obliged to consider the receiving body's EQS when granting or renewing pollution permits of firms.[60]

[58] see Sayer et al. (2025); Dudgeon et al. (2006); Dudgeon (2019).
[59] see Haase et al. (2023); Sinclair et al. (2024).
[60] see ECHA (2019) and Posthuma et al. (2020). The EQSs can be stricter than *BAT* emission limits (IED

To investigate whether banks amend their loan conditions to firms contributing to chemical status failures of downstream water bodies, we first construct firm-level metrics of risk exposure. First, we use geospatial analysis to determine monitoring sites downstream to the E-PRTR facilities (see Figure 5).[61] Second, we assess whether the water monitoring stations record pollutant concentrations above permissible EQS limits (see Table C.2).[62] EQS limits are set for the long term, the annual average (AA), and the short term, the maximum allowable concentration (MAC), which relates to pollution accidents. An exceedance in only one single recorded pollutant implies a chemical status failure. Our analysis concentrates on identifying the annual average exceedance. Third, we leverage the fact that facility-level emissions of EQS monitored pollutants are largely documented through the E-PRTR and determine whether upstream facilities, as reported by the E-PRTR, are emitting the same pollutant, hence potentially contributing to the failure to achieve good environmental status. We focus on pollutants emitted to water, and we exclude wastewater treatment (NACE lvl2 36) that mitigates the pollution problem. For each firm, we calculate two metrics of EQS failures: one for the nearest downstream water monitoring station (MSI1) and another aggregating failures across the first five downstream stations (MSI15).[63] We split status failures in MSI1 (MSI15) into two bins: a first with 1 to 2 (2 to 5) failures and a second with more than 3 (6) failures. The analysis is limited by inconsistent reporting years across monitoring stations. In our analysis, we use one-year lagged values for the temporal dimension of the data, filling any gaps with last year's values.

As shown in Table 9, our analysis indicates that banks are likely aware of firms contributing to EQS good quality failures, which could be the case as all relevant data is publicly accessible.[64] Consequently, in the total set of loans, banks substantially set lower LTV values for these firms, particularly for those contributing to more than three failures in the first downstream monitoring site, resulting in 41 percentage points less collateral. The signal that involves up to five downstream monitoring sites is weaker, resulting in only a 14 pp reduced LTV ratio

Article 18), acting as a 'safety net' for water protection (see Ricardo (2020) and Undeman et al. (2022)). While EU law emphasises legal certainty, adaptive management tools, such as *BAT* conclusions, have shown that it is possible to balance legal flexibility with predictability, even in the face of emerging scientific knowledge and dynamic lists of priority substances, see Undeman et al. (2022).

[61] For details on the dataset construction see Appendix C.4.2.

[62] see Loga and Przeździecki (2021).

[63] see Table B.26 for descriptive statistics on 'good status' failures and exposed loans.

[64] The results for pollutants emitted to all release media can be found in Table B.25.

TABLE 9 Downstream water monitoring stations and annual average (AA) 'good status', emissions to water

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	LTV		Spread		LTV		Spread	
	Total loans	New loans	Total loans	New loans	Total loans	New loans	Total loans	New loans
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	970.259	3007.926***	−58.122***	34.951	984.711	3018.890***	−58.086***	35.099
	(666.352)	(996.453)	(18.706)	(37.151)	(666.003)	(999.214)	(18.707)	(37.163)
Leverage	36.733	459.466	73.750***	117.405***	47.344	461.239	73.912***	117.445***
	(389.073)	(376.235)	(12.609)	(26.160)	(389.219)	(376.507)	(12.600)	(26.139)
Log-Total assets	225.879***	−46.814	−7.169***	−11.272***	223.208**	−45.573	−7.341***	−11.334***
	(86.458)	(93.089)	(2.065)	(3.827)	(87.097)	(93.112)	(2.055)	(3.844)
Log-Direct GHG emissions (level)	−18.328**	−6.504	1.019***	0.808**	−19.233**	−6.568	1.022***	0.809**
	(9.209)	(6.688)	(0.271)	(0.342)	(9.263)	(6.693)	(0.271)	(0.342)
Log-Freshwater ecotoxicity (orthog, level)	−16.952*	−28.073**	0.258	0.000	−17.101*	−28.224**	0.254	−0.002
	(8.863)	(13.574)	(0.311)	(0.387)	(8.831)	(13.595)	(0.308)	(0.386)
Emissions to water: $1 \leq$ MSI1 EQS failed 'good status' ≤ 2	654.472	1075.366	24.475*	47.373*				
	(662.352)	(1005.291)	(14.760)	(27.081)				
Emissions to water: $3 \leq$ MSI1 EQS failed 'good status'	−4102.477***	3212.813***	−15.780	47.938				
	(492.854)	(1073.799)	(43.224)	(37.391)				
Emissions to water: $2 \leq$ MSI15 EQS failed 'good status' ≤ 5					335.638	288.371	17.514	33.888*
					(958.385)	(883.525)	(18.657)	(20.111)
Emissions to water: $6 \leq$ MSI15 EQS failed 'good status'					−1443.749	4574.253***	−63.421*	96.552***
					(2194.193)	(1593.889)	(32.638)	(28.206)
Constant	11058.103***	9450.975***	209.422***	241.335***	11064.985***	9444.410***	209.961***	241.481***
	(348.997)	(426.677)	(10.074)	(19.783)	(350.949)	(426.776)	(9.965)	(19.819)
Observations	1564908	80684	4461354	500002	1564908	80684	4461354	500002
R^2_a	0.831	0.882	0.579	0.636	0.831	0.882	0.579	0.636
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(non-significant). Overall, the plausibility of the first water monitoring station is highest. An alternative explanation could be that we have created a reliable proxy for firms contributing to local environmental issues being subject to possible regulators' action that banks are aware of.[65] At the same time, we see increased LTV ratios in new loans (32 to 46 pp). Interestingly, on the spread side, spreads for these firms increased to 1 pp. Overall, the reduction in the LTV ratio is proportionally greater for firms with a higher number of pollutant emissions contributing to the failure, suggesting a direct relationship between the extent of environmental harm and the bank's lending decision. Still, the obtained findings should be interpreted cautiously, as only a few dozen firms contributed to a 'good status' failure and in more recent times, special lending and state aid could have played a larger role, trying to compensate additional risks with increased spreads.

On another note, chemical and nutrient pollution are also increasingly considered a risk to drinking water resources used by households and industrial production. To investigate this further, we complement the analysis on biodiversity-protected areas by examining the loan pricing of *freshwater ecotoxicity*, *pollution to water* and *freshwater eutrophication* near WFD protected areas. In particular, we use the WISE WFD dataset and use the minimum distance of facilities to *Drinking Water Protected Areas* (DWPA) designated for the abstraction of water intended for human consumption under WFD Article 7 (incl. both abstraction points and drivers).[66] The results[67] show that the impact of pollution on lending terms is nuanced. The evidence for *freshwater ecotoxicity* polluters is not very strong. The analysis unveils that those operating within 1 km of DWPA are subject to lower LTV ratios. In contrast, lenders respond more strongly to the *pollution to water* metric, with significant effects observed at distances of up to 4 km. Moreover, *freshwater eutrophication* polluters located within 1-2 km of DWPA face loan premiums of up to 1 basis point (bps) for a unit value increase in log-*Freshwater eutrophication (orthog, level)*, and those within 1 km also experience reduced LTV ratios, indicating a weak but heightened risk perception to nutrient polluters. Indeed, when it comes to drinking water

[65] We also tested static measures of contributions to failures, which resulted in stronger LTV responses. Sampling randomly from *freshwater ecotoxicity* polluters structurally similar to the EQS failures didn't unveil any sizeable and/or significant coefficients.

[66] For details on the data construction see Appendix C.4.3.

[67] see Tables B.22, B.23 and B.24 in Appendix B.1.3.2.

pollution, nutrients have traditionally been a primary concern in Europe, while the awareness of chemical pollution only entered political discussions recently in the context of resilience to water scarcity.[68] Overall, banks appear to incorporate both factors into their lending conditions. Therefore, neither the results on WFD-DWPA nor the Environmental Quality Standards allow us to reject the third hypothesis.

5 Conclusion

Our results suggest that biodiversity protection legislation is starting to influence financial decision-making in the banking system, despite biodiversity and pollution regulations being less stringent than their climate counterpart. By reducing loan-to-value ratios for large polluters, banks reduce their exposure to biodiversity risks from chemical pollution in their corporate loan portfolios. At the same time, they charge spreads based on factors tied to regulatory risks, impaired liquidity, and potential default. Interestingly, lending patterns appear aligned with concepts proposed in the sustainable finance legislation, e.g., to steer harmful activities away from biodiversity-protected areas, as well as with those proposed in the water protection legislation, intended to protect the 'good chemical status' of surface waters. While the latter is clearly an outcome of regulation that can constrain firms' operations, we find that banks adopting and committing to biodiversity and pollution policies take a more proactive approach to revising their lending practices, creating a financial incentive for firms to mitigate pollution and relocate adverse activities, which in turn enables financial supervisors to mitigate the chemical pollution-induced pressures on biodiversity in Europe. While our findings suggest that banks are beginning to incorporate biodiversity and chemical pollution risks into their lending practices and risk management, establishing robust causal relationships is an essential next step, albeit a challenging one given current data limitations, including short time series, data gaps, lack of temporal variation (protected areas), special lending and state aid.

Concerning policy implications, the results underscore the importance of supervisory bodies and policymakers extending their focus to consider emission-related biodiversity risks in their regulatory frameworks. Additionally, they can use the findings to align the role of the banking

[68] see EU Water Resilience Strategy, acessed on 14 October 2025.

sector with the EU's zero pollution ambition and biodiversity strategy objectives, thereby mitigating risks to the financial sector. They can support the development of standardised practices across the banking sector. Ultimately, the proposed approach enables biodiversity protection from chemical pollution via the financial sector worldwide, as pollution registries, protected areas and environmental quality standards have been established globally.

Declaration of Generative AI and AI-assisted technologies in the writing process

While preparing this manuscript, the authors used LLM to proofread and improve the flow of the text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content in the manuscript.

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Supplementary material

A Literature on biodiversity-related financial risks

Integrating biodiversity-related risks into financial frameworks is an ongoing challenge. The literature has expanded from examining isolated events to exploring a broader range of nature-related risks, particularly those associated with pollution and its ecological consequences and their impact on corporate financing costs, equity valuations, and credit constraints.

Early research laid the groundwork for biodiversity risk pricing, examining the impact of acute biodiversity events on corporate bond markets in Brazil and Australia.[69] The development of a Biodiversity Risk Index using Global Data on Events, Location, and Tone (GDELT) news data has since influenced other studies that explored data from corporate filings (10-K statements), fund holdings, and stakeholder surveys that showed that equity valuations may already be affected by biodiversity risks.[70] In another vein, a comprehensive international investigation has shown that investors consider biodiversity risk when valuing equities. Corporate Biodiversity Footprint data generally fails to explain cross-sectional returns from 2019 to 2022, except after key policy announcements, when a biodiversity premium emerges. Notably, after the 2021 Kunming Declaration, companies with larger footprints saw higher returns, despite an initial stock decline.[71] Further research introduced a biodiversity factor to capture the distinct market response to biodiversity intensity, independent of GHG emissions or conventional risk factors.[72] This approach documented a positive risk premium on realised returns but a negative premium on expected returns in biodiversity-sensitive sectors. Crucially, the negative expected return premium strengthened after 2021, aligning with heightened regulatory scrutiny and increased investor awareness of biodiversity risks. A more granular analysis examined how pollution impacts near biodiverse areas affect firm valuation.[73] By integrating toxic emissions data from the US Environmental Protection Agency with biodiversity metrics, this study found that firms operating in highly biodiverse regions were systematically undervalued by 41 basis

[69] see Cherief et al. (2022).
[70] see Giglio et al. (2023).
[71] see Garel et al. (2024).
[72] see Coqueret et al. (2025).
[73] see Dey (2025).

points per month. Other research shows that industrial facilities near protected areas in the US significantly reduced toxic emissions, primarily through scaled-back production and workforce contraction rather than investment in pollution abatement, highlighting the importance of the biodiversity conservation channel.[74]

Various works demonstrate similar dynamics in credit markets.[75] For example, the improved long-term refinancing conditions linked to effective biodiversity management[76] mirror the patterns identified in equity markets, where firms that manage biodiversity risks more effectively enjoy valuation benefits. Moreover, the elevated bond yields observed in municipalities with national nature reserves[77] parallel the equity market findings that heightened biodiversity awareness and regulatory signals translate into tangible pricing effects. Finally, by revealing how sovereign credit default swap spreads react more strongly to biodiversity loss in ecologically depleted regions.[78]. Also, international lenders have been found to increasingly incorporate pressure-related borrowers' information into their financing decisions.[79]

The importance of broader ecosystem health is also evidenced in recent European cases where, under inadequate environmental policy responses and insufficient biodiversity protection, pollution-related algae blooms have been shown to affect demand and prices for housing in some regions adversely[80], with property markets particularly sensitive to both local management practices and broader ecosystem health conditions. Dropping house prices can cause reduced credit to manufacturing firms, leading to reduced investment, capital ratio, total factor productivity and economic activity in the area.[81] At the same time, N2000-related land use restrictions show negative effects on economic activities and positive ones on built properties, inside or nearby.[82] In addition, stronger liability protection for corporate parents leads to up to 9% increase in toxic emissions by their subsidiaries, which appears to be driven by lower investment in abatement technologies.[83] In this context, other evidence shows that traditional debt financing can exacer-

[74]see Akbari et al. (2025).
[75]see Chen et al. (2024) and Giglio et al. (2024).
[76]see Hoepner et al. (2024).
[77]see Chen et al. (2024).
[78]see Giglio et al. (2024).
[79]see Becker et al. (2025).
[80]see Lamas Rodríguez et al. (2023).
[81]see Basco et al. (2025).
[82]see Ahlvik and van Kooten (2024).
[83]see Akey and Appel (2021).

bate short-termism in firm operations, leading to a sacrifice of long-term investments leading to increases in both pollution levels and intensity after debt issuance (loans and bonds).[84] The evidence from fixed income markets reinforces the idea that biodiversity considerations increasingly drive risk premia, financing costs, and valuation metrics across various asset classes.

