Do words reduce negative impacts on biodiversity? Evidence from central bank communication on nature

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Abstract

This paper investigates whether central bank communication on nature and biodiversity shapes banks' behaviour. We build a novel dictionary of nature-related terms and apply it to a large corpus of central bankers' speeches between 2016 and 2023, constructing two novel measures of nature-related attention. These Nature focus indicators are matched with bank-level data on the Corporate Biodiversity Footprint (CBF) for 186 commercial banks across 38 countries. We find that the frequency and the salience of biodiversity-related references in central bank communications are followed by a significant reduction in banks' biodiversity impacts. The results suggest that central bank communication acts as a credible signal of emerging supervisory priorities, prompting banks to adjust their strategies in anticipation of future requirements and regulatory changes. Overall, the findings highlight the role of "soft" institutional channels in fostering early biodiversity action within the financial sector.

Keywords: Biodiversity finance; Nature-related risks; Financial institutions; Banks; Central banking; Text analysis

JEL Codes: E58; G21; Q5; Q57

1. Introduction

Over the past twenty years, climate change has become a central concern in economics and finance. Supervisor authorities and financial institutions now widely acknowledge that climate-related risks can affect macroeconomic conditions, financial performances, asset valuations, and financial stability (Marcinkowska et al., 2025; van 't Klooster & Prodani, 2025; Vyshnevskyi & Sohn, 2025).

By contrast, the financial implications of nature degradation and biodiversity loss have received significantly less attention and have only recently entered the academic and policy debate. This delay is noteworthy, given that ecosystem services underpin nearly half of global economic output (World Economic Forum, 2022), that most firms directly or indirectly rely on natural capital, and that nature loss can affect firms' financial performance and value (Bach et al., 2025; Chen et al., 2025b; Cosma et al., 2025a). The relative marginalisation of biodiversity

considerations in finance, therefore, does not reflect a lack of financial relevance. Rather, it stems from the intrinsic conceptual and operational challenges associated with translating ecological degradation into financial risk, a process often described as the "riskification of nature" (van 't Klooster & Prodani, 2025). Unlike climate-related risks, which can be assessed using a relatively well-established set of global, standardised indicators, such as carbon dioxide (CO_2) concentrations or greenhouse gas (GHG) emissions, nature loss manifests across different ecosystems, geographic areas, and species, and is frequently characterised by non-linear processes, thresholds, and irreversible tipping points not easily quantifiable (Lucey et al., 2025). As with any other economic activity, financial institutions are nonetheless deeply exposed to nature and biodiversity loss through indirect dependencies and impacts arising from lending, investment, and insurance activities (Kedward et al., 2023). These exposures may give rise to nature-related physical risks driven by ecosystem degradation and ecological shocks, transition risks linked to policy, regulatory, or market responses to nature loss, and, in more severe cases, such shocks can then propagate through global supply chains, firms, commodity markets, ultimately transmitting stress to the financial system as a whole (Kulionis et al., 2024; Lucey et al., 2025; Mies, 2025). Recent empirical evidence demonstrates that financial institutions' investment portfolios are heavily tied to sectors that depend on ecosystem services and, at the same time, contribute to ecosystem degradation (Hadji-Lazaro et al., 2024; Mundaca & Heintze, 2024). This two-way interaction creates a feedback loop in which nature-negative financial flows accelerate ecosystem degradation, weaken firms' economic fundamentals and feed back into higher financial risk. Despite this interaction, the evidence shows that banks' engagement with biodiversity remains largely voluntary and uneven (Azizi et al., 2025), especially when compared with the regulatory progress achieved in the climate domain. Neglecting biodiversity risks may create "blind spots" (Kedward et al., 2023), leaving financial institutions unknowingly exposed to them.

Against this background, a simple question arises: does central bank communication on nature drive supervised financial institutions to start reducing biodiversity impacts before clear regulatory obligations are in place? Recent research has questioned whether a "measure first, act later" approach is well-suited to biodiversity-related risks, given their complexity, uncertainty, and potential to materialise over relatively short time horizons (Kedward et al., 2023). In such a setting – from our perspective – the communicative role of central banks becomes particularly fundamental. Beyond formal regulation, central banks influence financial institutions, markets and investors' behaviours through speeches, public statements, and policy announcements that shape expectations and signal emerging priorities (Altavilla et al., 2019;

Campiglio et al., 2025). Such communication can convey credible information about how supervisors interpret new sources of risk and how their agendas may evolve. For supervised entities, repeated references to biodiversity in central bank communication may therefore act as an early signal, encouraging adjustments to their strategy in anticipation of future requirements.

While a growing body of literature documents the effects of climate-related central bank communication, much less is known about whether communication on nature and biodiversity has any measurable influence on banks' behaviour. To fill this gap, we examine whether and to what extent the central bank's focus on nature is associated with biodiversity-related action by commercial banks. To do so, we first develop a novel dictionary of nature-related keywords and apply it to a large corpus of central bankers' speeches collected by Campiglio et al. (2025), identifying a sub-sample of 1,087 communications that explicitly address nature-related issues. Second, we construct novel indicators of nature-related attention (i.e., *Nature frequency* and *Nature salience*) based on a large dataset of central bankers' speeches from Campiglio et al. (2025). Next, we combine them with the Corporate Biodiversity Footprint (*CBF*), a measure for the biodiversity loss caused by a firm's annual activities. Finally, using an international panel of 186 commercial banks operating in 38 countries over the period 2016-2023, we analyse whether stronger attention to nature in central bank communication is followed by reductions in banks' biodiversity footprints arising from financing activities. Our results show that banks operating in environments where central banks pay greater attention to biodiversity tend to exhibit lower biodiversity impacts, with the effect being driven solely by Scope 3 (or indirect impacts). These findings suggest that central bank communication can influence banks' behaviour even in the absence of formal biodiversity regulation, by shaping expectations and encouraging anticipatory responses. These findings are robust across multiple specifications, including several endogeneity tests, replacement in the dependent variable and heterogeneity tests. We interpret these findings in the light of institutional and signalling theories. Our findings are also consistent with similar evidence from the climate-related literature (Zhang et al., 2025) and corroborate and extend previous research in biodiversity finance literature (Garel et al., 2024; Coqueret et al., 2025; El Ouadghiri et al., 2025).

The paper contributes to the literature in three ways. First, it extends research on central bank communication by moving beyond climate change and focusing explicitly on nature and biodiversity, highlighting that biodiversity-related signals convey distinct information that is not fully captured by climate-oriented narratives. Second, it contributes to the emerging biodiversity finance literature by shifting attention from the financial consequences of

biodiversity loss to the institutional channels that drive the banking industry to integrate biodiversity considerations into its decision-making. Third, it offers policy-relevant insights by showing that central bank communication can function as an effective and timely tool to encourage a biodiversity positive action in the financial sector, particularly in contexts characterised by uncertainty and limited formal requirements.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature and develops the research hypothesis. Section 3 introduces the dataset of central bankers' speeches and focuses on speeches classified as nature-related. Section 4 describes data sources and the methodological framework. Section 5 presents the empirical findings. Section 6 concludes by discussing its implications.

2. Literature review

Neo-institutionalism is often used to explain the diffusion of practices and structural arrangements across organisations. According to neo-institutional theory, organisations operating within different institutional settings face a range of coercive, normative and mimetic pressures that influence their behaviour and decision-making, leading them to align with practices deemed legitimate within their environment (DiMaggio & Powell, 1983). Empirical evidence has so far shown that the institutional context in which organisations operate can influence their engagement in sustainable practices (Candio, 2024; Uyar et al., 2025).

From a neo-institutional perspective, central bank communication can be understood as a credible form of "soft law", providing institutional pressures that shape the responses of market participants and supervised entities to emerging priorities. This is because central banks utilise public speeches, official statements, and press conferences to clarify the rationale behind policy decisions, steer expectations, and enhance policy effectiveness, while also reinforcing their legitimacy as public institutions (Moschella et al., 2020; Campiglio et al., 2025). A growing number of studies indicate that central banks' public statements, speeches, and policy announcements influence macro-financial dynamics, as financial market participants closely analyse such communication to form expectations about future economic conditions, with direct effects on asset prices and risk premia (Altavilla et al., 2019; Swanson, 2021; Rostagno et al., 2025).

In recent years, central bank communication has increasingly incorporated environmental and climate-related risks, which are now widely regarded as relevant sources of macro-financial

and financial stability concerns (Marcinkowska et al., 2025). Vyshnevskyi and Sohn (2025) argue that this change highlights a growing awareness that climate-related risks can affect central banks' core mandates (such as price stability, financial stability, maximum employment, and sustainable economic growth), influence balance sheets and reserve management, and expose central banks to reputational and accountability challenges as societal pressure intensifies. Scholars claim that "green" messages may generate measurable effects in financial markets. For instance, central banks' green communication can influence banks' lending behaviour. By signalling a stronger emphasis on environmental issues, central banks may encourage commercial banks to reduce credit to more polluting firms (Chen et al., 2025a) and incorporate sustainability metrics into lending criteria (Wang et al., 2025). Central bank green communication can also alter investment preferences. Campiglio et al. (2025) find that the frequency and salience of climate-related communication across 131 central banks are systematically associated with higher returns for greener firms, pointing to a consistent informational role of central bank discourse in shaping investors' climate-related risk perceptions. Similarly, Neszveda and Siket (2025) document short-term return divergences around high-environmental-content European Central Bank (ECB) speeches, with firms exhibiting stronger emissions reduction performance outperforming more polluting firms only on speech days. According to Kumari and Pandey (2025), this occurs because markets mainly react to climate-related signals from central banks in the short run, as such communications shape expectations about immediate compliance costs and help reduce uncertainty.

This evidence is also consistent with signalling theory, which posits that credible actors can reduce information asymmetries by sending signals that shape the expectations of other agents (Spence, 1973). In this regard, central bank communication signals the future regulatory and supervisory agenda, highlights emerging risk factors, and indicates which activities may be subject to increased scrutiny or potential penalties in the future. These signals affect agents' expectations, prompting anticipatory adjustments in their behaviour. For instance, Zhang et al. (2025) demonstrate that green signals issued by central banks encourage firms to increase investments in green technologies and renewable energy projects, thereby contributing to lower firm-level carbon emissions. In line with signalling theory and neo-institutional theory, it follows that supervised financial institutions may interpret repeated signals as prompts to anticipate regulatory developments and adjust their strategies accordingly. Therefore, it is reasonable to expect that commercial banks may perceive central bank communication on nature as an early signal of potential future requirements, prompting them to proactively reconsider their exposures to nature-degrading activities and, thus, reduce their negative impact

on biodiversity to maintain legitimacy and align with evolving institutional pressures. This idea is further consistent with recent empirical evidence from biodiversity finance literature showing that biodiversity-related risks begin to influence investors' attention and affect stock returns mainly in response to heightened public attention and institutional developments, such as following the Kunming Declaration in October 2021 (Garel et al., 2024; Coqueret et al., 2025; El Ouadghiri et al., 2025). Thus, we propose our hypothesis as follows:

H1. *An increase in nature-related communication by the central bank authority is positively associated with biodiversity action in commercial banks.*

3. Nature and central bank communication

This section introduces the dataset of central bankers' speeches used in the analysis. Section 3.1 explains how nature-related communications are identified, while Section 3.2 presents an overview of these speeches and discusses their evolution over time.