An emerging body of work tries to apply the findings to portfolio construction and project financing, offering investors and financial institutions actionable guidance on incorporating biodiversity into their investment decisions. A significant breakthrough proposes a portfolio optimisation framework simultaneously targeting biodiversity and climate goals.[85] Over a 21-year empirical analysis, the authors demonstrate that investors can enhance their portfolios' biodiversity and climate profile without significantly eroding risk-adjusted returns. While there is a modest initial performance trade-off, these results improve as sustainability ambitions rise or long-only constraints are relaxed, suggesting that thoughtful portfolio design can balance environmental considerations with financial objectives. Relatedly, other work investigates the financing structures best suited for biodiversity investments.[86] This paper finds that high-return but smaller-scale projects attracting private capital often yield limited biodiversity benefits. In contrast, larger, more impactful projects rely on blended finance arrangements that deliver steadier, if lower, returns. This nuanced relationship between project characteristics and financing mechanisms helps bridge the gap between market pricing inefficiencies documented in earlier studies and practical solutions that align investment outcomes with biodiversity goals. This body of research highlights that, although trade-offs and complexities persist, incorporating biodiversity objectives need not preclude competitive financial performance.

Novel studies have highlighted the complexities of measuring and implementing biodiversity risk, revealing notable gaps between theoretical aspirations and practical realities. These challenges have become evident in the interpretation of biodiversity indicators and attempts to align them with financial decision-making processes. For instance, a recent study testified a "biodiversity confusion" in ESG biodiversity ratings as those often fail to correlate meaningfully with firm characteristics - apart from firm size - and offer limited predictive power for stock returns.[87] This

[84] see Lyu et al. (2025).
[85] see Bouyé et al. (2024).
[86] see Flammer et al. (2025).
[87] see Xin et al. (2023).

weak linkage is further complicated by the apparent disregard of biodiversity ratings by institutional investors and analysts, a pattern that may help explain the puzzling results observed in earlier studies, such as the sector-specific discrepancies[88] and varying biodiversity risk premia.[89] Indeed, the complexity of translating biodiversity measures into financial metrics becomes especially evident when considering that biodiversity ratings predict negative returns for metals and mining firms, yet correlate positively with returns in the utilities sector. A significant concern is that many of the targets outlined in the Kunming-Montreal declaration such as ecosystem integrity or aquatic biodiversity are not adequately addressed by existing major biodiversity indices, which poses a risk to the overall goal of conserving, restoring, and sustainably managing biodiversity.[90]

The lack of standardised approaches undermines meaningful comparisons across firms and sectors. Moreover, biodiversity footprints can be calculated based on installation or production-based perspective, or on a product-based perspective taking into account high biodiversity impacts from upstream (e.g. due to the feedstock used for production) and downstream (e.g. the type of product sold such as a pesticide or other hazardous chemical leading to diffuse emissions). In addition, the growing body of research underscores the pressing need to advance more scientifically robust and ecologically accurate biodiversity measures to overcome the inherent difficulties of incorporating ecological criteria into market-based valuations and align financial markets with evolving biodiversity stewardship principles, facilitating consistent evaluation of ecological factors, and promoting sustainable and responsible investment decisions.

[88] see Garel et al. (2024).
[89] see Coqueret et al. (2025).
[90] see Zhu et al. (2024).

B Supplementary analyses

B.1 Freshwater ecotoxicity

B.1.1 Basic regressions

TABLE B.10 Freshwater ecotoxicity and loan-to-value ratios

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios are expressed in basis points. Profitability and leverage are expressed in decimals. Intensity refers to total emission levels normalised by the firm's revenues.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Profitability	914.637	953.747	933.774	982.508	956.094	950.266	975.051
	(663.995)	(665.413)	(664.433)	(666.307)	(673.618)	(672.480)	(673.938)
Leverage	45.384	28.145	63.050	46.010	−32.211	5.463	−9.863
	(387.233)	(389.490)	(386.719)	(388.423)	(393.402)	(390.373)	(391.801)
Log-Total assets	190.531**	214.449**	196.166**	224.938***	204.376**	193.712**	207.523**
	(80.298)	(85.574)	(80.565)	(86.346)	(82.842)	(80.781)	(83.072)
Log-Direct GHG emissions (level)		−16.498*		−19.184**			
		(9.198)		(9.274)			
Log-Freshwater ecotoxicity (orthog, level)			−14.466*	−16.928*			
			(8.749)	(8.832)			
Log-Direct GHG emissions (intensity)					−20.730**		−23.100**
					(9.938)		(10.035)
Log-Freshwater ecotoxicity (orthog, intensity)						−16.103*	−18.520**
						(8.918)	(9.026)
Constant	11187.258***	11108.181***	11155.438***	11058.071***	11067.592***	11167.901***	11040.218***
	(331.444)	(345.144)	(332.908)	(348.869)	(354.262)	(334.350)	(356.345)
Observations	1564908	1564908	1564908	1564908	1551665	1551665	1551665
R^2_a	0.831	0.831	0.831	0.831	0.832	0.832	0.832
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

TABLE B.11 Freshwater ecotoxicity and interest rate spreads

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals. Intensity refers to total emission levels normalised by the firm's revenues.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Profitability	−57.758***	−58.014***	−57.764***	−58.039***	−57.574***	−58.357***	−57.444***
	(19.022)	(18.691)	(19.034)	(18.697)	(18.806)	(19.225)	(18.814)
Leverage	72.515***	73.484***	72.505***	73.506***	73.738***	72.962***	73.723***
	(12.532)	(12.608)	(12.532)	(12.610)	(12.682)	(12.620)	(12.683)
Log-Total assets	−5.142***	−6.766***	−5.241***	−7.048***	−5.980***	−5.267***	−6.147***
	(1.990)	(2.050)	(2.016)	(2.065)	(1.992)	(2.004)	(1.983)
Log-Direct GHG emissions (level)		0.974***		1.018***			
		(0.267)		(0.271)			
Log-Freshwater ecotoxicity (orthog, level)			0.131	0.279			
			(0.305)	(0.311)			
Log-Direct GHG emissions (intensity)					1.027***		1.067***
					(0.268)		(0.270)
Log-Freshwater ecotoxicity (orthog, intensity)						0.167	0.301
						(0.305)	(0.309)
Constant	202.511***	207.763***	202.990***	209.017***	209.026***	203.309***	209.934***
	(9.942)	(10.050)	(10.052)	(10.101)	(10.180)	(10.029)	(10.148)
Observations	4461354	4461354	4461354	4461354	4439966	4439966	4439966
R_a^2	0.578	0.579	0.578	0.579	0.579	0.578	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

B.1.2 Equator Principles Financial Institutions

Table B.12 Freshwater ecotoxicity, EPFI and interest rate spreads

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	Spread		
	Total loans		New loans
	(1)	(2)	(3)
Profitability	−58.039***	−58.077***	36.330
	(18.697)	(18.719)	(37.199)
Leverage	73.506***	73.467***	117.941***
	(12.610)	(12.626)	(26.158)
Log-Total assets	−7.048***	−7.040***	−11.037***
	(2.065)	(2.065)	(3.804)
Log-Direct GHG emissions (level)	1.018***	1.018***	0.788**
	(0.271)	(0.271)	(0.349)
Log-Freshwater ecotoxicity (orthog, level)	0.279	0.299	−0.173
	(0.311)	(0.328)	(0.391)
Log-Freshwater ecotoxicity (orthog, level) x signed		−0.057	0.427
		(0.454)	(0.571)
Constant	209.017***	209.002***	240.086***
	(10.101)	(10.107)	(19.726)
Observations	4461354	4461354	500002
R_a^2	0.579	0.579	0.636
Bank-Time FE	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes

B.1.3 Proximity to protected areas

B.1.3.1 Biodiversity-sensitive areas

Table B.13 Freshwater ecotoxicity and WDPA biodiversity-sensitive areas, total loans

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	979.299	976.800	973.729	973.020	-58.052^{***}	-57.358^{***}	-57.645^{***}	-57.944^{***}
	(665.904)	(666.133)	(666.479)	(666.605)	(18.680)	(18.704)	(18.709)	(18.712)
Leverage	37.138	35.396	31.367	28.948	73.509^{***}	73.163^{***}	73.182^{***}	73.589^{***}
	(388.451)	(388.894)	(390.189)	(390.403)	(12.612)	(12.616)	(12.620)	(12.628)
Log-Total assets	225.737^{***}	228.204^{***}	224.090^{***}	224.885^{***}	-6.998^{***}	-6.879^{***}	-6.852^{***}	-6.882^{***}
	(86.922)	(86.929)	(86.625)	(86.969)	(2.080)	(2.075)	(2.086)	(2.086)
Log-Direct GHG emissions (level)	-20.590^{**}	-18.394^{*}	-17.499^{*}	-18.813^{*}	0.999^{***}	1.069^{***}	1.037^{***}	1.000^{***}
	(9.384)	(10.135)	(9.938)	(10.096)	(0.272)	(0.299)	(0.295)	(0.288)
Log-Freshwater ecotoxicity WDPA $\leq$ 1km (orthog, level)	-29.513^{***}				-0.490			
	(10.705)				(0.382)			
Log-Freshwater ecotoxicity WDPA $>$ 1km (orthog, level)	-8.002				0.401			
	(8.910)				(0.307)			
Log-Freshwater ecotoxicity WDPA $\leq$ 2km (orthog, level)		-22.683^{**}				-0.266		
		(9.707)				(0.343)		
Log-Freshwater ecotoxicity WDPA $>$ 2km (orthog, level)		-9.450				0.286		
		(8.395)				(0.292)		
Log-Freshwater ecotoxicity WDPA $\leq$ 3km (orthog, level)			-19.033^{*}				-0.147	
			(10.178)				(0.321)	
Log-Freshwater ecotoxicity WDPA $>$ 3km (orthog, level)			-6.416				0.191	
			(8.555)				(0.296)	
Log-Freshwater ecotoxicity WDPA $\leq$ 4km (orthog, level)				-19.641^{**}				0.081
				(9.982)				(0.326)
Log-Freshwater ecotoxicity WDPA $>$ 4km (orthog, level)				-3.215				0.066
				(8.826)				(0.290)
Constant	11056.842^{***}	11045.720^{***}	11063.629^{***}	11061.296^{***}	208.788^{***}	208.123^{***}	208.084^{***}	208.227^{***}
	(351.537)	(351.509)	(350.102)	(351.478)	(10.165)	(10.136)	(10.169)	(10.153)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R_a^2	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.14 Freshwater ecotoxicity and World Database of Protected Areas, new loans