The central bankers' speeches used in this study are drawn from the dataset provided by Campiglio et al. (2025). This dataset builds on the Bank for International Settlements (BIS) repository by complementing it with speeches collected directly from central bank websites and archives. As a result, it offers substantially broader coverage than the BIS dataset alone and includes communications from a wider set of central banks.

The initial dataset in our work consists of 12,917 unique speeches from 119 central banks between January 2016 and December 2023. Panel A in Table 1 summarises the size of the dataset and reports the distribution of speeches across central banks. Compared to the BIS repository, this corresponds to an increase of 99% in the number of speeches available for analysis. Consistent with Campiglio et al. (2025), countries are classified into two groups: (i) advanced economies, and (ii) emerging and developing economies. Although speeches from advanced economies still account for the largest share of the sample, all central banks not covered by the BIS database and added by Campiglio et al. (2025) belong to the group of emerging and developing economies. This expansion allows for a significant broadening of the geographical scope of central bank communication. Panel B shows that Governor speeches represent approximately 57% of the full sample, and three-quarters of all observations when

Deputy Governors are included. This concentration suggests that central bank communication in our dataset predominantly reflects high-level institutional messaging.

[Table 1 here]

3.1. Identifying nature-related speeches

We start by defining a set of nature-related keywords with the aim of measuring the extent to which central banks explicitly address nature-related issues in their public communications. Within the literature on central bank communication, dictionary-based approaches are widely used to classify speeches by topics, relying on lists of possible keywords associated with a particular theme (Campiglio et al., 2025; Chen et al., 2025a; Feldkircher & Teliha, 2024). One possible approach would be to analyse the full corpus of central bank speeches without any prior filtering. However, central bank communications typically cover a very broad range of themes, including monetary policy, financial stability, macroeconomic developments and regulatory issues. As a result, the specific narratives relevant to nature-related risks and biodiversity would likely be diluted by the predominance of unrelated topics. Since we are interested in including also speeches where nature-related topics are mentioned as part of a broader discussion on other themes, Campiglio et al. (2025) suggest that a dictionary-based approach is better suited to isolate the subset of selected communications while avoiding false positives[1].

A further challenge is that, unlike climate finance, the biodiversity finance literature does not yet provide a standardised or widely accepted nature-related dictionary. To address this gap, Giglio et al. (2025) built their own biodiversity-related dictionary using an endogenous approach based on Google's word2vec algorithm. Starting from the seed word "biodiversity", they identify 100 terms that are semantically close to it, based on cosine similarity. This procedure allows them to capture expressions that are commonly used in discussions of biodiversity loss, even when the term "biodiversity" itself is not explicitly mentioned. At the same time, seeding approaches are known to be sensitive to the initial choice of the seed word, which can influence the composition of the resulting dictionary (Campiglio et al., 2025).

[1] Alternative text analysis techniques, such as topic modelling methods based on word co-occurrence patterns (e.g. Latent Dirichlet Allocation or Structural Topic Modelling), are also not ideal for this purpose. These methods generally perform better when applied to relatively small and thematically coherent texts, whereas central bank speeches are highly heterogeneous in content (Campiglio et al., 2025).

Therefore, along the same lines as Campiglio et al. (2025), we build our dictionary by combining existing resources with insights from the biodiversity finance literature. In particular, we start from a few dictionaries currently available[2], including the one proposed by Giglio et al. (2025)[3], and eventually enrich them with our knowledge on biodiversity finance literature. This process yields an initial list of more than 1,000 expressions. The dictionary is then refined through several screening steps. First, we remove duplicates and terms that would clearly generate false matches (e.g., "impact drivers", "scenarios", "supply chain"). Second, we exclude keywords that primarily refer to climate change or green finance rather than to nature and biodiversity, as well as terms already covered in Campiglio et al. (2025). We also discard overly broad environmental expressions, such as "pollution", "green", "environmental risk(s)" and "natural resource(s)", which are too generic to reliably identify nature-related content in central bank speeches. While some keywords (for example, "wildlife") are sufficiently specific to identify nature-related content, others might be more imprecise due to their broad usage across different contexts. This creates the risk of classifying speeches as nature-related even when the term is used in a different context[4]. To mitigate this issue, we adopt a similar approach to that of Giglio et al. (2025) and impose a co-occurrence requirement for a subset of ambiguous terms. Specifically, when a speech contains words such as "ecosystems", "species", "conservation", or "unep", it is classified as nature-related only if at least one additional, non-ambiguous nature-related keyword in our dictionary appears in the same speech[5]. After this process, the final dictionary consists of 99 keywords. Table 2 reports the complete list of keywords included in the dictionary, together with the number of speeches in which each term

[2] These dictionaries are publicly available online and provide standardised definitions and terminology commonly associated with biodiversity and nature. Specifically, we rely on internationally recognised and authoritative glossaries, such as the Biodiversity A-Z glossary (https://www.biodiversitya-z.org/themes/terms?s=home-icons), the Convention on Biological Diversity glossary (https://www.cbd.int/cepa/toolkit/2008/doc/cbd-toolkit-glossaries.pdf), the International Fund for Animal Welfare glossary (https://www.ifaw.org/international/journal/biodiversity-terms-definitions), the Taskforce on Nature-related Financial Disclosures glossary (https://tnfd.global/wp-content/uploads/2023/09/TNFD-Glossary-of-terms-V4-June-2025.pdf), and the World Wide Fund for Nature glossary (https://wwf.panda.org/discover/our_focus/biodiversity/biodiversity_glossary/).

[3] Some compound expressions included in Giglio et al. (2025) are not treated as separate words in our dictionary when their semantic content is fully captured by the individual keywords already included. For instance, the expression "wetland_habitats" is not counted separately, as both "wetland" and "habitats" are already considered as standalone keywords. This approach reduces double-counting and ensures consistency across related terms.

[4] For instance, the keyword "ecosystems" can be used outside nature-related contexts, including references to "digital ecosystems", as illustrated in the following example: "Bigtech firms recognised the value of data in general and of payment data in particular early on. Almost all the major providers of technology platforms are based outside Europe. They are constantly adding new services to their digital ecosystems, which then make it attractive to use other services within those ecosystems as well."

[5] As an additional robustness exercise in our regression analyses, we implement a more stringent exclusion criterion, classifying a speech as nature-related only when it has at least two distinct nature-related keywords (Giglio et al., 2025), thereby further reducing the risk of false positives. We will discuss it in section 5.4.1.

appears[6]. Unsurprisingly, the term "biodiversity" emerges as the most frequently used keyword, appearing in 686 speeches. Other very common expressions are "ecological" (275 speeches), "forest" (183), "ecosystems" (176), "ocean" (176), and "marine" (148), suggesting a recurring focus on large-scale terrestrial and marine ecosystem services.

[Table 2 here]

3.2. Nature-related speeches: an overview

Our dictionary allows us to identify 1,087 speeches that mention nature-related keywords at least once. A substantial share of these speeches (516) is not included in the BIS repository. The nature-related speeches identified within our sample originate from 87 different central banks, but their contribution to nature-related communication is far from uniform. Indeed, most central banks pay scarce attention to nature, biodiversity and ecosystem services in their public speeches. 42 institutions have fewer than 5 nature-related speeches over the sample period, indicating that nature and biodiversity loss remain a relatively sporadic theme for a large part of the sample. By contrast, a small group of central banks is much more active: just 10 institutions are responsible for slightly half of all nature-related speeches. This concentration suggests that the public discussion on nature loss is driven primarily by a limited number of central banks. A similar degree of heterogeneity emerges when considering the intensity of nature-related content within individual speeches.

Only 377 speeches contain more than two distinct nature-related keywords[7], suggesting that references to biodiversity loss remain relatively limited in most communications. This pattern is further confirmed by Figure 1, which shows the evolution over time of the number of nature-related speeches and their relative intensity across regions. Panel (a), shown on the left-hand side of the figure, documents a clear upward trend in the number of speeches that address nature-related topics over the sample period. This increase is largely driven by European authorities, which consistently represent the most active contributors and account for the largest share of such communications throughout the period considered. In contrast, other regions

[6] Prior to computing the frequency of nature-related terms, the text corpus is pre-processed to ensure accurate identification of all relevant occurrences. Following Campiglio et al. (2025), we transform speeches into lowercase letters, then we replace all '-' with ' ' and transform special characters (such as ligatures or accents) into standard lowercase characters.

[7] The three speeches with the highest concentration of nature-related content were delivered by François Villeroy de Galhau, Governor of the Banque de France, in September 2022; Sylvie Goulard, Deputy Governor of the Banque de France, in October 2022; and Alejandro Díaz de León, Governor of the Banco de México, in November 2021.

exhibit lower levels of engagement. Nevertheless, their involvement gradually increases over time, with a more noticeable acceleration after 2020, suggesting a growing, although still uneven, international attention to nature-related issues. Panel (b), displayed on the right-hand side, focuses on the intensity of nature-related content at the individual speech level and reveals substantial heterogeneity. While most speeches contain only a small number of nature-related keywords, a limited subset of speeches, particularly in late 2020, exhibit a much higher concentration. This suggests a gradual shift from occasional mentions to a more in-depth discussion. Considering that biodiversity loss has become a salient issue in financial markets only after major institutional events, such as the Kunming Declaration and the launch of the Taskforce for Nature-related Financial Disclosures (TNFD) in late 2021 (Garel et al., 2024), these outcomes were largely expected.

[Figure 1 here]

4. Data and Methods

4.1. Data sources and sample construction

To examine whether increased nature-related attention in central bank communication is associated with biodiversity action in commercial banks, we use information from various sources. To quantify nature-related central bank communication, we use the dataset of central bankers' speeches from Campiglio et al. (2025). Data on biodiversity is sourced from Iceberg Data Lab (IDL). Bank-specific characteristics are collected from LSEG Data and Analytics (formerly Refinitiv). Country-level data are obtained from the World Bank database and Yale Center for Environmental Law and Policy. Our sample construction starts with 203 listed commercial banks for which a match across IDL, Refinitiv and the central bankers' speeches dataset is possible. After removing any missing observations in the dependent, independent and control variables, our final sample consists of 186 commercial banks operating in 38 countries over the period 2016-2023[8]. This results in a panel dataset of 904 bank-year observations.

[8] The sample selection strategy is contingent on our data availability from IDL. The chosen time span is also in line with recent evidence (e.g., Christofi et al., 2025; Di Tommaso et al., 2025).

4.2. Empirical model

To test our research question, we derive a model that represents the bank's impact on biodiversity as a function of nature-related central bank communication, firm- and country-specific characteristics. Our baseline regression model is therefore specified as follows:

$$CBF_{i,t} = \beta_0 + \beta_1 Nature\ Focus_{c,t-1} + \gamma X_{i,c,t-1} + \theta_t + \mu_i + \epsilon_{i,c,t} \quad (1)$$

Our dependent variable is the Corporate Biodiversity Footprint ($CBF_{i,t}$) developed by IDL. Given the lack of alternative and reliable data on biodiversity (Mundaca & Heintze, 2024)[9], we use the *CBF* as a proxy for the degree of commercial banks' commitment toward a biodiversity-positive action. This is because the *CBF* is a standardised indicator designed to quantify the extent to which corporate activities contribute to biodiversity loss by altering ecosystems away from their pristine conditions. IDL computes the *CBF* by combining firm-level financial and operational data with a multi-regional, environmentally extended input–output model, known as Wunderpus. This modelling framework makes it possible to trace the environmental pressures generated by a firm through the flows of goods and services on which its activities depend. As a result, the *CBF* captures not only the direct environmental impacts associated with a firm's own operations, but also the indirect impacts arising along its entire value chain. It is worth noting that, for the banking industry, biodiversity impacts do not primarily stem from banks' direct operations, which are relatively limited in environmental terms, but rather from the allocation of capital through lending activities. Accordingly, the *CBF* for banks is derived from a loan book impact assessment, which captures the indirect environmental impacts generated by financed activities (Iceberg Data Lab, 2022). The methodology accounts for multiple sources of environmental pressure, including land use, greenhouse gas emissions, pollution, resource use and invasive alien species. These pressures are quantified using a life cycle assessment (LCA) approach, which assigns environmental impacts to each stage of production and upstream supply-chain activities. As a result, the *CBF* reflects the cumulative biodiversity impact attributable to a firm's economic activity. Biodiversity loss is then

[9] While a number of data vendors offer firm-level measures of climate impact, often relying on standardised and comparable indicators as carbon dioxide (CO_2) or greenhouse gas (GHG) emissions, comparable firm-level data on biodiversity are not widely available. To the best of our knowledge, IDL is among the few providers currently offering a systematic and standardised measure of corporate biodiversity impacts that is consistently available at the firm level and comparable across countries and sectors.

expressed in square kilometres of Mean Species Abundance[10] (km²·MSA). In simple terms, the *CBF* captures biodiversity loss in terms of the equivalent surface area that has been "artificialized" or ecologically degraded by corporate activity[11] (Garel et al., 2024). Following Garel et al. (2024), the *CBF* values are multiplied by -1 so that higher values correspond to a greater negative impact on biodiversity and implement it in its natural logarithm form due to strong skewness. As part of robustness checks, we also consider the impact intensity, constructed as the ratio between the *CBF* and the bank's total assets (*CBF intensity*).

Our main independent variable is $Nature\ focus_{c,t-1}$. Consistent with Campiglio et al. (2025), we construct two different measures of general central bank attention using our dictionary of nature-related keywords (see Table 2). The first measure, the *Nature frequency* index, quantifies the overall prominence of nature-related topics by counting the total number of nature-related expressions mentioned in each speech. As such, it can be interpreted as a simple word-count indicator. The second measure, the *Nature salience* index, captures the relative importance of nature loss within each speech. It is calculated as the ratio between the *Nature frequency* measure and the total number of words in each speech, multiplied by 100. This normalisation allows the indicator to account for differences in speech length and to reflect the intensity of nature-related content rather than its absolute frequency. Both measures are then aggregated at the central bank and year level[12]. This aggregation yields annual indicators that capture the extent to which central banks' attention to nature loss and ecosystem degradation is reflected in their communication.

In our model, $X_{i,c,t-1}$ denotes a vector of control variables included to capture firm-level and country-level characteristics. Consistent with the existing literature on banking, sustainability, and Environmental, Social and Governance (ESG) performance (Bătae et al., 2021; Birindelli et al., 2022; Christofi et al., 2025; Cosma et al., 2025b), we control[13] for: (i) bank size measured

[10] The MSA metric measures the relative abundance of native species compared to a pristine reference state. An MSA value equal to 1 corresponds to an ecosystem in its natural condition, whereas values approaching 0 indicate severe ecological degradation.

[11] For example, a *CBF* of –5 km²·MSA can be interpreted either as a loss of all native biodiversity over an area of 5 km² or as a 50% reduction in biodiversity over an area of 10 km².

[12] It should be noted that the measure of $Nature\ focus_{c,t-1}$ for countries in the Eurozone can be constructed using either: (i) speeches delivered by members of the boards of the respective national central banks; or (ii) speeches delivered by members of the Executive Board of the European Central Bank. Campiglio et al. (2025), recognising the potential impact of communications originating from both national authority and the European Central Bank, construct their focus measures by jointly considering both groups of speeches. Following their approach, we compute our measures by taking the simple average of the two sets of speeches.

[13] Bank-specific financial variables are winsorized at the 1 per cent and 99 per cent levels (Garel et al., 2024).

as the natural logarithm of the total asset (*size*); (ii) profitability (*ROA*); (iii) capital adequacy (*TIER*); (iv) efficiency (*CIR*); (v) *leverage*; (vi) *credit growth*; (vii) the natural logarithm of the size of the board (*board size*); (viii) the percentage of independent board members (*board independence*), (ix) the percentage of female board members (*board female*); (x) the bank's ESG Score (*ESG Score*); and (xi) the GDP per capita growth (*GDP*). As part of our robustness analysis, we extend the baseline specification by incorporating additional bank-specific variables, along with further controls at the country level. These include: (i) the total market value of equity divided by the total book value of equity (*Market-to-Book*); (ii) the *green attitudes*, a dummy variable indicating the presence of a strategic orientation toward environmental sustainability; (iii) the presence of a dedicated ESG remuneration policy within the board of directors (*ESG pay*); (iv) the bank's Environmental Score (*Env score*) in replacement of the overall ESG score; (v) the Environmental Performance Index score at the country level (*EPI*); and (vi) the *Climate frequency* and *Climate salience* measure from Campiglio et al. (2025), which captures the relative importance of climate change in central bank communications.

In our equation, i indicates the bank, c indicates the country, and t indicates the year. All regressors are lagged by 1 year to mitigate the effects of potential reverse causality and endogeneity issues (Cosma et al., 2025a). To further alleviate endogeneity concerns, we introduce bank fixed effects[14] (μ_i) and year dummies (θ_t). This specification mitigates potential biases by controlling for unobserved time-invariant bank characteristics through bank fixed effects and for common shocks over time – such as macroeconomic fluctuations or national policy changes – through time fixed effects, allowing a cleaner identification of the relationship between central bank nature-related communication and bank-level environmental outcomes (Zhang et al., 2025). Finally, standard errors are clustered at the bank level. Appendix A2 provides information regarding variable descriptions and sources.

5. Empirical results

5.1. Descriptive statistics

[14] Based on a significant Hausman Test.

Appendix A1 presents a detailed overview of the sample composition and its geographical distribution. For each country, it reports the total number of central bank speeches, the subset of speeches addressing biodiversity and nature-related issues, and the corresponding average value of the *CBF*. Following the combination of multiple data sources, data availability constraints lead to a reduction in the number of countries relative to the original dataset from Campiglio et al. (2025). Nevertheless, our final sample still retains most of the original observations. The resulting dataset covers banks operating in 38 countries. The largest shares of observations come from the Eurozone (17.74%), followed by China (12.9%), India (9.7%), and the United States (8.6%). With respect to biodiversity exposure, the highest average *CBF* values are observed in France (8.91), Finland (8.04), Brazil (7.96), Canada (7.95), and Germany (7.58). Overall, speeches explicitly focusing on nature and biodiversity represent a relatively small fraction of the sample, accounting for only 8.3% of all central bank speeches.

Table 2 reports descriptive statistics. The average value of *CBF* is 6.09, which corresponds to a biodiversity loss equivalent to approximately 444 $km^2 \cdot MSA$, an area comparable in size to more than 60,000 standard football pitches. A comparison between nature-related and climate-related variables reveals substantial differences in both frequency and salience. Climate-related issues appear far more prominently in central bank communication than nature loss. On average, the *Nature frequency* is equal to 8.26 words, compared to 115.39 for *Climate frequency*, indicating that references to climate change occur more than ten times as often as references to nature and biodiversity. A similar pattern emerges when considering salience measures. Overall, these descriptive statistics suggest a clear imbalance in central bank attention. This is because climate change has been extensively discussed and emphasised, whereas nature and biodiversity loss have received more limited attention over the years (Giglio et al., 2025).

Appendix A3 presents the pairwise correlation matrix for the variables included in the baseline model. Overall, the correlations among variables are moderate in magnitude. With the sole exception of *Size* and *CBF*, all correlation coefficients are below 0.70, indicating that potential multicollinearity is unlikely to distort our results. This is further confirmed by the analysis of Variance Inflation Factors (VIF) (mean VIF = 1.58; maximum VIF = 2.59).

5.2. Baseline results

Table 4 presents the results of panel regressions estimated with firm and year fixed effects. Columns (1) and (2) examine the relationship between nature-related central bank communications and commercial banks' impact on biodiversity, as defined in Equation (1). The

results show that both *Nature frequency* and *Nature salience* are negative and significant (-0.0012 and -0.0291, respectively; $p<0.05$). This indicates that greater emphasis on nature-related issues in central bank communications is associated with lower biodiversity footprints among commercial banks, thereby providing empirical support for H1[15]. In line with the signalling theory, repeated nature-related references by central banks act as credible signals about the growing importance of biodiversity loss and ecosystem degradation within the future supervisory agenda. In response, commercial banks may undertake positive biodiversity actions and adjust their behaviour by integrating biodiversity considerations into risk management and financial decision-making processes. These adjustments are consistent with the observed reduction in the negative impact of banks on biodiversity. To assess the robustness of our baseline findings, we replace in Columns (3) and (4) the *CBF* level with the *CBF intensity*, defined as the ratio between the bank's biodiversity footprint and its total assets (expressed in million euros). This alternative specification allows us to verify whether the baseline findings hold when *CBF* is scaled. The coefficients in Table 4 for the sensitivity test remain negative and statistically significant, further supporting H1.