	New loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	2987.460***	3134.309***	3022.357***	3019.706***	34.535	35.041	34.187	30.648
	(1004.583)	(1016.313)	(996.800)	(993.429)	(37.182)	(36.739)	(36.726)	(36.628)
Leverage	428.869	331.741	360.672	341.903	116.627***	117.421***	118.251***	122.266***
	(371.872)	(383.347)	(385.778)	(397.539)	(26.378)	(26.054)	(25.974)	(26.034)
Log-Total assets	−50.373	−33.955	−50.007	−57.473	−11.256***	−10.877***	−10.798***	−10.402***
	(92.859)	(91.085)	(89.588)	(89.247)	(3.873)	(3.854)	(3.881)	(3.902)
Log-Direct GHG emissions (level)	−12.545*	−3.224	−4.210	−8.781	0.739**	0.755*	0.711	0.553
	(7.229)	(9.152)	(8.558)	(8.773)	(0.340)	(0.448)	(0.433)	(0.395)
Log-Freshwater ecotoxicity WDPA $\leq$ 1km (orthog, level)	−51.337***				−0.636			
	(18.248)				(0.471)			
Log-Freshwater ecotoxicity WDPA $>$ 1km (orthog, level)	−22.711*				0.205			
	(12.008)				(0.388)			
Log-Freshwater ecotoxicity WDPA $\leq$ 2km (orthog, level)		−45.810***				−0.084		
		(14.562)				(0.511)		
Log-Freshwater ecotoxicity WDPA $>$ 2km (orthog, level)		−24.302**				−0.128		
		(11.333)				(0.365)		
Log-Freshwater ecotoxicity WDPA $\leq$ 3km (orthog, level)			−37.362**				−0.030	
			(15.016)				(0.478)	
Log-Freshwater ecotoxicity WDPA $>$ 3km (orthog, level)			−22.366*				−0.208	
			(11.604)				(0.362)	
Log-Freshwater ecotoxicity WDPA $\leq$ 4km (orthog, level)				−37.799**				0.234
				(15.919)				(0.435)
Log-Freshwater ecotoxicity WDPA $>$ 4km (orthog, level)				−20.384*				−0.525
				(11.444)				(0.344)
Constant	9480.535***	9417.349***	9487.807***	9531.432***	241.700***	239.581***	239.025***	236.266***
	(429.743)	(418.769)	(410.009)	(407.883)	(20.023)	(19.874)	(20.000)	(20.089)
Observations	80684	80684	80684	80684	500002	500002	500002	500002
R_a^2	0.883	0.883	0.883	0.883	0.637	0.636	0.636	0.637
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.15 Freshwater ecotoxicity and N2000 sites, new loans

	New loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	2998.424***	3148.816***	3030.000***	3022.833***	34.195	33.597	32.929	29.302
	(1005.730)	(1018.878)	(998.447)	(993.967)	(37.388)	(36.736)	(36.709)	(36.624)
Leverage	444.674	298.204	324.970	327.063	116.797***	118.855***	119.680***	123.732***
	(370.870)	(383.927)	(385.395)	(394.563)	(26.207)	(25.988)	(25.920)	(25.910)
Log-Total assets	−50.167	−36.355	−54.436	−62.385	−11.048***	−10.887***	−10.786***	−10.374***
	(92.783)	(91.366)	(89.570)	(89.126)	(3.892)	(3.879)	(3.865)	(3.863)
Log-Direct GHG emissions (level)	−12.663*	−1.686	−2.406	−7.409	0.755**	0.673	0.627	0.497
	(7.166)	(9.490)	(8.821)	(8.668)	(0.345)	(0.440)	(0.428)	(0.378)
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	−56.598***				−0.391			
	(18.193)				(0.469)			
Log-Freshwater ecotoxicity N2000 $>$ 1km (orthog, level)	−22.816*				0.048			
	(12.012)				(0.385)			
Log-Freshwater ecotoxicity N2000 $\leq$ 2km (orthog, level)		−47.342***				0.072		
		(14.658)				(0.499)		
Log-Freshwater ecotoxicity N2000 $>$ 2km (orthog, level)		−22.823**				−0.222		
		(11.242)				(0.355)		
Log-Freshwater ecotoxicity N2000 $\leq$ 3km (orthog, level)			−38.461**				0.120	
			(15.041)				(0.457)	
Log-Freshwater ecotoxicity N2000 $>$ 3km (orthog, level)			−20.291*				−0.309	
			(11.232)				(0.344)	
Log-Freshwater ecotoxicity N2000 $\leq$ 4km (orthog, level)				−36.946**				0.429
				(15.823)				(0.415)
Log-Freshwater ecotoxicity N2000 $>$ 4km (orthog, level)				−19.021*				−0.614*
				(11.176)				(0.335)
Constant	9476.857***	9441.613***	9521.731***	9561.205***	240.644***	239.350***	238.676***	235.762***
	(430.091)	(419.833)	(408.912)	(406.759)	(20.060)	(19.939)	(19.890)	(19.921)
Observations	80684	80684	80684	80684	500002	500002	500002	500002
R_a^2	0.883	0.883	0.883	0.883	0.636	0.636	0.637	0.637
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.16 Freshwater ecotoxicity to water and World Database of Protected Areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	962.980	964.967	966.554	955.665	-57.530^{***}	-57.866^{***}	-58.007^{***}	-57.543^{***}
	(665.308)	(665.402)	(665.869)	(665.809)	(18.785)	(18.824)	(18.849)	(18.829)
Leverage	9.235	10.842	13.846	11.763	73.218^{***}	73.444^{***}	73.536^{***}	73.732^{***}
	(391.402)	(391.450)	(391.489)	(391.990)	(12.616)	(12.619)	(12.610)	(12.607)
Log-Total assets	220.861^{**}	219.980^{**}	216.797^{**}	225.675^{***}	-6.792^{***}	-6.775^{***}	-6.808^{***}	-6.909^{***}
	(86.995)	(87.136)	(86.630)	(87.563)	(2.073)	(2.068)	(2.062)	(2.050)
Log-Direct GHG emissions (level)	-23.854^{**}	-22.911^{*}	-20.046^{*}	-22.317^{*}	0.952^{***}	0.971^{***}	1.006^{***}	1.045^{***}
	(12.008)	(12.178)	(12.106)	(13.163)	(0.313)	(0.313)	(0.312)	(0.321)
Log-Freshwater ecotoxicity to water WDPA $\leq$ 1km (orthog, level)	-67.152^{***}				0.852^{*}			
	(21.033)				(0.477)			
Log-Freshwater ecotoxicity to water WDPA > 1km (orthog, level)	−7.210				−0.258			
	(22.504)				(0.541)			
Log-Freshwater ecotoxicity to water WDPA $\leq$ 2km (orthog, level)		-58.831^{***}				0.246		
		(21.979)				(0.463)		
Log-Freshwater ecotoxicity to water WDPA > 2km (orthog, level)		−4.359				−0.076		
		(24.299)				(0.575)		
Log-Freshwater ecotoxicity to water WDPA $\leq$ 3km (orthog, level)			-70.120^{***}				−0.154	
			(24.886)				(0.407)	
Log-Freshwater ecotoxicity to water WDPA > 3km (orthog, level)			17.692				0.156	
			(21.827)				(0.620)	
Log-Freshwater ecotoxicity to water WDPA $\leq$ 4km (orthog, level)				-65.999^{***}				0.138
				(21.667)				(0.445)
Log-Freshwater ecotoxicity to water WDPA > 4km (orthog, level)				49.171^{**}				0.150
				(23.038)				(0.588)
Constant	11084.514^{***}	11086.644^{***}	11098.254^{***}	11062.491^{***}	208.024^{***}	207.832^{***}	207.866^{***}	208.195^{***}
	(349.772)	(350.541)	(348.736)	(351.726)	(10.080)	(10.054)	(10.018)	(9.956)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R_a^2	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.17 Freshwater ecotoxicity to water and N2000 sites

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	968.688	964.857	963.371	962.401	-57.754^{***}	-57.985^{***}	-58.586^{***}	-58.033^{***}
	(664.958)	(665.119)	(665.062)	(665.119)	(18.819)	(18.856)	(18.914)	(18.863)
Leverage	11.581	12.318	15.893	15.959	73.670^{***}	73.841^{***}	73.807^{***}	73.570^{***}
	(391.595)	(391.564)	(391.555)	(391.825)	(12.609)	(12.602)	(12.600)	(12.611)
Log-Total assets	221.524^{**}	220.978^{**}	220.864^{**}	221.074^{**}	-6.849^{***}	-6.875^{***}	-6.884^{***}	-6.752^{***}
	(87.002)	(87.259)	(87.333)	(87.640)	(2.062)	(2.052)	(2.044)	(2.067)
Log-Direct GHG emissions (level)	-25.126^{**}	-24.954^{**}	-24.633^{**}	-26.624^{**}	1.017^{***}	1.051^{***}	1.095^{***}	0.975^{***}
	(11.928)	(12.161)	(12.220)	(13.401)	(0.312)	(0.312)	(0.307)	(0.322)
Log-Freshwater ecotoxicity to water N2000 $\leq$ 1km (orthog, level)	-52.940^{**}				−0.002			
	(22.344)				(0.643)			
Log-Freshwater ecotoxicity to water N2000 > 1km (orthog, level)	−15.467				0.141			
	(22.318)				(0.508)			
Log-Freshwater ecotoxicity to water N2000 $\leq$ 2km (orthog, level)		-39.313^{*}				−0.529		
		(23.594)				(0.577)		
Log-Freshwater ecotoxicity to water N2000 > 2km (orthog, level)		−17.930				0.387		
		(24.197)				(0.532)		
Log-Freshwater ecotoxicity to water N2000 $\leq$ 3km (orthog, level)			−23.322				−0.790	
			(23.489)				(0.495)	
Log-Freshwater ecotoxicity to water N2000 > 3km (orthog, level)			−20.718				0.608	
			(25.032)				(0.552)	
Log-Freshwater ecotoxicity to water N2000 $\leq$ 4km (orthog, level)				−27.992				−0.450
				(22.381)				(0.528)
Log-Freshwater ecotoxicity to water N2000 > 4km (orthog, level)				−8.608				0.521
				(25.203)				(0.561)
Constant	11081.343^{***}	11083.301^{***}	11083.154^{***}	11084.188^{***}	208.000^{***}	207.992^{***}	207.960^{***}	207.658^{***}
	(349.719)	(350.782)	(350.990)	(352.226)	(10.015)	(9.969)	(9.926)	(10.033)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R_a^2	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.18 Pollution to water and World Database of Protected Areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	959.606	962.233	966.384	968.201	-57.917^{***}	-58.177^{***}	-58.150^{***}	-57.895^{***}
	(663.664)	(663.764)	(665.118)	(665.196)	(18.759)	(18.778)	(18.785)	(18.764)
Leverage	−5.718	−5.797	1.485	5.853	73.386^{***}	73.474^{***}	73.490^{***}	73.538^{***}
	(393.652)	(393.684)	(393.139)	(393.504)	(12.611)	(12.608)	(12.606)	(12.609)
Log-Total assets	227.194^{***}	226.239^{**}	221.206^{**}	228.537^{***}	-6.750^{***}	-6.747^{***}	-6.770^{***}	-6.819^{***}
	(87.696)	(87.832)	(87.052)	(88.049)	(2.089)	(2.085)	(2.083)	(2.066)
Log-Direct GHG emissions (level)	-32.226^{**}	-30.875^{**}	-25.871^{**}	-30.883^{**}	0.959^{***}	0.969^{***}	0.987^{***}	0.982^{***}
	(12.851)	(12.954)	(12.838)	(14.459)	(0.326)	(0.323)	(0.329)	(0.332)
Log-Pollution to water WDPA $\leq$ 1km (orthog, level)	-73.738^{**}				0.251			
	(30.351)				(0.679)			
Log-Pollution to water WDPA > 1km (orthog, level)	−53.138				−0.129			
	(36.961)				(0.948)			
Log-Pollution to water WDPA $\leq$ 2km (orthog, level)		-88.933^{***}				−0.183		
		(30.534)				(0.671)		
Log-Pollution to water WDPA > 2km (orthog, level)		−42.572				0.024		
		(39.869)				(1.000)		
Log-Pollution to water WDPA $\leq$ 3km (orthog, level)			-120.631^{***}				−0.188	
			(38.613)				(0.622)	
Log-Pollution to water WDPA > 3km (orthog, level)			3.766				0.115	
			(36.363)				(1.109)	
Log-Pollution to water WDPA $\leq$ 4km (orthog, level)				-106.690^{***}				0.363
				(34.189)				(0.687)
Log-Pollution to water WDPA > 4km (orthog, level)				39.532				−0.356
				(42.540)				(1.181)
Constant	11061.351^{***}	11063.394^{***}	11080.562^{***}	11052.553^{***}	207.749^{***}	207.690^{***}	207.752^{***}	207.995^{***}
	(351.608)	(352.233)	(349.809)	(353.082)	(10.132)	(10.118)	(10.107)	(10.024)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.19 Pollution to water and N2000 sites