Among the control variables, *ROA* is positive and statistically significant across all specifications. This suggests that more profitable banks tend to exhibit higher biodiversity footprints, both in level and in intensity, indicating that financial performance is positively associated with biodiversity impacts. Not surprisingly, larger banks exhibit higher absolute biodiversity footprints but lower footprint intensity, reflecting a pattern similar to that documented for corporate carbon emissions (Bolton & Kacperczyk, 2021). Finally, *GDP* is positive and only marginally significant.

Overall, our findings align with the evidence reported by Zhang et al. (2025), who show that firms' carbon emission impacts decline in response to stronger green signals conveyed through green central bank speeches. Our results also align with recent contributions in the biodiversity finance literature, which document that biodiversity-related risks begin to influence investors' attention and affect stock returns when institutional development and public attention intensify (Garel et al., 2024; El Ouadghiri et al., 2025; Ma et al., 2025). In this context, the focus on nature in central bank communications acts as a credible institutional signal that amplifies awareness of biodiversity risks, encouraging supervised financial institutions to incorporate biodiversity considerations into their decision-making.

[15] The results remain consistent when standard errors are clustered at the country level. Due to space constraints, these additional estimations are not reported but are available upon request.

[Table 4 here]

5.3. Direct and indirect impacts

We also disaggregate commercial banks' biodiversity impacts into Scope 1 (*CBF scope1*), Scope 2 (*CBF scope2*), and Scope 3 (*CBF scope3*) to explore how the central bank nature focus relates to different sources of biodiversity impact[16] (Table 5). This breakdown is especially relevant for financial institutions, whose interactions with biodiversity mainly occur through their financing and investment activities rather than their own direct consumption (Azizi et al., 2025). Consequently, the reduction in banks' biodiversity footprint is likely to be concentrated in Scope 3, which captures indirect impacts linked to financed activities. The results in Table 5 show that the *Nature focus* measures are negative and statistically significant only in the Scope 3 specifications (Columns 3 and 6). As expected, a higher frequency of nature-related words in central bank speeches is associated with a reduction in banks' indirect biodiversity impacts linked to financed activities (Scope 3), while no significant effects are observed for direct (Scope 1) or energy-consumption (Scope 2) impacts.

[Table 5 here]

5.4. Robustness tests

5.4.1. A more precise identification of nature-related central bank communication

As a first robustness exercise, we re-estimate the baseline model using a stricter definition of nature-related central bank communication. Specifically, a central bank speech is now classified as nature-related only if it contains at least 2 distinct keywords from our nature-related dictionary, rather than a single occurrence. This approach follows Giglio et al. (2025) and is designed to reduce the risk of false positives by filtering out speeches where nature-related terms are mentioned only incidentally, thereby improving the reliability of our *Nature focus* measures. Although the stricter classification reduces the number of identified speeches in our

[16] Scope 1 captures direct biodiversity impacts arising from the bank's own operations, Scope 2 refers to indirect impacts linked to purchased energy and utilities, while Scope 3 encompasses indirect impacts arising from banks' financing activities.

sample, it allows us to focus on communications where nature-related content plays a more central role, thus enhancing the reliability of our baseline results.

Table 6 reports the results obtained by re-estimating the baseline specifications for *CBF* and *CBF intensity* with the more stringent *Nature focus* measures. Overall, the evidence from Table 6 reinforces the baseline findings. Both *Nature frequency* and *Nature salience* variables continue to exhibit negative and statistically significant coefficients across all specifications. Compared to the baseline estimates, the coefficients increase slightly in absolute magnitude (-0.0014 and -0.0006 for *Nature frequency*, and -0.0349 and -0.0149 for *Nature salience*) and improve in statistical precision ($p<0.01$). This suggests that the negative relationship between nature-related central bank communication and banks' biodiversity footprint is not driven by incidental references to nature but persists when focusing on communications with a clearer and more substantial focus on nature and biodiversity.

[Table 6 here]

5.4.2. Accounting for central bank communication on climate change when assessing biodiversity-specific impacts

Central banks have been addressing climate change and the low-carbon transition in their public communication for a considerably longer period than biodiversity and nature-related issues. Over time, climate change has become a well-established component of central banks' supervisory and policy agendas, shaping a broad environmental narrative that is now familiar to both financial institutions and market participants (Marcinkowska et al., 2025). This means that central bank communication on nature can often be embedded within broader discussions of climate change and the green transition. This overlap raises an important identification concern. Our *Nature focus* measures may capture not only a genuine increase in attention to biodiversity loss, but also a more general emphasis on environmental risks or climate issues. As a result, it becomes necessary to distinguish whether the estimated effects are truly driven by biodiversity-specific communication or whether they reflect the influence of an already established climate-oriented narrative. To address this issue, our empirical strategy explicitly controls for climate-related communication by including the *Climate focus* measures introduced in Campiglio et al. (2025) in order to take into account the relative importance of climate-related topics in central bank communications. If climate-oriented communication were driving the reduction in banks' biodiversity footprint, controlling for climate attention would absorb the

effect of *Nature focus* variables. We also include a broader set of firm- and country-level control variables to further strengthen the identification of the relationship between nature-related communication and banks' biodiversity footprint and to reduce concerns related to omitted variable bias.

The results in Table 7 indicate that the negative association of *Nature frequency* and *Nature salience* with banks' biodiversity footprint persists even after controlling for *Climate frequency* and *Climate* salience, whereas the corresponding climate measures are not statistically significant. The finding from enhanced specifications suggests that the negative relationship between nature-related central bank communication and banks' impact on biodiversity is not driven by an overall attention on climate change. Instead, it indicates that communication on nature and biodiversity conveys information that is distinct from broader climate narratives. Among bank-specific controls, the *green attitudes* variable enters with a negative and significant coefficient. As we expected, banks with an explicit environmental strategic orientation tend to have a lower adverse impact on biodiversity. Importantly, the effect of nature-related communication remains robust and is not absorbed by the bank's internal environmental strategic commitment. Overall, by splitting biodiversity-related attention from more general environmental and climate change communication, these results strengthen the validity of the baseline findings and further confirm that the specific focus on nature influences biodiversity action in commercial banks, as reflected in lower negative impacts on biodiversity.

[Table 7 here]

5.4.3. Alternative dependent variable

In the baseline analysis, the *CBF* captures the negative impact on biodiversity generated by banks' activities, both directly and indirectly through their financing decisions. Due to the lack of alternative and reliable data on biodiversity, we use this outcome-based proxy to assess the banks' commitment to biodiversity-positive action, since lower *CBF* values indicate smaller negative biodiversity impacts associated with banks' financing operations. However, this measure does not explicitly state whether reductions in biodiversity impacts through financing decisions stem from deliberate internal actions, such as the adoption of biodiversity screening criteria for projects, or formal risk management procedures addressing biodiversity concerns.

In an effort to better capture this dimension, we complement the impact-based analysis with an alternative dependent variable that focuses on banks' explicit commitments and internal

practices related to biodiversity management. Following prior studies (e.g., Christofi et al., 2025; Di Tommaso et al., 2025), we construct a variable which identifies whether a bank reports its biodiversity impacts or activities aimed at reducing ecological damage, or has formally adopted policies, risk assessment procedures, or measurable targets designed to address biodiversity-related risks. Specifically, the variable *Biodiversity engagement* is coded as 1 when a bank demonstrates an explicit consideration of biodiversity through the adoption of at least one of the following practices: (i) a formal commitment to reducing biodiversity impacts (Biodiversity Commitment); (ii) a commitment to achieving a net positive biodiversity impact through restoration or compensation initiatives (Biodiversity Net Positive Impact); (iii) the inclusion of biodiversity due diligence in the assessment of new projects (Biodiversity Due Diligence); (iv) the monitoring of biodiversity risks in ongoing operations (Biodiversity Risk Assessment); (v) the reporting of biodiversity impacts and/or actions aimed at reducing ecological damage (Biodiversity Impact Reduction); and (vi) the adoption of measurable biodiversity targets with explicit deadlines (Biodiversity Targets). Such a measure allows for a more direct assessment of a firm's stated intentions, organisational responses, and the efforts put in place to reduce their contribution to biodiversity loss, rather than focusing solely on the observed ecological outcome (Di Tommaso et al., 2025). Given the binary nature of the dependent variable, we employ Chamberlain (1980) conditional logistic regression (clogit) to run Equation (1).

Unablated results[17] show that our *Nature focus* measures are positively and statistically significant (0.0639 for *Nature frequency* and 1.637 for *Nature salience*; $p<0.01$), indicating that central bank attention on nature is associated with a higher likelihood that banks adopt explicit biodiversity policies and practices. This robustness exercise confirms to us that an increase in institutional attention on nature by central banks positively influences biodiversity action in supervised financial institutions, further supporting the overall consistency of our baseline findings.

5.5. Addressing endogeneity

5.5.1. GMM and LSDVC models

[17] Available upon request.

Potential endogeneity concerns in this study may arise from measurement errors, omitted variables, or reverse causality. Among these, reverse causality is unlikely to pose a serious threat to our identification strategy. As argued in Zhang et al. (2025), environmental emissions of a single firm are unlikely to significantly influence the implementation or frequency of central bank environmental communication. Our key explanatory variable captures central bank nature-related communication, which reflects aggregate policy signals and strategic narratives formulated at the macro level, rather than responses to individual bank-level outcomes. However, to prevent potential reverse causality issues, the baseline model includes the *Nature focus* measures lagged by 1 year.

To further address potential endogeneity concerns, we complement our baseline analysis with a two-step system generalised method of moments (SYS-GMM) model. This approach is particularly well-suited to our setting, as it allows us to account for several sources of endogeneity that may arise in panel data, including omitted variables, simultaneity, and reverse causality (Arellano & Bover, 1995; Blundell & Bond, 1998). The key advantage of SYS-GMM is that it exploits the panel structure of the data by using lagged values of the endogenous variables as internal instruments (Köhler, 2015). This feature is especially useful in our contexts, where identifying a valid external instrument is challenging. In our setting, the variables capturing the central bank *Nature focus* dimension, together with the firm-level control variables, are treated as endogenous and instrumented using their own lagged values. Time dummies and *GDP* are treated as strictly exogenous and are included as instrumental variables (Baselga-Pascual et al., 2015). Finally, to improve inference in samples of limited size, standard errors are adjusted using the finite-sample correction proposed by Windmeijer (2005).

Table 8 reports the two-step SYS-GMM results along with the AR(1) and AR(2) tests for the first-order and second-order serial correlation in the first-differenced residuals, together with the Hansen J-test of over-identifying restrictions. Consistent with our baseline findings, two-step SYS-GMM models suggest that *Nature frequency* (Column 1) and *Nature salience* (Column 2) negatively influence *CBF*. Our estimates reject the null hypothesis of first-order autocorrelation (AR1) ($p<0.05$) and accept the null hypothesis of the second-order autocorrelation (AR2) ($p>0.05$), and the Hansen J-test fails to reject the hypothesis of instruments' homogeneity.

Cosma et al. (2025a) point out that GMM estimators may not perform optimally in panels with a very short time dimension and therefore recommend complementing them with the Least Squares Dummy Variable Correction (LSDVC) model. LSDVC applies a recursive bias

correction to the dynamic fixed-effects estimator and is specifically designed for panels with a small time dimension. Simulation evidence shows that, in short panels, LSDVC delivers estimates with lower bias and mean squared error than GMM estimators (Bruno, 2005; Tanin et al., 2024). Since LSDVC does not rely on internal instruments, it is not affected by weak identification or instrument proliferation, which may be common concerns in GMM settings with limited time periods. Table 8 reports the results obtained using the Arellano-Bond (Columns 3 and 4) and Blundell-Bond (Columns 5 and 6) as initial estimators for the bias correction up to order $O(1/NT^2)$. The findings are consistent with the two-step SYS-GMM and the baseline results.

5.5.2. Entropy balancing

To mitigate endogeneity concerns arising from sample selection bias driven by observable characteristics and from confounding factors, we employ entropy balancing. This method re-weights observations in the control group to align the moment distribution (i.e., mean, standard deviation, and skewness) of all covariates with those in the treatment group (Hainmueller, 2012). In this way, entropy balancing reduces systematic differences between treated and control units that could otherwise contaminate the estimated treatment effects. As a result, the comparison between groups becomes more credible, and the estimated effects can be more plausibly attributed to the treatment rather than to pre-existing observable differences (Bach et al., 2025). In our setting, we divide the firm-year observations into treatment (*high CBF*) and control (*low CBF*) groups based on the yearly mean value of *CBF*. Then, we re-estimate Equation (1) using entropy-balanced observations. Appendix A4 shows the entropy balancing diagnostics. Columns (7) and (8) in Table 8 report the reports the regression results using the entropy balancing methods. Again, the coefficients for our *Nature focus* measures are negative and statistically significant in both model specifications.

[Table 8 here]

5.5.3. Placebo tests

As a final exercise to bolster the reliability of our findings, a placebo permutation test is implemented. Specifically, the treatment variable (i.e., *Nature focus* measures in our setting) is repeatedly reshuffled across observations, and the model is re-estimated each time in order to

observe the range of estimated effects that arise purely by chance. If statistically significant estimates were to persist under these random reassignments, this would indicate that the observed negative association between central bank communication on nature and banks' impact on biodiversity may reflect spurious correlations or confounding influences driven by unobservable omitted factors, rather than a genuine causal relationship (Eggers et al., 2024; Lei & Yu, 2024; Zhang et al., 2025). Following Zhang et al. (2025), we randomly shuffled the *Nature focus* measures across banks and re-estimated the baseline specification 1,000 times. Figure 2 displays the resulting distribution of these placebo coefficients. As expected, the density is centred around zero and follows a normal distribution, indicating that the model does not produce significant effects when the data structure is randomised. Our original baseline coefficient (represented by the red dashed line) lies in the extreme left tail, well outside the 95% confidence interval of the placebo distribution. These provide strong evidence that the observed negative impact of *Nature frequency* and *Nature salience* on *CBF* is not driven by unobserved factors or spurious correlations.

[Figure 2 here]

5.6. Further analyses

This section extends the baseline analysis by conducting a heterogeneity analysis. Heterogeneity analysis is widely employed to assess the conditional nature of theoretical mechanisms (Cosma et al., 2025a). To this end, banks are divided into subsamples based on their location. Specifically, banks are first classified as headquartered in developed or emerging markets, following the approach proposed by Hambali and Adhariani (2024). Banks are then further grouped according to whether they are located in the Eurozone or in the rest of the world. The baseline empirical analysis is replicated separately for each subgroup.

Prior research suggests that environmental perception differs systematically between developed and emerging markets due to variations in institutional quality, stakeholder pressure, reputational consequences, and governance structures (Gaganis et al., 2021; Hambali & Adhariani, 2024). In developed countries, stronger regulatory frameworks, active NGOs, and well-organised stakeholder groups increase public scrutiny and incentivise companies to align their sustainability practices with societal expectations (Campbell, 2007; Lozano & Martínez-Ferrero, 2022). These differences in institutional context provide a rationale for examining whether banks' responses to nature-related central bank communications vary across developed

and emerging economies. To do so, we divide developed and emerging countries based on the classification from Campiglio et al. (2025). The results in Table 9 (Columns 1 and 2) show that the influence of *Nature frequency* on *CBF* is negative in both developed and emerging economies. However, the effect is strongly statistically significant in developed economies ($p<0.01$), whereas the evidence is weaker in emerging markets ($p<0.1$). These differences in statistical strength may reflect cross-country variation in institutional settings and, to some extent, suggest that banks headquartered in developed countries are more likely to internalise nature-related central bank policy signals, potentially reflecting expectations about future regulatory developments or compliance-related costs.

To further investigate geographic heterogeneity, we isolate banks headquartered in the Eurozone from those operating outside the Eurozone. The European context represents a relatively homogeneous institutional setting, characterised by coordinated environmental strategies and policy objectives (Birindelli et al., 2022). Beyond the general increase in EU-wide regulatory pressure to disclose biodiversity-related risks, driven by initiatives such as the EU Biodiversity Strategy for 2030 and the Corporate Sustainability Reporting Directive (CSRD), banks headquartered in the Eurozone operate within a distinct supervisory architecture. Under the Single Supervisory Mechanism[18], banking supervision is organised within a common framework in which the ECB plays a central coordinating role. Over the years, the ECB has progressively integrated climate- and environmental risks into its supervisory agenda (Neszveda & Siket, 2025). Taken together, this unique institutional setting suggests that banks operating in the Eurozone may be more responsive to nature-related policy signals, translating heightened attention into tangible actions aimed at reducing the ecological impacts associated with their financing activities. The larger and more statistically significant coefficient for Eurozone banks compared to those located in the rest of the world (Table 9, Columns 3 and 4) points to heterogeneity across geographic contexts, consistently with the hypothesised differences between dissimilar regulatory and supervisory environments.

As a final heterogeneity exercise, we examine whether our results differ across countries where central banks talk about nature more intensively (Table 9, Columns 5 and 6). Following Zhang et al. (2025), we construct a frequency-based grouping using the number of speeches that our classification labels as nature-related. Countries with a number of nature-related speeches above the cross-country annual mean are classified as high-frequency, whereas those below the annual mean are classified as low-frequency. The underlying idea is that in high-frequency

[18] The ECB directly supervises the larger banks designated as Significant Institutions. Less Significant Institutions are instead supervised by the national competent authorities under the supervisory authority of the ECB.

countries, more frequent references can strengthen the policy signal, reinforce expectations about the direction of future environmental development, and provide organisations with more information about the relevance of environmental considerations for future policy decisions (Zhang et al., 2025). In turn, firms operating in these environments may be more inclined to proactively react by adopting biodiversity-reduction measures. Consistent with the earlier evidence, the estimated effect of *Nature Frequency* is significantly negative only for banks located in high-frequency countries, indicating lower biodiversity impacts in this group.

[Table 9 here]

6. Discussion and Conclusions

This paper responds to the growing call within the finance literature for a more active involvement of scholars in addressing biodiversity loss and nature-related risks (Karolyi & Tobin-de la Puente, 2023). A rapidly expanding strand of research has documented that biodiversity loss is financially material for firms and financial institutions, affecting firm value, asset returns, lending decisions and financial stability more broadly (e.g., Garel et al., 2024; Becker et al., 2025; Cosma et al., 2025a; Mies, 2025; Chen et al., 2025b); and for an extensive literature review, Lucey et al., 2025). Existing banking-related studies have primarily focused on measuring financial exposures to biodiversity loss, developing risk assessment frameworks, or analysing emerging supervisory and regulatory practices (Kedward et al., 2023; Hadji-Lazaro et al., 2024; Mundaca & Heintze, 2024). However, the communicative channel through which central banks frame nature and biodiversity loss as a source of financial risk and convey their relevance to supervised institutions remains underexplored, despite the central role of communication in shaping banks' behavioural responses.

This paper addresses this gap by constructing a central bank nature communication index that allows for a systematic analysis of how central banks' attention to nature loss and ecosystem degradation is associated with banks' biodiversity-positive actions.

To this end, we first develop a novel dictionary of nature-related keywords and apply it to a large corpus of central bankers' speeches collected by Campiglio et al. (2025), identifying a sub-sample of 1,087 communications that explicitly address nature-related issues. We show how nature-related communication is highly uneven across regions, originating predominantly

from European central banks, followed by authorities in the Asia-Pacific region. At the same time, the overall intensity of nature-related communication increases over time, with a marked acceleration in late 2020, suggesting a growing institutional attention to biodiversity and ecological deterioration.

Second, we introduce two new *Nature focus* measures (i.e., *Nature frequency* and *Nature salience*) to capture the extent to which central banks pay general attention to nature and biodiversity loss in their public communications. Then, using a global panel of 186 publicly listed commercial banks from 38 countries over the period 2016-2023, we show that a stronger emphasis on nature-related issues in central bank communication is associated with a significant reduction in banks' biodiversity impact, as measured by the Corporate Biodiversity Footprint (*CBF*), in line with similar evidence from the climate-related literature (Zhang et al., 2025). This finding is consistent with institutional and signalling theories, which highlight the role of authoritative communication in shaping expectations and influencing organisational behaviour in settings where future supervisory developments are anticipated. These findings are robust across multiple specifications, including several endogeneity tests. By decomposing the effect across Scopes, we find that the effect is driven only by Scope 3, suggesting that banks respond to nature-related signals by adjusting their financing activities rather than their direct footprint. This result is consistent with the specific role of banks as financial intermediaries whose main environmental impacts arise indirectly through capital allocation (Azizi et al., 2025). Our results remain robust when the dependent variable is substituted. As the *CBF* does not directly capture banks' explicit biodiversity-related policies and practices, we complement the baseline analysis with an alternative measure (*Biodiversity engagement*) that more closely reflects biodiversity-related actions and commitments (Christofi et al., 2025; Di Tommaso et al., 2025). Finally, we investigate heterogeneity across different institutional and geographic contexts, and we find stronger significance only in more developed economies, particularly within the Eurozone, and in countries with a higher frequency of nature-related communication. Overall, our results suggest that biodiversity attention is starting to materialise in banks' decisions, driven by "soft" institutional channels that operate well before formal requirements become binding.