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	957.288	958.881	956.982	955.075	-58.449^{***}	-58.787^{***}	-59.130^{***}	-58.316^{***}
	(663.392)	(663.600)	(663.502)	(663.321)	(18.818)	(18.857)	(18.907)	(18.823)
Leverage	−5.935	−5.857	−1.649	2.024	73.868^{***}	73.892^{***}	73.872^{***}	73.649^{***}
	(393.730)	(393.820)	(393.843)	(394.143)	(12.601)	(12.593)	(12.597)	(12.607)
Log-Total assets	228.017^{***}	227.620^{***}	227.136^{***}	227.435^{**}	-6.809^{***}	-6.824^{***}	-6.849^{***}	-6.720^{***}
	(87.662)	(87.890)	(87.943)	(88.268)	(2.075)	(2.067)	(2.060)	(2.078)
Log-Direct GHG emissions (level)	-33.562^{***}	-32.882^{**}	-32.057^{**}	-32.678^{**}	1.033^{***}	1.062^{***}	1.107^{***}	0.971^{***}
	(12.754)	(13.125)	(13.073)	(14.163)	(0.322)	(0.322)	(0.321)	(0.329)
Log-Pollution to water N2000 $\leq$ 1km (orthog, level)	-52.943^{*}				−0.906			
	(31.822)				(0.955)			
Log-Pollution to water N2000 > 1km (orthog, level)	-64.978^{*}				0.481			
	(36.200)				(0.883)			
Log-Pollution to water N2000 $\leq$ 2km (orthog, level)		-63.167^{**}				−1.309		
		(31.411)				(0.870)		
Log-Pollution to water N2000 > 2km (orthog, level)		−59.766				0.740		
		(39.519)				(0.928)		
Log-Pollution to water N2000 $\leq$ 3km (orthog, level)			−43.397				−1.210	
			(31.863)				(0.782)	
Log-Pollution to water N2000 > 3km (orthog, level)			−61.837				0.920	
			(40.182)				(0.975)	
Log-Pollution to water N2000 $\leq$ 4km (orthog, level)				−39.866				−0.632
				(31.495)				(0.825)
Log-Pollution to water N2000 > 4km (orthog, level)				−48.294				0.734
				(41.516)				(1.031)
Constant	11058.819^{***}	11060.047^{***}	11061.567^{***}	11060.594^{***}	207.725^{***}	207.734^{***}	207.765^{***}	207.501^{***}
	(351.447)	(352.159)	(352.292)	(353.613)	(10.061)	(10.028)	(9.990)	(10.081)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.20 Freshwater eutrophicaton and World Database of Protected Areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	971.561	973.655	970.985	972.249	-58.008^{***}	-58.612^{***}	-58.493^{***}	-59.081^{***}
	(666.965)	(666.850)	(667.090)	(667.507)	(18.693)	(18.700)	(18.689)	(18.709)
Leverage	31.639	32.481	31.679	32.955	73.469^{***}	73.579^{***}	73.533^{***}	73.630^{***}
	(388.877)	(389.231)	(389.644)	(389.388)	(12.607)	(12.615)	(12.623)	(12.620)
Log-Total assets	225.283^{***}	223.752^{**}	220.234^{**}	220.620^{**}	-6.768^{***}	-6.882^{***}	-6.807^{***}	-6.850^{***}
	(86.906)	(86.993)	(86.864)	(87.104)	(2.068)	(2.054)	(2.066)	(2.040)
Log-Direct GHG emissions (level)	-23.270^{**}	-20.449^{**}	-19.782^{**}	-20.115^{**}	0.977^{***}	0.946^{***}	0.934^{***}	0.886^{***}
	(9.959)	(10.030)	(9.767)	(9.793)	(0.288)	(0.276)	(0.277)	(0.270)
Log-Freshwater eutrophication WDPA $\leq$ 1km (orthog, level)	-32.866^{**}				0.020			
	(13.576)				(0.633)			
Log-Freshwater eutrophication WDPA $>$ 1km (orthog, level)	-7.806				-0.014			
	(10.733)				(0.401)			
Log-Freshwater eutrophication WDPA $\leq$ 2km (orthog, level)		-19.466^{*}				0.396		
		(11.291)				(0.447)		
Log-Freshwater eutrophication WDPA $>$ 2km (orthog, level)		-14.165				-0.266		
		(11.419)				(0.450)		
Log-Freshwater eutrophication WDPA $\leq$ 3km (orthog, level)			-14.468				0.226	
			(11.450)				(0.421)	
Log-Freshwater eutrophication WDPA $>$ 3km (orthog, level)			-13.113				-0.289	
			(11.508)				(0.471)	
Log-Freshwater eutrophication WDPA $\leq$ 4km (orthog, level)				-14.265				0.449
				(11.337)				(0.396)
Log-Freshwater eutrophication WDPA $>$ 4km (orthog, level)				-12.575				-0.681
				(12.037)				(0.488)
Constant	11064.701^{***}	11068.455^{***}	11083.219^{***}	11081.464^{***}	207.774^{***}	208.398^{***}	208.074^{***}	208.417^{***}
	(350.577)	(351.023)	(350.350)	(351.566)	(10.137)	(10.074)	(10.111)	(9.988)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.21 Freshwater eutrophicaton and N2000 sites

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	972.675	974.355	967.464	970.014	-58.040^{***}	-58.017^{***}	-58.041^{***}	-58.453^{***}
	(666.928)	(667.680)	(667.481)	(667.076)	(18.692)	(18.683)	(18.673)	(18.679)
Leverage	33.047	31.539	33.745	33.307	73.520^{***}	73.511^{***}	73.410^{***}	73.646^{***}
	(388.861)	(390.150)	(390.275)	(389.336)	(12.603)	(12.616)	(12.639)	(12.630)
Log-Total assets	225.429^{***}	223.526^{**}	219.503^{**}	219.277^{**}	-6.776^{***}	-6.784^{***}	-6.725^{***}	-6.798^{***}
	(87.004)	(87.128)	(86.774)	(86.824)	(2.070)	(2.061)	(2.068)	(2.050)
Log-Direct GHG emissions (level)	-22.729^{**}	-20.676^{**}	-20.063^{**}	-20.181^{**}	0.976^{***}	0.979^{***}	0.963^{***}	0.916^{***}
	(10.004)	(9.980)	(9.686)	(9.683)	(0.288)	(0.282)	(0.284)	(0.274)
Log-Freshwater eutrophication N2000 $\leq$ 1km (orthog, level)	-30.137^{**}				-0.011			
	(13.839)				(0.678)			
Log-Freshwater eutrophication N2000 $>$ 1km (orthog, level)	-10.227				0.037			
	(10.738)				(0.393)			
Log-Freshwater eutrophication N2000 $\leq$ 2km (orthog, level)		-17.999				0.023		
		(11.542)				(0.475)		
Log-Freshwater eutrophication N2000 $>$ 2km (orthog, level)		-14.980				0.017		
		(11.346)				(0.441)		
Log-Freshwater eutrophication N2000 $\leq$ 3km (orthog, level)			-11.755				-0.046	
			(11.216)				(0.449)	
Log-Freshwater eutrophication N2000 $>$ 3km (orthog, level)			-14.988				-0.045	
			(11.481)				(0.447)	
Log-Freshwater eutrophication N2000 $\leq$ 4km (orthog, level)				-10.635				0.292
				(10.783)				(0.424)
Log-Freshwater eutrophication N2000 $>$ 4km (orthog, level)				-15.135				-0.456
				(11.897)				(0.464)
Constant	11063.368^{***}	11069.839^{***}	11086.249^{***}	11086.932^{***}	207.797^{***}	207.830^{***}	207.617^{***}	208.040^{***}
	(350.943)	(351.283)	(349.747)	(350.269)	(10.143)	(10.087)	(10.106)	(10.032)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

B.1.3.2 Protected Areas under the 2016 Water Framework Directive

Table B.22 Freshwater ecotoxicity and drinking water protected areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	978.964	979.534	974.157	977.165	-58.002^{***}	-58.030^{***}	-57.784^{***}	-57.827^{***}
	(664.848)	(665.259)	(665.835)	(665.983)	(18.694)	(18.692)	(18.694)	(18.697)
Leverage	49.677	46.467	47.466	45.813	73.629^{***}	73.561^{***}	73.553^{***}	73.564^{***}
	(387.798)	(388.511)	(389.117)	(388.803)	(12.604)	(12.602)	(12.591)	(12.595)
Log-Total assets	231.384^{***}	225.276^{***}	225.156^{***}	225.193^{***}	-7.016^{***}	-6.940^{***}	-6.890^{***}	-6.904^{***}
	(87.601)	(87.205)	(87.104)	(86.900)	(2.073)	(2.078)	(2.079)	(2.077)
Log-Direct GHG emissions (level)	-20.760^{**}	-19.473^{**}	-20.063^{**}	-19.957^{**}	1.016^{***}	1.003^{***}	1.037^{***}	1.029^{***}
	(9.536)	(9.529)	(9.414)	(9.409)	(0.272)	(0.272)	(0.285)	(0.285)
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 1km (orthog, level)	-19.658^{*}				0.147			
	(11.420)				(0.318)			
Log-Freshwater ecotoxicity WFD DWPA $>$ 1km (orthog, level)	-17.331^{*}				0.237			
	(8.869)				(0.318)			
Log-Freshwater ecotoxicity $\leq$ 2km WFD DWPA (orthog, level)		-12.581				0.104		
		(10.507)				(0.298)		
Log-Freshwater ecotoxicity WFD DWPA $>$ 2km (orthog, level)		-14.851^{*}				0.165		
		(8.973)				(0.322)		
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 3km (orthog, level)			-11.101				-0.093	
			(10.344)				(0.358)	
Log-Freshwater ecotoxicity WFD DWPA $>$ 3km (orthog, level)			-16.146^{*}				0.236	
			(9.209)				(0.329)	
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 4km (orthog, level)				-13.873				-0.030
				(10.150)				(0.356)
Log-Freshwater ecotoxicity WFD DWPA $>$ 4km (orthog, level)				-15.766^{*}				0.210
				(9.546)				(0.336)
Constant	11030.132^{***}	11056.313^{***}	11056.611^{***}	11056.480^{***}	208.831^{***}	208.515^{***}	208.189^{***}	208.273^{***}
	(354.125)	(352.177)	(352.197)	(351.262)	(10.127)	(10.151)	(10.154)	(10.147)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.23 Pollution to water and drinking water protected areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	959.347	955.179	936.511	935.778	-57.678^{***}	-57.678^{***}	-57.474^{***}	-57.416^{***}
	(664.638)	(663.922)	(663.260)	(663.295)	(18.739)	(18.742)	(18.754)	(18.751)
Leverage	-4.857	-8.321	-16.358	-17.121	73.653^{***}	73.659^{***}	73.763^{***}	73.769^{***}
	(392.546)	(393.199)	(394.425)	(394.474)	(12.602)	(12.601)	(12.592)	(12.590)
Log-Total assets	228.385^{***}	228.992^{***}	227.831^{***}	227.668^{***}	-6.858^{***}	-6.870^{***}	-7.009^{***}	-7.033^{***}
	(87.166)	(87.261)	(87.208)	(87.209)	(2.080)	(2.076)	(2.048)	(2.047)
Log-Direct GHG emissions (level)	-31.855^{***}	-31.933^{***}	-29.417^{**}	-29.337^{**}	1.020^{***}	1.024^{***}	1.091^{***}	1.103^{***}
	(11.360)	(11.431)	(11.653)	(11.725)	(0.317)	(0.321)	(0.323)	(0.324)
Log-Pollution to water WFD DWPA $\leq$ 1km (orthog, level)	-135.858^{*}				0.060			
	(80.813)				(1.033)			
Log-Pollution to water WFD DWPA $>$ 1km (orthog, level)	-61.087^{**}				0.204			
	(26.952)				(0.831)			
Log-Pollution to water WFD DWPA $\leq$ 2km (orthog, level)		-122.110^{*}				-0.038		
		(66.756)				(0.936)		
Log-Pollution to water WFD DWPA $>$ 2km (orthog, level)		-62.554^{**}				0.219		
		(27.924)				(0.855)		
Log-Pollution to water WFD DWPA $\leq$ 3km (orthog, level)			-134.864^{**}				-0.457	
			(53.563)				(1.026)	
Log-Pollution to water WFD DWPA $>$ 3km (orthog, level)			-45.975				0.544	
			(29.541)				(0.825)	
Log-Pollution to water WFD DWPA $\leq$ 4km (orthog, level)				-134.877^{**}				-0.459
				(52.346)				(1.007)
Log-Pollution to water WFD DWPA $>$ 4km (orthog, level)				-45.013				0.593
				(30.052)				(0.826)
Constant	11054.787^{***}	11052.952^{***}	11061.015^{***}	11061.932^{***}	208.036^{***}	208.084^{***}	208.554^{***}	208.639^{***}
	(350.186)	(350.398)	(349.576)	(349.561)	(10.089)	(10.070)	(9.915)	(9.906)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R^2_a	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.24 Freshwater eutrophication and drinking water protected areas