This work has several theoretical, practical and policy implications. From a theoretical perspective, this study contributes to the literature on central bank climate and green communication by extending the analysis to nature and biodiversity. While existing research has largely focused on climate change as the primary environmental dimension in central bank

discourse, our findings suggest that nature-related communication appears to convey additional information that is not fully encompassed in climate-focused narratives and, therefore. shapes future expectations and responses in ways that cannot be reduced to climate-related signals alone. We also contribute to the biodiversity finance literature by shifting the focus away from the financial consequences of corporate biodiversity impacts and towards the processes through which biodiversity considerations are put in place. In simple terms, this study asks: what drives banks to begin integrating biodiversity considerations into their strategies in the first place? This question is important because it speaks directly to the timing of policy interventions aimed at addressing biodiversity loss through the financial system. If banks begin to integrate biodiversity considerations only in response to binding regulation, policy action may come too late to prevent the accumulation of nature-related risks. Our results suggest instead that banks' strategies start to adjust earlier, when biodiversity concerns gain institutional relevance and are framed as forward-looking financial risks through "soft" central bank signals. Understanding what triggers this early integration is therefore crucial for designing policies that influence behaviour before formal supervisory requirements are introduced. Our results call on central banks to play a constructive role by strengthening the visibility of nature and biodiversity loss within their mandates, thereby supporting the early integration of biodiversity considerations into banks' strategic and financing decisions.

This paper faces some limitations that should be acknowledged when interpreting the results, most notably the reliance on the *CBF* as a proxy for banks' biodiversity-related outcomes. While the *CBF* provides a comprehensive and standardised measure of realised biodiversity impacts and is widely used in the literature, its outcome-based nature implies that it does not directly reflect the underlying mix of internal strategic choices that shape these outcomes. Although we address this limitation by complementing the analysis with an alternative measure of biodiversity-related actions and commitments, data availability remains an important constraint today. Future research would benefit from more granular portfolio-level data sources to strengthen empirical robustness. A further limitation concerns the textual analysis of central bank communication. While the dictionary-based approach allows for a systematic identification of nature-related content (Campiglio et al., 2025), it does not account for differences in tone, emphasis, or sentiment, which may convey additional information about how biodiversity-related issues are framed. Future research could complement this approach with methods that capture qualitative aspects of communication strategies. In addition, the scope of the analysis could be extended to examine the broader financial implications of nature-

related communication. While this study focuses on the association between central bankers' speeches and banks' biodiversity impacts, future work could explore whether similar effects also affect equity, bond, or derivatives markets. Finally, further research could investigate how nature-related topics originate and spread within and across central banking networks. Nonetheless, the findings of this paper provide novel insights into the role of nature-related communication by central banks with strong and timely policy implications.

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Table 1: Summary statistics of the central bankers' speeches dataset

		Number of central banks	Number of speeches	Words per speech
Panel A				
Full database	Advanced	36	8,343	2,758.6
	Emerging and developing	83	4,574	1,730.8
	Total	119	12,917	2,852.1
Of which BIS	Advanced	36	4,694	2,938.0
	Emerging and developing	50	1,805	2,091.2
	Total	86	6,499	3,217.6
Panel B				
Full database	Governor		7,314	2,487.2
	Deputy Governor		2,352	3,085.9
	Board member		2,121	3,642.1
	Senior management		1,130	3,244.6
	Total		12,917	2,852.1
Of which BIS	Governor		3,356	2,850.4
	Deputy Governor		1,470	3,501.1
	Board member		1,158	3,773.0
	Senior management		515	3,552.5
	Total		6,499	3,217.6

Note: This table reports summary statistics for the dataset of central bankers' speeches used in the analysis. Panel A reports summary statistics by country group (advanced vs. emerging and developing economies), while Panel B reports statistics by speaker role.

Table 2: Nature-related dictionary

Keyword	#N	Keyword	#N	Keyword	#N	Keyword	#N
acidification #	10	ecosystem services ∫	100	key biodiversity areas †	1	pollinators *	3
aichi #	6	ecosystems *	176	land use ∫	68	protected areas *	8
amphibian *	1	ecotourism *	7	life on land	3	rainforest *	10
animals	99	environmental degradation *	101	mammals	7	rainforests *	8
anthropocene #	18	eutrophication †	1	marine *	148	red list ∫	1
bio diversity *	2	extinction ∫	53	megadiverse	8	reforestation †	17
biodiverse *	4	fauna *	30	natural capital †	95	sea turtles	1
biodiversity *	686	fisheries *	87	natural ecosystem †	3	seagrass meadows *	1
biological diversity *	11	flora *	33	natural environment ∫	40	seagrasses *	3
biological resources ǂ	5	forest *	183	natural habitat †	2	soil *	104
biomass †	20	forests *	61	natural habitats †	5	species *	101
biosphere *	13	freshwater *	15	natural heritage #	14	state of nature †	1
clean water	28	gbf	2	nature action †	1	taskforce on nature related financial disclosures #	3
conservation *	78	gene ∫	24	nature loss †	43	terrestrial *	12
convention on biological diversity #	5	genes	10	nature positive †	8	tnfd †	21
coral reef *	2	genetic *	21	nature restoration	6	unep *	26
coral reefs *	15	global biodiversity framework §	7	nature risk	6	wastewater †	5
deforestation *	52	groundwater †	3	nature risks	8	water consumption †	11
dependencies on nature	1	habitat *	57	ocean *	176	water pollution	7
desertification *	6	habitats *	16	oceans	32	water scarcity †	16
ecological *	275	hazardous waste †	2	organisms #	17	water stress †	11
ecology *	37	impact on nature	1	overexploitation *	6	water use	5
ecosystem approach ∫	9	ipbes *	27	overfishing †	14	wetlands *	3
ecosystem resilience	1	iucn *	2	pesticides #	5	wildlife *	35
ecosystem restoration	1	kba	17	pollination	38		

Note: This table reports the list of keywords used in our dictionary. #N indicates the number of speeches using each keyword at least once. Symbols indicate the source of each keyword: * Giglio et al. (2025); # Biodiversity A–Z Glossary; § International Fund for Animal Welfare Glossary; † Taskforce on Nature-related Financial Disclosures Glossary; ǂ World Wide Fund for Nature Glossary; ∫ Convention on Biological Diversity Glossary.

Table 3: Descriptive statistics

Variable	#N	Mean	SD	Min	Max
CBF	904	6.09	1.52	-4.73	10.88
CBF intensity	904	0.42	0.26	0.09	1.29
CBF scope1	904	-2.69	1.36	-6.66	1.68
CBF scope2	904	-1.00	1.37	-6.74	4.29
CBF scope3	904	6.09	1.58	-7.13	10.88
Biodiversity engagement	904	0.14	0.35	0	1
Nature frequency	904	8.26	15.86	0	143
Nature salience	904	0.31	0.64	0.00	5.24
Climate frequency	904	115.39	188.42	0	923
Climate salience	904	4.16	6.77	0	33.50
ROA	904	1.10	0.82	-2.07	4.44
CIR	904	64.77	19.20	31.13	156.11
Size	904	25.52	1.25	22.35	28.84
Credit growth	904	62.69	12.03	13.98	84.49
TIER	904	14.45	3.54	8.63	28.30
Leverage	904	12.21	4.28	4.94	28.69
Market-to-Book	902	-0.167	0.694	-1.744	1.696
ESG score	904	59.41	18.47	6.67	95.66
Env score	904	60.36	26.15	0	97.70
Green attitudes	902	0.49	0.50	0	1
ESG pay	904	0.36	0.48	0	1
Board independence	904	54.44	24.65	0	100
Board female	904	21.95	15.22	0	66.67
Board size	904	2.46	0.29	0	3.33
GDP	904	2.46	4.14	-11.39	14.64
EPI	897	47.82	14.25	23.37	73.12

Note: This table reports the summary statistics for the variables included in our analyses. We include the number of observations, minimum, mean, maximum, and standard deviation. Variable definitions are presented in Appendix A2.

Table 4: The effect of Nature focus measures on CBF and CBF intensity

Variable	(1) CBF	(2) CBF	(3) CBF intensity	(4) CBF intensity
Nature frequency	-0.00120**		-0.000458**	
	(0.000501)		(0.000195)	
Nature salience		-0.0291**		-0.0123**
		(0.0136)		(0.00516)
ROA	0.0630**	0.0652**	0.0281**	0.0287**
	(0.0287)	(0.0285)	(0.0127)	(0.0126)
CIR	-0.00165	-0.00155	0.000294	0.000327
	(0.00196)	(0.00195)	(0.000624)	(0.000619)
Size	0.478***	0.482***	-0.108**	-0.107**
	(0.114)	(0.114)	(0.0496)	(0.0494)
Credit growth	-0.0000011	-0.0000969	-0.000173	-0.000213
	(0.00434)	(0.00434)	(0.00171)	(0.00171)
TIER	-0.00552	-0.00536	-0.00110	-0.00101
	(0.00851)	(0.00854)	(0.00321)	(0.00320)
Leverage	-0.0108	-0.0106	0.000024	0.000114
	(0.00814)	(0.00812)	(0.00242)	(0.00245)
Board independence	0.00131	0.00131	0.000349	0.000349
	(0.000942)	(0.000943)	(0.000370)	(0.000371)
Board female	-0.00207	-0.00203	-0.000544	-0.000535
	(0.00169)	(0.00170)	(0.000722)	(0.000721)
Board size	0.0259	0.0276	0.00170	0.00275
	(0.0665)	(0.0667)	(0.0308)	(0.0309)
ESG score	-0.00101	-0.000934	-0.000180	-0.000156
	(0.00166)	(0.00165)	(0.000663)	(0.000663)
GDP	0.00629*	0.00633*	0.000120	0.000190
	(0.00328)	(0.00333)	(0.00101)	(0.00104)
Constant	-6.304**	-6.404**	3.034**	3.009**
	(2.864)	(2.861)	(1.232)	(1.226)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	904	904	904	904
R^2	0.608	0.608	0.278	0.279

Note: This table reports regression estimates of the effect of our *Nature focus* measures on *CBF* and *CBF intensity*. All variables are defined in Appendix A2. All regressors are lagged one year. Standard errors in parentheses are clustered at the bank level. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Table 5: The effect of Nature focus measures on CBF by scopes

Variable	(1) CBF scope1	(2) CBF scope2	(3) CBF scope3	(4) CBF scope1	(5) CBF scope2	(6) CBF scope3
Nature frequency	-0.00005	0.000113	-0.00123**			
	(0.00101)	(0.00235)	(0.000503)			
Nature salience				-0.0126	0.0220	-0.0298**
				(0.0290)	(0.0548)	(0.0137)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	904	904	904	904	904	904
R^2	0.262	0.288	0.608	0.262	0.289	0.608