	Total loans							
	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	980.682	982.059	977.138	978.154	-57.970^{***}	-57.782^{***}	-58.303^{***}	-58.242^{***}
	(665.417)	(666.323)	(666.331)	(666.536)	(18.765)	(18.745)	(18.774)	(18.765)
Leverage	36.545	38.308	40.188	34.978	73.541^{***}	73.429^{***}	73.771^{***}	73.683^{***}
	(389.311)	(389.426)	(389.969)	(389.678)	(12.608)	(12.612)	(12.624)	(12.619)
Log-Total assets	224.580^{***}	220.213^{**}	220.535^{**}	219.567^{**}	-6.851^{***}	-6.746^{***}	-6.722^{***}	-6.727^{***}
	(86.619)	(86.419)	(86.324)	(86.136)	(2.042)	(2.067)	(2.078)	(2.072)
Log-Direct GHG emissions (level)	-19.822^{**}	-18.933^{**}	-19.503^{**}	-18.978^{*}	0.959^{***}	0.945^{***}	0.897^{***}	0.916^{***}
	(9.603)	(9.553)	(9.687)	(9.719)	(0.279)	(0.284)	(0.295)	(0.297)
Log-Freshwater eutrophication WFD DWPA $\leq$ 1km (orthog, level)	-26.298^{*}				1.101^{**}			
	(13.997)				(0.499)			
Log-Freshwater eutrophication WFD DWPA $>$ 1km (orthog, level)	-23.768^{**}				-0.315			
	(10.881)				(0.416)			
Log-Freshwater eutrophication WFD DWPA $\leq$ 2km (orthog, level)		-16.558				0.954^{**}		
		(13.056)				(0.451)		
Log-Freshwater eutrophication WFD DWPA $>$ 2km (orthog, level)		-19.171^{*}				-0.413		
		(10.957)				(0.420)		
Log-Freshwater eutrophication WFD DWPA $\leq$ 3km (orthog, level)			-15.908				0.276	
			(11.387)				(0.443)	
Log-Freshwater eutrophication WFD DWPA $>$ 3km (orthog, level)			-20.849^{*}				-0.255	
			(11.628)				(0.468)	
Log-Freshwater eutrophication WFD DWPA $\leq$ 4km (orthog, level)				-20.253^{*}				0.205
				(11.303)				(0.436)
Log-Freshwater eutrophication WFD DWPA $>$ 4km (orthog, level)				-19.320				-0.187
				(11.974)				(0.481)
Constant	11064.137^{***}	11081.285^{***}	11079.417^{***}	11084.445^{***}	208.153^{***}	207.699^{***}	207.652^{***}	207.655^{***}
	(349.217)	(348.346)	(348.213)	(347.384)	(10.023)	(10.127)	(10.180)	(10.146)
Observations	1564908	1564908	1564908	1564908	4461354	4461354	4461354	4461354
R_a^2	0.831	0.831	0.831	0.831	0.579	0.579	0.579	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

B.2 Environmental Quality Standards

TABLE B.25 Downstream water monitoring stations and annual average (AA) ‘good status’, emissions to all release media

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals.

	LTV		Spread		LTV		Spread	
	Total loans	New loans	Total loans	New loans	Total loans	New loans	Total loans	New loans
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	964.634	2932.152***	−58.189***	33.830	978.069	2989.659***	−58.221***	34.382
	(666.379)	(974.811)	(18.717)	(37.177)	(666.951)	(1001.706)	(18.715)	(37.157)
Leverage	37.398	443.223	73.589***	117.687***	49.004	450.415	73.810***	117.550***
	(389.129)	(376.851)	(12.609)	(26.151)	(389.323)	(377.659)	(12.617)	(26.139)
Log-Total assets	225.353***	−44.256	−7.097***	−11.253***	223.260**	−42.799	−7.188***	−11.294***
	(86.483)	(93.001)	(2.067)	(3.814)	(86.781)	(93.470)	(2.052)	(3.825)
Log-Direct GHG emissions (level)	−18.557**	−6.665	1.017***	0.801**	−19.318**	−6.745	1.016***	0.804**
	(9.203)	(6.617)	(0.271)	(0.343)	(9.247)	(6.665)	(0.272)	(0.343)
Log-Freshwater ecotoxicity (orthog, level)	−17.116*	−27.872**	0.268	−0.008	−17.185*	−28.089**	0.263	−0.007
	(8.842)	(13.550)	(0.312)	(0.387)	(8.820)	(13.560)	(0.308)	(0.386)
$1 \leq$ MSI1 EQS failed ‘good status’ ≤ 2	634.715	786.400	8.834	37.847***				
	(443.164)	(551.700)	(11.426)	(9.716)				
$3 \leq$ MSI1 EQS failed ‘good status’	−4096.691***	3191.440***	−16.131	48.470				
	(492.639)	(1078.356)	(43.127)	(37.375)				
$2 \leq$ MSI15 EQS failed ‘good status’ ≤ 5					283.666	357.721	10.265	26.960**
					(521.981)	(458.229)	(12.816)	(11.667)
$6 \leq$ MSI15 EQS failed ‘good status’					−983.414	4908.809***	−31.721	9.357
					(1882.539)	(1246.395)	(30.906)	(49.666)
Constant	11057.777***	9420.943***	209.176***	240.964***	11063.432***	9424.786***	209.408***	241.175***
	(348.954)	(426.622)	(10.093)	(19.752)	(349.711)	(428.658)	(10.000)	(19.762)
Observations	1564908	80684	4461354	500002	1564908	80684	4461354	500002
R_a^2	0.831	0.883	0.579	0.637	0.831	0.882	0.579	0.636
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B.26 Failed 'good status' relations by share of loans

Spread

	All release media: Failed relations	Loans	Percent		Pollutants released to water: Failed relations	Loans	Percent
MSI1	0	4,409,891	98.85	MSI1	0	4,424,492	99.17
	1	40,618	0.91		1	26,031	0.58
	2	5,280	0.12		2	5,266	0.12
	3	2,423	0.05		3	2,423	0.05
	4	906	0.02		4	906	0.02
	5	1,675	0.04		5	1,675	0.04
	7	561	0.01		7	561	0.01
		4,461,354	100			4,461,354	100
	Failed relations	Loans	Percent		Failed relations	Loans	Percent
MSI15	0	4,300,201	96.39	MSI15	0	4,322,236	96.88
	1	31,383	0.7		1	25,776	0.58
	2	66,637	1.49		2	80,844	1.81
	3	30,871	0.69		3	2,491	0.06
	4	2,687	0.06		4	18,355	0.41
	5	19,308	0.43		5	4,581	0.1
	6	1,526	0.03		6	1,526	0.03
	7	5,320	0.12		7	2,124	0.05
	8	341	0.01		8	341	0.01
	9	855	0.02		9	855	0.02
	10	96	0		10	96	0
	11	823	0.02		11	823	0.02
	12	446	0.01		12	446	0.01
	13	657	0.01		13	657	0.01
	14	203	0		14	203	0
		4,461,354	100			4,461,354	100

LTV

	All release media: Failed relations	Loans	Percent		Pollutants released to water: Failed relations	Loans	Percent
MSI1	0	1,553,988	99.3	MSI1	0	1,561,308	99.77
	1	8,701	0.56		1	1,393	0.09
	2	984	0.06		2	972	0.06
	3	342	0.02		3	342	0.02
	4	214	0.01		4	214	0.01
	5	548	0.04		5	548	0.04
	7	131	0.01		7	131	0.01
		1,564,908	100			1,564,908	100
	Failed relations	Loans	Percent		Failed relations	Loans	Percent
MSI15	0	1,539,794	98.4	MSI15	0	1,549,602	99.02
	1	11,403	0.73		1	8,669	0.55
	2	6,325	0.4		2	4,508	0.29
	3	5,366	0.34		3	620	0.04
	4	494	0.03		4	117	0.01
	5	333	0.02		5	205	0.01
	6	278	0.02		6	278	0.02
	7	468	0.03		7	462	0.03
	8	11	0		8	11	0
	9	226	0.01		9	226	0.01
	10	8	0		10	8	0
	11	45	0		11	45	0
	12	2	0		12	2	0
	13	143	0.01		13	143	0.01
	14	12	0		14	12	0
		1,564,908	100			1,564,908	100

B.3 Freshwater eutrophication

TABLE B.27 Freshwater eutrophication

Notes: Standard errors are presented in brackets and are clustered at the firm level. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Loan controls include the purpose and type of the instrument. Loan-to-value ratios and loan spreads are expressed in basis points. Profitability and leverage are expressed in decimals. Intensity refers to total emission levels normalized by the firm's revenues.

	LTV				Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Profitability	939.024	984.696	948.892	971.525	−57.860***	−58.206***	−58.431***	−57.584***
	(665.244)	(667.261)	(672.402)	(674.310)	(19.041)	(18.730)	(19.223)	(18.819)
Leverage	52.804	34.433	−4.096	−21.006	72.647***	73.754***	73.140***	73.993***
	(386.498)	(388.943)	(389.967)	(392.263)	(12.519)	(12.602)	(12.602)	(12.671)
Log-Total assets	192.098**	218.736**	184.137**	196.588**	−5.186***	−6.892***	−5.155***	−5.944***
	(80.458)	(86.030)	(80.178)	(82.395)	(1.982)	(2.052)	(1.987)	(1.981)
Log-Freshwater eutrophication (orthog, level)	−20.805*	−22.820**			0.170	0.310		
	(10.846)	(10.953)			(0.436)	(0.428)		
Log-Direct GHG emissions (level)		−18.270*				1.003***		
		(9.565)				(0.260)		
Log-Freshwater eutrophication (orthog, intensity)			−24.296**	−26.041**			0.228	0.352
			(11.297)	(11.513)			(0.438)	(0.427)
Log-Direct GHG emissions (intensity)				−22.159**				1.054***
				(10.464)				(0.259)
Constant	11177.471***	11088.954***	11216.957***	11098.902***	202.687***	208.234***	202.715***	208.843***
	(332.181)	(346.951)	(331.736)	(352.484)	(9.931)	(10.074)	(9.946)	(10.132)
Observations	1564908	1564908	1551665	1551665	4461354	4461354	4439966	4439966
R_a^2	0.831	0.831	0.832	0.832	0.578	0.579	0.578	0.579
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILS-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

C Data

C.1 Variable description

Variables	Variable definition
Firm-level E-PRTR data	
Direct GHG emissions	The GHG emissions of plants in CO2-equivalent kg.
Freshwater ecotoxicity	The freshwater ecotoxicity potential of emissions to air, water and soil in CTUe.
Freshwater eutrophication	The freshwater eutrophication potential of emissions to air, water and soil in P-equivalent kg.
Pollution to water	The sum of all pollutants emitted to water in tonnes.
Log-Freshwater ecotoxicity WDPA $\leq$ *1km (orthog, level)*	The freshwater ecotoxicity emitted in less than 1km distance to a World Database of Protected Area site in log-levels. The metric is orthogonalised as described in Appendix C.3.
2 $\leq$ *MSI15 EQS failed 'good status'* $\leq$5	1 if firm emits pollutants to all release media, contributing to two to five long-term good quality failures in five downstream monitoring stations in a year, 0 otherwise. Failures can take place, e.g. due to either several pollutants creating failures in one station, or one pollutant affecting several stations. 'Emissions to water:' has the same definition, but considers only emissions to water.
Bank-level data	
Biodiversity policy	1 if the bank has biodiversity policy, 0 otherwise.
Pollution policy	1 from the first year of pollution policy issuance, 0 otherwise.
Firm-level balance sheet data	
Profitability	Operating profits-over-total assets.
Leverage	Total debt-over-total assets.
Total assets	Log total assets.
Loan-level data	
Loan interest rate	Annualised interest rate offered by the bank to a borrowing firm during a year. We consider the following types of facilities: loans other than overdrafts, convenience credit, credit card credit, extended credit, reverse purchase agreements, revolving credit other than credit card credit, trade receivables and financial leases.
Interest rate spread	The difference in annualised loan interest rate that a bank offers to a borrowing firm and the rate at which the bank can borrow money from the central bank.
Loan-to-value ratio	Is the loan per collateral granted.

C.2 Firm distribution

Table C.2 Firms by sector and size category

Sector	Micro	Small	Medium	Large	Total
A. Agriculture	409	241	62	13	725
B. Mining	8	45	24	15	92
C.A Food	9	109	250	215	583
C.B Textiles & Leather	2	34	56	28	120
C.C Wood & Paper		57	121	67	245
C.D Chemicals	6	154	319	204	683
C.E Minerals	68	421	430	244	1163
C.F Electronics		6	14	32	52
C.G Machinery & Vehicles	3	19	53	108	183
C.I Furniture & Other	1	9	14	11	35
D. Electricity	7	24	9	24	64
E. Water	66	272	151	76	565
F. Construction	8	27	11	12	58
G. Wholesale & Retail	42	107	49	46	244
H. Transport & Storage	5	21	12	7	45
I. Accommodation & Food		1	2		3
J. Information	1	1	1	2	5
K. Finance & Insurance	1	1		4	6
L. Real Estate	10	8	3	2	23
M-Z Other Services	13	19	26	26	84
Total	659	1576	1607	1136	4978

C.3 Orthogonalisation

Table C.3 displays the correlations between the *E-PRTR*-derived variables. It appears that *freshwater ecotoxicity* is highly correlated with the SFDR's *pollution to water* concept, which aggregates pollutant emissions one to one. The *direct GHG emissions* variable shows a weak but statistically significant correlation with the other metrics. To account for possible collinearity due to this overlap, we *orthogonalise* the latter ones for their *direct GHG emissions* before entering them into our analysis.

TABLE C.3 Pairwise correlations of non-orthogonalised variables

Direct GHG emissions (tonnes of CO2e)	1.0000					
Freshwater ecotoxicity (CTUe)	0.0312***	1.0000				
Freshwater ecotoxicity WDPA $\leq$ 1km (CTUe)	0.0335***	0.6708***	1.0000			
Freshwater ecotoxicity WDPA $>$ 1km (CTUe)	0.0158***	0.8144***	0.1181***	1.0000		
Freshwater ecotoxicity to water (CTUe)	0.0309***	1.0000***	0.6709***	0.8143***	1.0000	
Pollution to water (tonnes)	0.0322***	0.9662***	0.6947***	0.7515***	0.9662***	1.0000

The orthogonalisation of the variables is performed as follows, using the *freshwater ecotoxicity* variable as an example. In the first step, we regress firms' *freshwater ecotoxicity* on their *direct GHG emissions* as specified in Equation C.1. In the second step, we predict firms' *freshwater ecotoxicity* $\widehat{Z}_{i,t}$ using the calibrated coefficient ϕ_1. Finally, we define the orthogonalised version of firms' *freshwater ecotoxicity* Z_{orthog} as the residual between firms' true and predicted *freshwater ecotoxicity*, using Equation C.2. This residual is defined as the part of firms' *freshwater ecotoxicity* impact potential that does not correlate with firms' *direct GHG emissions*. Table C.4 displays the descriptive statistics for the orthogonalised variables.

$$Z_{i,t} = \alpha_2 + \phi_1 \log \text{ Direct GHG emissions}_{i,t} + \epsilon_i \tag{C.1}$$

$$Z_{orthog,i,t} = Z_{i,t} - \widehat{Z_{i,t}} \tag{C.2}$$

Table C.4 Loan-level summary statistics of orthogonalised variables

	N	Mean	SD	Min	p25	Median	p75	Max
Spread								
Log-Direct GHG emissions (level)	4,461,354.00	2.44	6.40	0.00	0.00	0.00	0.00	23.86
Log-Freshwater ecotoxicity (orthog, level)	4,461,354.00	0.03	5.43	-16.30	-2.26	-2.26	-2.26	23.91
Log-Freshwater ecotoxicity to water (orthog, level)	4,461,354.00	-0.00	4.21	-9.64	-0.46	-0.46	-0.46	25.70
Log-Pollution to water (orthog, level)	4,461,354.00	0.00	3.04	-6.80	-0.31	-0.31	-0.31	17.72
Log-Freshwater eutrophication (orthog, level)	4,461,354.00	0.02	4.36	-12.64	-1.32	-1.32	-1.32	15.32
Log-Freshwater ecotoxicity WDPA $\leq$ 1km (orthog, level)	4,461,354.00	-0.04	3.74	-4.64	-0.65	-0.65	-0.65	23.37
Log-Freshwater ecotoxicity WDPA $\leq$ 2km (orthog, level)	4,461,354.00	-0.02	4.37	-8.97	-0.91	-0.91	-0.91	23.12
Log-Freshwater ecotoxicity WDPA $\leq$ 3km (orthog, level)	4,461,354.00	-0.02	4.62	-9.70	-1.08	-1.08	-1.08	22.94
Log-Freshwater ecotoxicity WDPA $\leq$ 4km (orthog, level)	4,461,354.00	-0.01	4.57	-13.54	-1.17	-1.17	-1.17	22.86
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	4,461,354.00	-0.03	3.57	-4.29	-0.56	-0.56	-0.56	23.47
Log-Freshwater ecotoxicity N2000 $\leq$ 2km (orthog, level)	4,461,354.00	0.00	4.22	-8.41	-0.79	-0.79	-0.79	23.24
Log-Freshwater ecotoxicity N2000 $\leq$ 3km (orthog, level)	4,461,354.00	0.00	4.47	-9.07	-0.96	-0.96	-0.96	23.07
Log-Freshwater ecotoxicity N2000 $\leq$ 4km (orthog, level)	4,461,354.00	0.01	4.46	-13.38	-1.03	-1.03	-1.03	23.00
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 1km (orthog, level)	4,461,354.00	0.06	3.83	-3.36	-0.74	-0.74	-0.74	26.11
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 2km (orthog, level)	4,461,354.00	0.06	4.06	-3.58	-0.88	-0.88	-0.88	25.98
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 3km (orthog, level)	4,461,354.00	0.05	4.50	-7.12	-1.02	-1.02	-1.02	25.84
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 4km (orthog, level)	4,461,354.00	0.05	4.57	-7.32	-1.08	-1.08	-1.08	25.77
Log-Pollution to water WDPA $\leq$ 1km (orthog, level)	4,461,354.00	-0.01	1.85	-1.89	-0.12	-0.12	-0.12	19.03
Log-Pollution to water WDPA $\leq$ 2km (orthog, level)	4,461,354.00	-0.02	2.02	-2.16	-0.16	-0.16	-0.16	18.77
Log-Pollution to water WDPA $\leq$ 3km (orthog, level)	4,461,354.00	-0.02	2.22	-2.64	-0.19	-0.19	-0.19	18.37
Log-Pollution to water WDPA $\leq$ 4km (orthog, level)	4,461,354.00	-0.01	2.59	-5.95	-0.18	-0.18	-0.18	17.85
Log-Direct GHG emissions (intensity)	4,440,190.00	-2.43	5.74	-10.84	-5.50	-4.23	-2.59	22.11
Log-Freshwater ecotoxicity (orthog, intensity)	4,440,190.00	0.01	5.47	-16.83	-2.52	-1.96	-0.93	24.46
Log-Freshwater eutrophication (orthog, intensity)	4,440,190.00	-0.01	4.48	-13.67	-1.71	-1.04	-0.07	16.19
LTV								
Log-Direct GHG emissions (level)	1,564,908.00	1.34	4.78	0.00	0.00	0.00	0.00	23.54
Log-Freshwater ecotoxicity (orthog, level)	1,564,908.00	-0.10	5.28	-16.28	-2.26	-2.26	-2.26	21.09
Log-Freshwater ecotoxicity to water (orthog, level)	1,564,908.00	-0.42	3.05	-9.27	-0.46	-0.46	-0.46	22.89
Log-Pollution to water (orthog, level)	1,564,908.00	-0.31	2.17	-6.54	-0.31	-0.31	-0.31	17.39
Log-Freshwater eutrophication (orthog, level)	1,564,908.00	0.01	4.39	-11.89	-1.32	-1.32	-1.32	15.22
Log-Freshwater ecotoxicity WDPA $\leq$ 1km (orthog, level)	1,564,908.00	-0.11	3.23	-4.46	-0.65	-0.65	-0.65	22.49
Log-Freshwater ecotoxicity WDPA $\leq$ 2km (orthog, level)	1,564,908.00	-0.00	3.87	-8.97	-0.91	-0.91	-0.91	22.44
Log-Freshwater ecotoxicity WDPA $\leq$ 3km (orthog, level)	1,564,908.00	-0.05	4.06	-9.70	-1.08	-1.08	-1.08	22.27
Log-Freshwater ecotoxicity WDPA $\leq$ 4km (orthog, level)	1,564,908.00	-0.15	4.19	-13.54	-1.17	-1.17	-1.17	22.18
Log-Freshwater ecotoxicity N2000 $\leq$ 1km (orthog, level)	1,564,908.00	-0.08	3.09	-4.12	-0.56	-0.56	-0.56	22.49
Log-Freshwater ecotoxicity N2000 $\leq$ 2km (orthog, level)	1,564,908.00	0.00	3.74	-8.41	-0.79	-0.79	-0.79	22.56
Log-Freshwater ecotoxicity N2000 $\leq$ 3km (orthog, level)	1,564,908.00	-0.04	3.95	-9.07	-0.96	-0.96	-0.96	22.39
Log-Freshwater ecotoxicity N2000 $\leq$ 4km (orthog, level)	1,564,908.00	-0.13	4.08	-13.38	-1.03	-1.03	-1.03	22.32
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 1km (orthog, level)	1,564,908.00	-0.05	3.45	-3.27	-0.74	-0.74	-0.74	23.25
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 2km (orthog, level)	1,564,908.00	-0.04	3.75	-3.49	-0.88	-0.88	-0.88	23.04
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 3km (orthog, level)	1,564,908.00	-0.06	4.11	-6.92	-1.02	-1.02	-1.02	22.33
Log-Freshwater ecotoxicity WFD DWPA $\leq$ 4km (orthog, level)	1,564,908.00	-0.04	4.21	-7.23	-1.08	-1.08	-1.08	22.27
Log-Pollution to water WDPA $\leq$ 1km (orthog, level)	1,564,908.00	-0.09	1.20	-1.86	-0.12	-0.12	-0.12	18.84
Log-Pollution to water WDPA $\leq$ 2km (orthog, level)	1,564,908.00	-0.12	1.31	-2.16	-0.16	-0.16	-0.16	18.59
Log-Pollution to water WDPA $\leq$ 3km (orthog, level)	1,564,908.00	-0.15	1.44	-2.64	-0.19	-0.19	-0.19	18.18
Log-Pollution to water WDPA $\leq$ 4km (orthog, level)	1,564,908.00	-0.25	1.83	-5.95	-0.18	-0.18	-0.18	17.53
Log-Direct GHG emissions (intensity)	1,551,732.00	-3.05	4.87	-10.84	-5.63	-4.00	-2.42	21.90
Log-Freshwater ecotoxicity (orthog, intensity)	1,551,732.00	0.03	5.48	-16.48	-2.57	-1.88	-1.04	21.75
Log-Freshwater eutrophication (orthog, intensity)	1,551,732.00	0.20	4.72	-13.67	-1.84	-0.93	-0.01	16.19

C.4 Geospatial analysis

C.4.1 Proximity to biodiversity protected areas

E-PRTR facilities were harmonised into unique point geometries and, using the pre-processed dataset from DOPA/GDBV[91], linked to the January 2025 WDPA dataset, which also includes Natura 2000 sites (metadataid=1832; cross-checked against the original N2000 dataset (Protected Planet: The World-Database of Protected Areas (WDPA) and (EEA Natura 2000 data - The European network of protected sites).[92] A buffered convex hull around the facilities defined the search extent, from which protected areas were extracted and separated into N2000 and non-N2000 groups for reporting. For each facility and reporting year, the nearest protected area existing at that time was identified through a nearest-neighbour search, optimised using the GiST index operator $<->$ in PostGIS[93], with geodesic distances computed via ST_Distance. Temporal validity was ensured by including only protected areas with status_yr $\leq$ reporting year. Facilities with unreliable coordinates at (0,0) were flagged but retained.

C.4.2 Downstream water monitoring stations

We calculate the downstream distance along the river network from a pollution effluent to WFD water monitoring stations as provided by the EEA Waterbase v2023 dataset. The effluent was connected to the nearest river segment in the primary catchment where it is located. Subsequently, the length of the potential flow path to the downstream monitoring station was computed. Also, the monitoring station was linked to the river system using the primary catchment in which it is based. The catchment and river system delineation is based on an elevation model with a resolution of 100 meters. The dataset catchment and characterisation modelling is available for the whole of Europe in ArcGIS format.[94]

[91] see Juffe-Bignoli et al. (2024).
[92] see UNEP-WCMC IUCN (2025) and EEA (2025).
[93] see PostGIS Project Steering Committee (2025).
[94] see De Jager and Vogt (2010).

C.4.3 Proximity to WFD drinking water protected areas

For our analysis, we use the WISE WFD Protected Areas under the Water Framework Directive dataset. We use QGIS to calculate the geodesic shortest line distances of *E-PRTR* facilities towards protected area (layername= "protectedareapoint") and (layername= "protectedarealine") with ("zoneType"="drinkingWaterProtectionArea"). Then, we take the minimum distance of both as a facility distance towards a drinking water protected area. Temporal validity was ensured by including protected areas with the reporting year being within the designation period.