Note: This table reports regression estimates of the effect of our *Nature focus* measures on *CBF* by scopes. Control variables include *ROA*, *CIR*, *Size*, *Credit growth*, *TIER*, *Leverage*, *Board independence*, *Board female*, *Board size*, *ESG score*, and *GDP*. All variables are defined in Appendix A2. All regressors are lagged one year. Standard errors in parentheses are clustered at the bank level. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Table 6: Robustness results based on a more stringent classification of nature-related speeches

Variable	(1) CBF	(2) CBF	(3) CBF intensity	(4) CBF intensity
Nature frequency	-0.00142***		-0.000577***	
	(0.000545)		(0.000212)	
Nature salience		-0.0349**		-0.0149***
		(0.0150)		(0.00558)
ROA	0.0625**	0.0648**	0.0277**	0.0285**
	(0.0285)	(0.0284)	(0.0126)	(0.0126)
CIR	-0.00169	-0.00157	0.000273	0.000317
	(0.00196)	(0.00195)	(0.000620)	(0.000617)
Size	0.478***	0.481***	-0.108**	-0.107**
	(0.114)	(0.114)	(0.0495)	(0.0493)
Credit growth	-0.000011	-0.000120	-0.000176	-0.000222
	(0.00434)	(0.00434)	(0.00171)	(0.00171)
TIER	-0.00554	-0.00529	-0.00109	-0.000971
	(0.00850)	(0.00854)	(0.00319)	(0.00319)
Leverage	-0.0105	-0.0105	0.000156	0.000171
	(0.00819)	(0.00814)	(0.00244)	(0.00245)
Board independence	0.00132	0.00132	0.000352	0.000354
	(0.000943)	(0.000943)	(0.000370)	(0.000370)
Board female	-0.00208	-0.00206	-0.000555	-0.000548
	(0.00170)	(0.00170)	(0.000721)	(0.000720)
Board size	0.0273	0.0288	0.00252	0.00337
	(0.0667)	(0.0670)	(0.0308)	(0.0310)
ESG score	-0.000997	-0.000917	-0.000179	-0.000149
	(0.00166)	(0.00165)	(0.000663)	(0.000663)
GDP	0.00639*	0.00654*	0.000191	0.000286
	(0.00329)	(0.00336)	(0.00100)	(0.00105)
Constant	-6.289**	-6.390**	3.050**	3.017**
	(2.870)	(2.864)	(1.230)	(1.225)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	904	904	904	904
R^2	0.609	0.608	0.280	0.280

Note: This table reports regression estimates of the effect of our *Nature focus* measures on *CBF* and CBF *intensity* based on a stricter classification of nature-related speeches, defined as containing at least two distinct keywords from the nature-related dictionary in line with (Giglio et al., 2025). All variables are defined in Appendix A2. All regressors are lagged one year. Standard errors in parentheses are clustered at the bank level. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Table 7: Robustness results based on enhanced specifications

Variable	(1) CBF	(2) CBF
Nature frequency	-0.00113**	
	(0.000554)	
Climate frequency	0.00002	
	(-0.00008)	
Nature salience		-0.0317**
		(0.0159)
Climate salience		0.00133
		(0.00231)
ROA	0.0549*	0.0561**
	(0.0281)	(0.0279)
CIR	-0.00131	-0.00124
	(0.00201)	(0.00199)
Size	0.493***	0.495***
	(0.112)	(0.113)
Credit growth	0.000577	0.000501
	(0.00427)	(0.00427)
TIER	-0.00729	-0.00709
	(0.00858)	(0.00860)
Leverage	-0.0151*	-0.0149*
	(0.00841)	(0.00837)
Market-to-Book	0.114**	0.115**
	(0.0523)	(0.0523)
Board independence	0.00138	0.00137
	(0.000917)	(0.000919)
Board female	-0.00246	-0.00245
	(0.00170)	(0.00169)
Board size	0.0347	0.0332
	(0.0643)	(0.0649)
ESG pay	0.0268	0.0281
	(0.0378)	(0.0377)
Green attitudes	-0.0741**	-0.0737**
	(0.0367)	(0.0368)
Env score	0.000511	0.000510
	(0.000881)	(0.000880)
GDP	0.00338	0.00346
	(0.00363)	(0.00363)
EPI	-0.0127	-0.0124
	(0.0180)	(0.0178)
Constant	-6.121**	-6.188**
	(2.756)	(2.755)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	893	893
R^2	0.617	0.617

Note: This table reports enhanced regression estimates of the effect of our *Nature focus* measures on *CBF*, controlling for *Climate focus* measures as well as bank- and country-specific additional controls. All variables are defined in Appendix A2. All regressors are lagged one year. Standard errors in parentheses are clustered at the bank level. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Table 8: Endogeneity tests

DV: CBF	(1) Two-step SYS-GMM	(2) Two-step SYS-GMM	(3) LSDVC (AB)	(4) LSDVC (AB)	(5) LSDVC (BB)	(6) LSDVC (BB)	(7) Entropy balancing	(8) Entropy balancing
Lag CBF	0.601***	0.573***	0.310***	0.309***	0.526***	0.524***		
	(0.104)	(0.0991)	(0.0495)	(0.0494)	(0.0523)	(0.0522)		
Nature frequency	-0.00259**		-0.000940**		-0.00121**		-0.00118**	
	(0.00129)		(0.000472)		(0.000588)		(0.000480)	
Nature salience		-0.0942***		-0.0288**		-0.0373**		-0.0286**
		(0.0299)		(0.0128)		(0.0158)		(0.0130)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	791	791	760	760	760	760	877	877
N. of groups	186	186						
No. of instruments	67	67						
AR(1) (p-value)	0.000	0.000						
AR(2) (p-value)	0.251	0.267						
Hansen test (p-value)	0.132	0.460						
Firm FE							Yes	Yes
Year FE							Yes	Yes

Note: This table reports regression results addressing endogeneity concerns using multiple approaches. Columns (1)-(2) report two-step SYS-GMM estimates using lags 2-5 of the endogenous variables as instruments; columns (3)-(6) report LSDVC estimates based on the Arellano-Bond (AB) and Blundell-Bond (BB) initial estimators; columns (7)-(8) report entropy balancing estimates. In models (3)-(8), regressors are lagged one year. Control variables include *ROA*, *CIR*, *Size*, *Credit growth*, *TIER*, *Leverage*, *Board independence*, *Board female*, *Board size*, *ESG score*, and *GDP.* All variables are defined in Appendix A2. Standard errors are clustered at the bank level in columns (1)-(2) and (7)-(8); bootstrapped standard errors are reported in parentheses in columns (3)-(6). Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Table 9: Heterogeneity analyses by country

DV: CBF	(1) Developed	(2) Emerging	(3) Eurozone	(4) Rest of the world	(5) High frequency	(6) Low frequency
Nature frequency	-0.00135***	-0.00261*	-0.00314***	-0.00154**	-0.00199***	-0.00318
	(0.000480)	(0.00152)	(0.000745)	(0.000754)	(0.000517)	(0.00244)
ROA	0.0137	0.0908*	-0.0359	0.0849**	-0.0177	0.0503
	(0.0345)	(0.0482)	(0.0397)	(0.0395)	(0.0479)	(0.0390)
CIR	-0.00297**	-0.000640	-0.00321*	-0.00113	-0.00244	-0.00573
	(0.00138)	(0.00428)	(0.00182)	(0.00325)	(0.00185)	(0.00424)
Size	0.505***	0.421**	0.261	0.539***	0.558***	0.298**
	(0.159)	(0.166)	(0.241)	(0.133)	(0.192)	(0.139)
Credit growth	-0.00662*	0.0106	-0.00807	0.00472	-0.0127***	0.00984**
	(0.00372)	(0.00695)	(0.00554)	(0.00526)	(0.00433)	(0.00459)
TIER	-0.00284	0.00396	-0.00558	-0.00512	-0.00728	0.00390
	(0.0107)	(0.0128)	(0.0207)	(0.00789)	(0.0154)	(0.00840)
Leverage	-0.0224***	0.0101	-0.0159	-0.0108	-0.0238***	0.00431
	(0.00724)	(0.0169)	(0.00982)	(0.00922)	(0.00845)	(0.0125)
Board independence	-0.000556	0.00236**	0.00112	0.000961	-0.000250	0.00176
	(0.00144)	(0.00115)	(0.00382)	(0.00102)	(0.00246)	(0.00165)
Board female	-0.00225	-0.00136	-0.00623*	-0.00186	-0.00112	-0.00148
	(0.00235)	(0.00177)	(0.00338)	(0.00173)	(0.00324)	(0.00212)
Board size	0.0931	-0.0377	-0.00590	-0.00445	0.0855	-0.100
	(0.0769)	(0.114)	(0.173)	(0.0725)	(0.129)	(0.0978)
ESG score	-0.00173	0.000650	-0.00493	0.000192	-0.00154	-0.00132
	(0.00225)	(0.00195)	(0.00505)	(0.00167)	(0.00241)	(0.00205)
GDP	0.00261	0.00883**	0.00411	0.00562	0.00475	0.00726*
	(0.00448)	(0.00431)	(0.00854)	(0.00372)	(0.00642)	(0.00389)
Constant	-6.363	-5.898	0.596	-8.190**	-7.259	-2.125
	(4.068)	(4.077)	(5.974)	(3.277)	(4.580)	(3.437)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	459	445	149	755	338	544
R^2	0.669	0.588	0.659	0.621	0.704	0.577

Note: This table reports regression estimates of the effect of *Nature frequency* on *CBF,* dividing the full sample into developed and emerging economies (models 1 and 2), the Eurozone and the rest of the world (models 3 and 4) and countries with high-frequency and low-frequency nature-related speeches (models 5 and 6). All variables are defined in Appendix A2. All regressors are lagged one year. Standard errors in parentheses are clustered at the bank level. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