C.5 Environmental footprint characterisation factors

Table C.1 Characterisation factors (EF 3.1)

Release medium	Pollutant name	Freshwater ecotoxicity (CTUe)	Climate change (CO_2e)
Air	1,1,1-trichloroethane	4.3169	161
Air	1,1,2,2-tetrachloroethane	15.584	0
Air	1,2,3,4,5,6-hexachlorocyclohexane	5172.9	0
Air	1,2-dichloroethane	0.40641	1.3
Air	Aldrin	1879.4	0
Air	Ammonia	134.42	0
Air	Anthracene	2258.6	0
Air	Arsenic and compounds (as As)	1196.477112	0
Air	Asbestos	0	0
Air	Benzene	0.82904	0
Air	Benzo(g,h,i)perylene	0	0
Air	Brominated diphenylethers	0	0
Air	Cadmium and compounds (as Cd)	238177.2238	0
Air	Carbon dioxide	0	1
Air	Carbon dioxide excluding biomass	0	1
Air	Carbon monoxide	0.022833	0
Air	Chlordecone	148800	0
Air	Chlorides (as total Cl)	21.086	0
Air	Chlorine and inorganic compounds (as HCl)	21.086	0
Air	Chlorofluorocarbons	91.959	2200
Air	Chromium and compounds (as Cr)	4288.011147	0
Air	CONFIDENTIAL	0	0
Air	Copper and compounds (as Cu)	17.03877713	0
Air	Di-(2-ethyl hexyl) phthalate	26.352	0
Air	Dichloromethane	0.78144	11.2
Air	Endrin	417830	0
Air	Ethyl benzene	0.2518	0
Air	Ethylene oxide	2.2094	0
Air	Fluoranthene	2216.3	0
Air	Fluorides (as total F)	0.34838	0
Air	Fluorine and inorganic compounds (as HF)	0.34838	0
Air	Halogenated organic compounds (as AOX)	55.537	0
Air	Halons	19.624	2.43
Air	Hexachlorobenzene	1763	0
Air	Hydrochlorofluorocarbons	0.2644	1960
Air	Hydro-fluorocarbons	0	135
Air	Hydrogen cyanide	2352.5	0
Air	Lead and compounds (as Pb)	27.80611908	0
Air	Lindane	148830	0
Air	Mercury and compounds (as Hg)	23429.21785	0
Air	Methane	0.31974	29.8
Air	Naphthalene	3.7495	0
Air	Nickel and compounds (as Ni)	9671.490845	0
Air	Nitrogen oxides	0	0
Air	Nitrous oxide	0	273
Air	Non-methane volatile organic compounds	8.6069	0
Air	Nonylphenol and Nonylphenol ethoxylates	50.217	0
Air	Particulate matter	0	0
Air	Particulate matter with a diameter of 2.5 micrometers or less	0	0
Air	PCDD + PCDF (dioxins + furans) (as Teq)	799680	0
Air	Pentachlorobenzene	924.46	0
Air	Pentachlorophenol	16974	0
Air	Perfluorocarbons	0	1.97
Air	Phenols (as total C)	336.11	0
Air	Polychlorinated biphenyls	526.24	0
Air	Polycyclic aromatic hydrocarbons	1137.1	0
Air	Sulphur hexafluoride	0.082379	25200
Air	Sulphur oxides	0	0
Air	Tetrachloroethylene	1.1557	6.34
Air	Tetrachloromethane	91.959	2200
Air	Toluene	0.27237	0
Air	Total nitrogen	0	0
Air	Total organic carbon(as total C or COD/3)	0	0
Air	Trichlorobenzenes (all isomers)	10.21	0
Air	Trichloroethylene	0.066499	0.044
Air	Trichloromethane	4.6212	20.6
Air	Vinyl chloride	0.0063829	0
Air	Xylenes	0.074368	0
Air	Zinc and compounds (as Zn)	628.4971011	0
Soil	1,1,1-trichloroethane	69.884	161
Soil	1,2-dichloroethane	3.9224	1.3
Soil	Anthracene	4429.5	0
Soil	Arsenic and compounds (as As)	1725.896653	0
Soil	Benzene	11.202	0

Release medium	Pollutant name	Freshwater ecotoxicity (CTUe)	Climate change (CO_2e)
Soil	Benzo(g,h,i)perylene	0	0
Soil	Cadmium and compounds (as Cd)	342796.2331	0
Soil	Chlorides (as total Cl)	6.1714	0
Soil	Chloro-alkanes, C10-C13	0.65156	0
Soil	Chromium and compounds (as Cr)	6164.338558	0
Soil	Copper and compounds (as Cu)	24.53395145	0
Soil	Cyanides (as total CN)	7603.8	0
Soil	Di-(2-ethyl hexyl) phthalate	0	0
Soil	Dichloromethane	4.4979	11.2
Soil	Diuron	13191	0
Soil	Fluoranthene	1042.2	0
Soil	Fluorides (as total F)	1.2573	0
Soil	Halogenated organic compounds (as AOX)	141	0
Soil	Hexabromobiphenyl	0	0
Soil	Lead and compounds (as Pb)	40.34680172	0
Soil	Mercury and compounds (as Hg)	23429.21785	0
Soil	Naphthalene	65.73	0
Soil	Nickel and compounds (as Ni)	13934.09356	0
Soil	Non-methane volatile organic compounds	18.202	0
Soil	Nonylphenol and Nonylphenol ethoxylates	87.461	0
Soil	Octylphenols and Octylphenol ethoxylates	171.63	0
Soil	Organotin compounds(as total Sn)	0	0
Soil	PCDD + PCDF (dioxins + furans) (as Teq)	1202800	0
Soil	Phenols (as total C)	1146.7	0
Soil	Polychlorinated biphenyls	102.59	0
Soil	Polycyclic aromatic hydrocarbons	396.4	0
Soil	Tetrachloroethylene	37.616	6.34
Soil	Toluene	10.094	0
Soil	Total nitrogen	0	0
Soil	Total organic carbon(as total C or COD/3)	0	0
Soil	Total phosphorus	0.0043676	0
Soil	Trichlorobenzenes (all isomers)	71.04	0
Soil	Vinyl chloride	0	0
Soil	Xylenes	7.0478	0
Soil	Zinc and compounds (as Zn)	909.1832124	0
Water	1,1,1-trichloroethane	495.88	161
Water	1,1,2,2-tetrachloroethane	1078.8	0
Water	1,2,3,4,5,6-hexachlorocyclohexane	118890	0
Water	1,2-dichloroethane	50.686	1.3
Water	Alachlor	253670	0
Water	Aldrin	892130	0
Water	Ammonia	2493.2	0
Water	Anthracene	974460	0
Water	Arsenic and compounds (as As)	3263.327402	0
Water	Asbestos	0	0
Water	Atrazine	849450	0
Water	Benzene	791.57	0
Water	Benzo(g,h,i)perylene	0	0
Water	Brominated diphenylethers	0	0
Water	Cadmium and compounds (as Cd)	674494.7621	0
Water	Carbon monoxide	4.3492	0
Water	Chlordane	611140	0
Water	Chlordecone	3966200	0
Water	Chlorfenvinphos	664310	0
Water	Chlorides (as total Cl)	301.44	0
Water	Chlorine and inorganic compounds (as HCl)	301.44	0
Water	Chloro-alkanes, C10-C13	10200	0
Water	Chlorpyrifos	393650000	0
Water	Chromium and compounds (as Cr)	12274.01347	0
Water	Copper and compounds (as Cu)	46.47592828	0
Water	Cyanides (as total CN)	26453	0
Water	DDT	928010	0
Water	Di-(2-ethyl hexyl) phthalate	1519.4	0
Water	Dichloromethane	141.6	11.2
Water	Dieldrin	2050700	0
Water	Diuron	196170	0
Water	Endosulphan	1980800	0
Water	Endrin	39311000	0
Water	Ethyl benzene	1678.5	0
Water	Ethylene oxide	80.053	0
Water	Fluoranthene	380060	0
Water	Fluorides (as total F)	20.361	0
Water	Halogenated organic compounds (as AOX)	3689.2	0
Water	Heptachlor	448420	0
Water	Hexabromobiphenyl	0	0
Water	Hexachlorobenzene	341750	0

Release medium	Pollutant name	Freshwater ecotoxicity (CTUe)	Climate change (CO_2e)
Water	Hexachlorobutadiene	25527	0
Water	Hydrogen cyanide	61265	0
Water	Isodrin	4055300	0
Water	Isoproturon	398850	0
Water	Lead and compounds (as Pb)	68.25546277	0
Water	Lindane	3470200	0
Water	Mercury and compounds (as Hg)	33175.97306	0
Water	Mirex	5725.2	0
Water	Naphthalene	4522.1	0
Water	Nickel and compounds (as Ni)	27049.47608	0
Water	Nitrogen oxides	0	0
Water	Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)	53425	0
Water	Octylphenols and Octylphenol ethoxylates	287020	0
Water	Organotin compounds (as total Sn)	513.1042026	0
Water	Particulate matter	0	0
Water	PCDD + PCDF (dioxins + furans) (as Teq)	31479000	0
Water	Pentachlorobenzene	55563	0
Water	Pentachlorophenol	302090	0
Water	Phenols (as total C)	17344	0
Water	Polychlorinated biphenyls	44637	0
Water	Polycyclic aromatic hydrocarbons	239130	0
Water	Simazine	666940	0
Water	Sulphur oxides	0	0
Water	Tetrachloroethylene	1260.2	6.34
Water	Tetrachloromethane	6459.6	2200
Water	Toluene	973.2	0
Water	Total nitrogen	0	0
Water	Total organic carbon(as total C or COD/3)	0	0
Water	Total phosphorus	2.0314	0
Water	Toxaphene	3515900	0
Water	Tributyltin and compounds	454680	0
Water	Trichlorobenzenes (all isomers)	3800.1	0
Water	Trichloroethylene	269.69	0.044
Water	Trichloromethane	696.98	20.6
Water	Trifluralin	1661800	0
Water	Triphenyltin and compounds	59088000	0
Water	Vinyl chloride	133.53	0
Water	Xylenes	674.82	0
Water	Zinc and compounds (as Zn)	1659.512214	0

C.6 Environmental Quality Standards thresholds

Table C.2 Chemical pollution thresholds in Environmental Quality Standards Directive

Notes: The following table describes the annual average (AA, long-term) for the Environmental Quality Standards for European surface waters. Source: (EQSD 2013/39/EU). The following abbreviations are used: IED for covered in Industrial Emissions Directive (E-PRTR). HAZ stands for Hazardous, uPBT stands for ubiquitous, persistent, bioaccumulative and toxic pollutant. AccSed stands for accumulates in sediment.

No	Name	Group	IED	HAZ	uPBT	AccSed	AA-EQS (μg/L) Inland
1	Alachlor	Pesticides	Yes				0.3
2	Anthracene	Industrial Substances	Yes	Yes		Yes	0.1
3	Atrazine	Herbicides	Yes				0.6
4	Benzene	Industrial Substances	Yes				10
5	Brominated diphenylethers	Industrial Substances	Yes	Yes	Yes	Yes	
6	Cadmium and its compounds						
	water hardness equivalent to $\leq$ 40 mg CaCO3/L	Metals	Yes	Yes		Yes	0.08
	water hardness equivalent to 40 to $<$ 50 mg CaCO3/L	Metals	Yes	Yes		Yes	0.08
	water hardness equivalent to 50 to $<$ 100 mg CaCO3/L	Metals	Yes	Yes		Yes	0.09
	water hardness equivalent to 100 to $<$ 200 mg CaCO3/L	Metals	Yes	Yes		Yes	0.15
	water hardness equivalent to $\geq$ 200 mg CaCO3/L	Metals	Yes	Yes		Yes	0.25
6a	Carbon-tetrachloride	Industrial substances	n.a.				12
7	C10-13 Chloroalkanes	Industrial substances	Yes	Yes		Yes	0.4
8	Chlorfenvinphos	Pesticides	Yes				0.1
9	Chlorpyrifos (Chlorpyrifos-ethyl)	Organophosphate pesticides	Yes		Yes	Yes	0.03
9a	Sum of cyclodiene pesticides (Aldrin, Dieldrin, Endrin, Isodrin)	Organochlorine pesticides	individual				0.01
9b	DDT total	Organochlorine pesticides	Yes				0.025
	para-para- DDT		Yes				0.01
10	1,2-Dichloroethane	Industrial substances	Yes				10
11	Dichloromethane	Industrial substances	Yes				20
12	"Di(2- ethylhexyl)- phthalate (DEHP)"	Industrial substances	Yes	Yes		Yes	1.3
13	Diuron	Herbicides	Yes				0.2
14	Endosulfan	Organochlorine pesticides	Yes	Yes			0.005
15	Fluoranthene	" Industrial substances"	Yes		Yes	Yes	0.0063
16	Hexachloro- benzene	Organochlorine pesticides	Yes	Yes		Yes	
17	Hexachloro- butadiene	Industrial substances	Yes	Yes		Yes	
18	Hexachloro- cyclohexane	Insecticides	Yes	Yes		Yes	0.02
19	Isoproturon	" Herbicides"	Yes				0.3
20	Lead and its compounds	Metals	Yes			Yes	1.2
21	Mercury and its compounds	Metals	Yes	Yes	Yes	Yes	
22	Naphthalene	Industrial substances	Yes				2
23	Nickel and its compounds	Metals	Yes				4
24	"Nonylphenols (4-Nonylphenol)"	Industrial substances	Yes	Yes			0.3
25	Octylphenols ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	Industrial substances	Yes				0.1
26	Pentachloro-benzene	Industrial substances	Yes	Yes		Yes	0.007
27	Pentachloro-phenol	Organochlorine pesticides	Yes				0.4
28	Polyaromatic hydrocarbons (PAH)	Combustion products					
	Benzo(a)pyrene		n.a.	Yes	Yes	Yes	0.00017
	Benzo(b)fluor- anthene		n.a.	Yes	Yes	Yes	
	Benzo(k)fluor- anthene		n.a.	Yes	Yes	Yes	
	Benzo(g,h,i)- perylene		Yes	Yes	Yes	Yes	
	Indeno(1,2,3- cd)-pyrene						
	Chrysene						
	Benzo(a)anthracene						
	Dibenz(a,h)anthracene						
29	Simazine	Pesticide	Yes				1
29a	Tetrachloro- ethylene	Industrial substances	Yes				10
29b	Trichloro- ethylene	Industrial substances	Yes				10
30	Tributyltin compounds (Tributyltin-cation)	Biocides	Yes	Yes	Yes	Yes	0.0002
31	Trichloro- benzenes	Industrial substances	Yes				0.4
32	Trichloro- methane	Herbicides	Yes				2.5
33	Trifluralin	Organochlorine pesticides	Yes	Yes			0.03
34	Dicofol	Industrial substances	n.a.	Yes		Yes	0.0013
35	Perfluorooctane sulfonic acid and its derivatives (PFOS)	Industrial substances	n.a.	Yes			0.00065
36	Quinoxyfen	Plant protection products	n.a.	Yes		Yes	0.15
37	Dioxins and dioxin-like compounds	Industrial byproducts	n.a.	Yes	Yes	Yes	
38	Aclonifen	Herbicides	n.a.				0.12
39	Bifenox	Herbicides	n.a.				0.012
40	Cybutryne	Biocides	n.a.				0.0025
41	Cypermethrin	Pyrethroid pesticides	n.a.			Yes	0.00008
42	Dichlorvos	Organophosphate pesticides	n.a.				0.0006
43	Hexabromocyclododecane (HBCDD)	Industrial substances	n.a.	Yes	Yes	Yes	0.0016
44	Heptachlor and heptachlor epoxide	Organochlorine pesticides	Yes	Yes	Yes	Yes	0.0000002
45	Terbutryn	Herbicides	n.a.				0.065

C.7 LLM-driven indicators for banks' biodiversity and pollution policies

We match 220 banks in our sample to the BankTrack's bank directory[95], covering the period from 2005 to 2024. BankTrack systematically tracks environmental and social impacts of banking policies and practices across major financial institutions. A comprehensive document collection was conducted for each bank using the Resources-Documents-Links section, focusing on annual reports and policy-related documents. The collection process resulted in a total of 3,156 full-content documents, covering the entire study period.

This study uses large language models (LLM) to construct binary and descriptive reasoning of whether a bank has factually walked their green claims by genuinely including biodiversity and/or pollution-related targets in their formal documents as a public commitment to their stakeholders. A biodiversity keyword framework was constructed following the guidance from the UN Environment Programme Finance Initiative (UNEPFI).[96] Furthermore, we developed a pollution keyword framework based on the European Pollutant Release and Transfer Registerand the Sustainable Development Goals[97], ensuring alignment with internationally recognised environmental standards and metrics. The Gemini 1.5 Flash LLM was employed to construct an automated pipeline for processing each bank document. It was programmed to read individual documents and generate binary proxies based on the established keywords. To ensure methodological rigour and enable manual validation, the system was designed to output comprehensive justifications for each classification decision in a structured format, including: (i) a binary classification result, (ii) a brief explanatory text, and (iii) relevant quotations that support the classification.

Two key binary variables were constructed: **Biodv_policy** (coded as 1 from the first year of biodiversity-related policy issuance, 0 otherwise), and **Pollu_policy** (coded as 1 from the first year of pollution policy issuance, 0 otherwise). Validation includes manual review of the LLM-generated explanatory text and supporting quotations, alongside systematic checks for SDG alignment to ensure classification accuracy and consistency.

The construction of these variables has limitations that may impact interpretability. Notably, the sample is limited to banks actively tracked by BankTrack, which may skew the results

[95] https://www.banktrack.org/bank/.
[96] see UNEPFI (2023) .
[97] https://sdgs.un.org/goals.

towards larger, more internationally prominent institutions. Additionally, the significant number of inaccessible documents (1,972 out of the total collection effort) may lead to gaps in policy tracking over time or across certain institutions.

```
biodiversity_filtered_keywords: Set[str] = {
    # Biodiversity Term Variations
    'biodiversity', 'bio-diversity', 'bio diversity', 'biological diversity', '
        biodiversity-related', 'bio-diverse',
    'biodiverse', 'biodiversity conservation', 'biodiversity protection', '
        biodiversity safeguard',
    'biodiversity preservation', 'biodiversity management', 'biodiversity
        governance', 'biodiversity assessment',
    'biodiversity monitoring', 'biodiversity reporting', 'biodiversity disclosure
        ', 'biodiversity performance',
    'biodiversity impact', 'biodiversity risk', 'biodiversity opportunity', '
        biodiversity commitment',
    'biodiversity target', 'biodiversity goal', 'biodiversity standard', '
        biodiversity requirement',
    'biodiversity compliance', 'biodiversity crisis', 'biodiversity emergency', '
        biodiversity challenge',
    'biodiversity threat', 'biodiversity decline', 'biodiversity degradation', '
        biodiversity recovery',
    'biodiversity restoration', 'biodiversity enhancement', 'biodiversity
        improvement', 'animal protection',
    'nature and biodiversity',
    # Ecosystem Conservation (Target 15.1)
    'terrestrial ecosystem', 'freshwater ecosystem', 'forest', 'mountain ecosystem
        ', 'protected area coverage',
    # Forest Management (Target 15.2)
    'sustainable forest management', 'deforestation', 'afforestation', '
        reforestation', 'forest degradation',
    'forest restoration', 'forest area', 'forest cover', 'flora',
    # Biodiversity and Species (Target 15.5)
    'natural habitat', 'habitat degradation', 'biodiversity loss', 'threatened
        species', 'endangered species',
    'species extinction', 'red list index', 'species protection', 'fauna',
```

```
    # Genetic Resources (Target 15.6)
    'genetic resources', 'genetic diversity', 'biodiversity framework', '
        biodiversity policy',
    # Wildlife Protection (Target 15.7, 15.c)
    'poaching', 'wildlife trafficking', 'protected species', 'illegal wildlife', '
        wildlife trade', 'wildlife product',
    # Invasive Species (Target 15.8)
    'invasive species', 'alien species', 'invasive alien', 'species control', '
        species eradication', 'species protection',
    # Planning and Resources (Target 15.9, 15.a, 15.b)
    'ecosystem value', 'biodiversity value', 'biodiversity planning', '
        biodiversity strategy', 'biodiversity action plan',
    'biodiversity finance', 'forest management finance',
    # Measurement Terms
    'sdg 15', 'life on land', 'biodiversity indicator', 'biodiversity metric', '
        biodiversity accounting'
}

pollution_filtered_keywords: Set[str] = {
    # SDG 6: Water and Sanitation
    'water pollution', 'wastewater', 'sewage treatment', 'contaminants', 'heavy
        metals', 'microplastics',
    'nutrient runoff', 'water quality',  'effluent', 'water reuse', 'sanitation',
        'fecal contamination',
    # SDG 12: Consumption and Waste
    'waste management', 'recycling', 'circular economy', 'hazardous waste', '
        chemical pollution', 'plastic pollution',
    'packaging waste', 'e-waste', 'industrial waste', 'solid waste', 'wastewater
        discharge',
    # SDG 14: Marine Pollution
    'marine pollution', 'ocean acidification', 'oil spill', 'marine litter',  '
        nutrient loading', 'plastic debris',
    'microbeads', 'underwater noise',
    # SDG 15: Land and Soil
    'land pollution', 'soil contamination', 'pesticide residue', 'agrochemical','
        mining runoff', 'dumping site',
    'leachate', 'soil erosion'
```

```
    # Pollution types
    'copper', 'total nitrogen', 'chromium', 'nickel', 'total phosphorus', 'mercury
        ', 'ammonia', 'phenols',
    'non-methane volatile organic compounds', 'carbon dioxide', 'benzene', '
        sulphur oxides', 'nitrogen oxides',
    'fluorides', 'total organic carbon', 'chlorides', 'halogenated organic
        compounds', 'carbon monoxide',
    'tetrachloroethylene', 'particulate matter', 'methane', 'dichloromethane', '
        trichloroethylene', 'chlorine', 'zinc',
    'cyanides', 'nitrous oxide', 'hydro-fluorocarbons', 'arsenic', 'cadmium', '
        lead', 'polychlorinated biphenyls',
    'polycyclic aromatic hydrocarbons', 'sulphur hexafluoride', 'dichloroethane',
        'fluorine', 'pccd + pcdf',
    'hydrogen cyanide', 'ethylene oxide', 'halons', 'trichloromethane', '
        tetrachloroethylene', 'chlorofluorocarbons',
    'hydrochlorofluorocarbons', 'vinyl chloride', 'perfluorocarbons', 'naphthalene
        ', 'fluoranthene', 'nonylphenol',
    'di-phthalate', 'chloro-alkanes', 'octylphenols', 'hexachlorobutadiene', '
        trichlorobenzenes', 'ddt', 'diuron',
    'isoproturon', 'anthracene', 'ethyl benzene', 'toluene', 'xylenes', '
        hexachlorobenzene', 'hexachlorocyclohexane',
    'pentachlorobenzene', 'trichloroethane',  'benzo(g,h,i)perylene', '
        tetrachloroethane',
    'carbon dioxide excluding biomass', 'lindane', 'confidential', 'organotin
        compounds', 'pentachlorophenol',
    'particulate matter 2.5', 'aldrin', 'dieldrin', 'endrin', 'isodrin', 'alachlor
        ', 'chlordane', 'chlorpyrifos', 'endosulphan',
    'heptachlor', 'toxaphene', 'tributyltin', 'triphenyltin', 'hexabromobiphenyl',
          'atrazine', 'trifluralin',
    'chlorfenvinphos', 'mirex', 'simazine', 'asbestos', 'brominated diphenylethers
        ', 'chlordecone'
}
```

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Dominik Hirschbühl (corresponding author)
European Commission, Joint Research Centre, Ispra, Italy; email: Dominik.Hirschbuehl@ec.europa.eu

Andrej Ceglar
European Central Bank, Frankfurt am Main, Germany; email: Andrej.Ceglar@ecb.europa.eu

Theodor Cojoianu
Singapore Management University, Singapore, Singapore; University of Edinburgh, Edinburgh, Scotland, United Kingdom; Bucharest University of Economic Studies, Bucharest, Romania; email: TCojoianu@smu.edu.sg

Tina Emambakhsh
European Central Bank, Frankfurt am Main, Germany; email: Tina.Emambakhsh@ecb.europa.eu

Yifan Qi
University of Edinburgh, Edinburgh, Scotland, United Kingdom; email: Y.Qi-18@sms.ed.ac.uk

Caterina Rho
European Commission, Joint Research Centre, Ispra, Italy; email: Caterina.Rho@ec.europa.eu

Elsie Hu
University of Edinburgh, Edinburgh, Scotland, United Kingdom; email: Elsie.YH.Hu@ed.ac.uk

Marco Petracco
European Commission, Joint Research Centre, Ispra, Italy; email: Marco.Petracco@ec.europa.eu

Fabrizio Biganzoli
Unisystems, Milano, Italy; email: F.Biganz@gmail.com

Alfred de Jager
European Commission, Joint Research Centre, Ispra, Italy; email: Alfred.de-Jager@ec.europa.eu

Laura Garcia Herrero
European Commission, Joint Research Centre, Ispra, Italy; email: Laura.Garcia-Herrero@ec.europa.eu

Andrea Mandrici
Arcadia SIT, Vigegano, Italy; email: Andrea.Mandrici@ext.ec.europa.eu

Carlo Pasqua
London School of Economics and Political Science, London, United Kingdom; email: C.Pasqua@lse.ac.uk

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Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

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