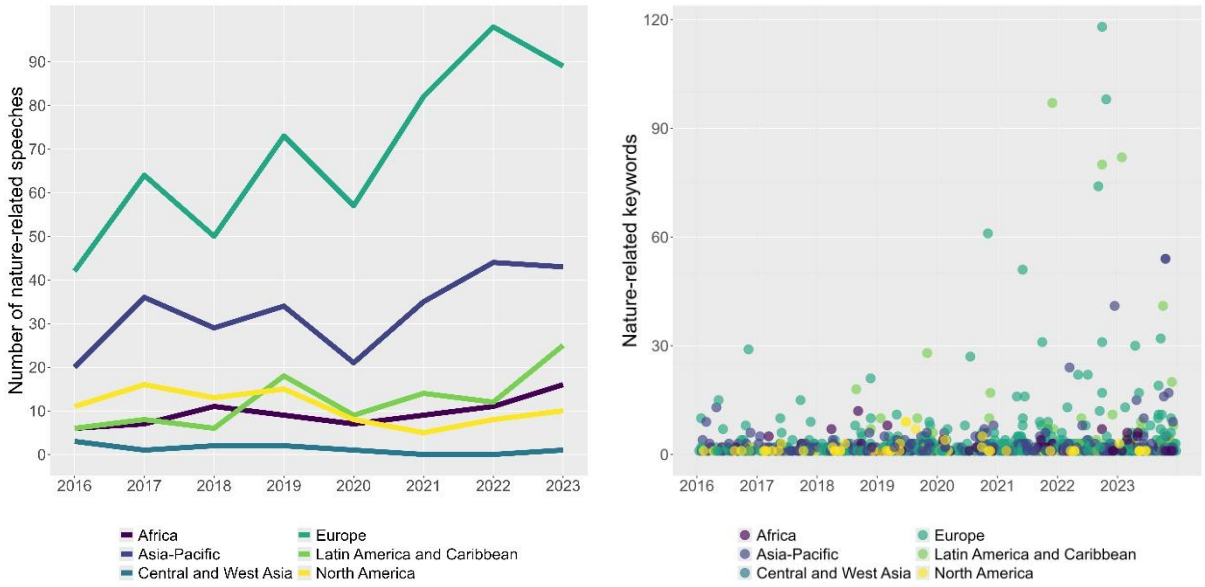
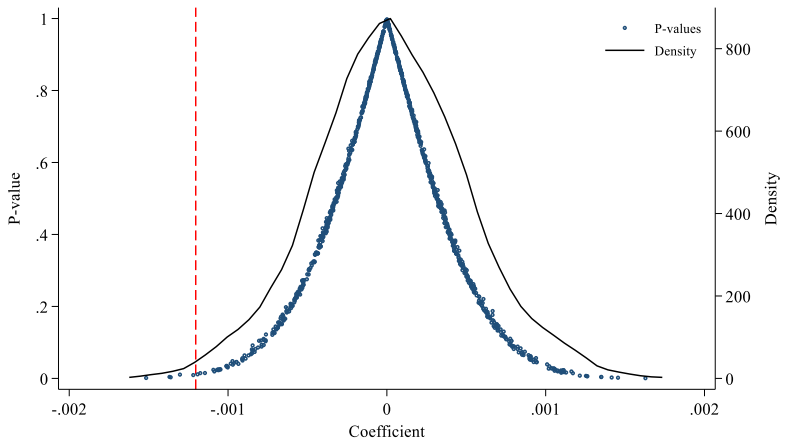
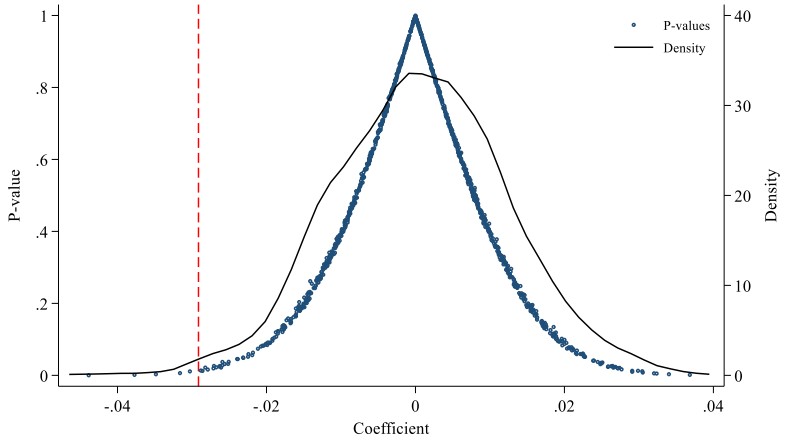


Figure 1: Temporal evolution of central bank nature-related communication



(a) Placebo test (*Nature frequency*)



(b) Placebo test (*Nature salience*)

Figure 2: Placebo test results

Appendix A1: Sample distribution

Country	#N	%	Number of speeches	Number of Nature-related speeches	CBF (mean)
Australia	6	3.23	240	6	6.14
Austria	2	1.08	421	33	6.02
Brazil	3	1.61	26	0	7.96
Canada	4	2.15	222	14	7.95
Chile	1	0.54	95	9	5.34
China	24	12.9	89	8	7.02
Colombia	1	0.54	8	0	6.48
Denmark	3	1.61	50	4	4.62
Finland	1	0.54	491	45	8.04
France	3	1.61	552	54	8.91
Germany	2	1.08	750	73	7.58
Greece	3	1.61	481	45	5.12
Hong Kong	1	0.54	192	8	6.50
India	18	9.68	213	20	6.15
Indonesia	4	2.15	35	3	6.17
Ireland	3	1.61	623	45	5.24
Israel	5	2.69	52	3	5.82
Italy	6	3.23	627	60	5.67
Japan	8	4.3	296	28	5.52
South Korea	5	2.69	54	1	6.62
Kuwait	3	1.61	18	7	5.39
Malaysia	6	3.23	264	37	5.05
Mexico	1	0.54	157	29	6.05
Netherlands	2	1.08	499	56	7.33
Norway	4	2.15	96	15	4.67
Philippines	3	1.61	491	19	5.33
Portugal	1	0.54	559	41	4.30
Qatar	3	1.61	2	0	4.93
Saudi Arabia	8	4.3	43	0	5.23
Singapore	3	1.61	351	62	6.88
South Africa	4	2.15	134	8	6.29
Spain	6	3.23	559	49	6.54
Sweden	4	2.15	144	5	5.16
Thailand	5	2.69	131	20	5.89
Turkey	5	2.69	49	0	5.68
United Arab Emirates	4	2.15	10	0	6.00
United Kingdom	5	2.69	541	50	6.73
United States of America	16	8.6	1,566	72	6.39
Total	186	100	11,131	928	6.09

Note: This table reports the country-level distribution of the sample. #N denotes the number of banks per country, % their share in the full sample, Number of speeches denotes the total number of central bank speeches, and Number of nature-related speeches denotes those classified as nature-related. *CBF* (mean) reports the average value of the *CBF* by country.

Appendix A2: Variable description and data sources

Variable	Definition	Source
	Dependent variables	
CBF	Biodiversity loss is caused by the company's annual economic activity. The CBF value is multiplied by -1 and implemented in its natural logarithm form (Garel et al., 2024).	Iceberg Data Lab
CBF intensity	CBF value scaled by total assets in million €. Winsorized at the 2.5 per cent and 97.5 per cent levels (Garel et al., 2024).	Iceberg Data Lab
CBF scope1	The biodiversity loss caused by the company's direct activities (Scope 1). The CBF scope1 is multiplied by -1 and implemented in its natural logarithm form (Garel et al., 2024).	Iceberg Data Lab
CBF scope2	The biodiversity loss caused by the company's electricity and utilities (Scope 2). The CBF scope2 is multiplied by -1 and implemented in its natural logarithm form (Garel et al., 2024).	Iceberg Data Lab
CBF scope3	The biodiversity loss caused by the company's indirect pressures (Scope 3). The CBF scope3 is multiplied by -1 and implemented in its natural logarithm form (Garel et al., 2024).	Iceberg Data Lab
Biodiversity engagement	The variable is coded as 1 when a bank demonstrates an explicit consideration of biodiversity through the adoption of at least one of the following biodiversity-related practices: (i) a specific commitment to reducing biodiversity impacts (Biodiversity Commitment); (ii) a commitment to achieving a net positive impact through restoration or compensation initiatives (Biodiversity Net Positive Impact); (iii) biodiversity risk assessments in new projects (Biodiversity Due Diligence); (iv) monitoring of biodiversity risks in ongoing operations (Biodiversity Risk Assessment); (v) reporting biodiversity impact and/or activities to reduce ecological impact (Biodiversity Impact Reduction); and (vi) measurable biodiversity targets with deadlines (Biodiversity Targets).	LSEG Data & Analytics
	Independent variables	
Nature frequency	The variable is a proxy for central bank attention to nature loss. It is calculated as the total number of nature-related expressions mentioned in a central bank speech. The measure is then aggregated at the year and central bank level.	Authors calculations
Nature salience	The variable is a proxy for central bank attention to nature loss. The variable is calculated as the Nature frequency divided by the total number of words used in a speech and multiplied by 100. Therefore, it reflects the relative importance of nature loss in a speech. The measure is then aggregated at the year and central bank level.	Authors calculations
	Control variables	
CIR	Operating expenses divided by operating income. A lower ratio indicates higher bank efficiency.	LSEG Data & Analytics
Credit growth	Net loans divided by total assets.	LSEG Data & Analytics
Leverage	Total assets divided by total equity.	LSEG Data & Analytics
ROA	Net income divided by total assets.	LSEG Data & Analytics
Size	Natural logarithm of total assets.	LSEG Data & Analytics

TIER	Tier 1 capital divided by risk-weighted assets.	LSEG Data & Analytics
Market-to-Book	Market capitalisation on total equity. Implemented in its natural logarithm form.	LSEG Data & Analytics
Board female	Percentage of female board members.	LSEG Data & Analytics
Board independence	Percentage of independent board members.	LSEG Data & Analytics
Board size	Natural logarithm of the size of the board.	LSEG Data & Analytics
ESG score	A score ranging between 0 and 100 that measures the environmental, social and governance (ESG) performance of a company.	LSEG Data & Analytics
Env score	A score ranging between 0 and 100 that measures the environmental performance of a company.	LSEG Data & Analytics
ESG pay	Dummy variable equal to 1 if the company has an ESG-linked executive compensation policy at the board level, 0 otherwise.	LSEG Data & Analytics
Green attitudes	Dummy variable equal to 1 if the bank reports partnerships or initiatives with specialised non-governmental organisations (NGOs), industry associations, or governmental and supranational institutions aimed at addressing environmental issues, and 0 otherwise. This measure is intended to proxy the bank's strategic commitment to environmental sustainability.	LSEG Data & Analytics
Climate frequency	The variable is a proxy for central bank attention to climate change. It is calculated as the total number of climate-related expressions mentioned in a central bank speech. The measure is then aggregated at the year and central bank level.	Campiglio et al. (2025)
Climate salience	The variable is a proxy for central bank attention to climate change. The variable is calculated as the Climate frequency divided by the total number of words used in a speech and multiplied by 100. Therefore, it reflects the relative importance of climate change in a speech. The measure is then aggregated at the year and central bank level.	Campiglio et al. (2025)
EPI	The Environmental Performance Index (EPI) Score is a metric that assesses a country's environmental performance. It ranks nations using 58 indicators across 11 categories, ranging from climate change mitigation and air pollution to waste management, sustainability of fisheries and agriculture, deforestation, and biodiversity protection. The EPI score helps identify how close countries are to meeting established environmental policy targets. Higher the score, higher the country's environmental performance.	Yale Center for Environmental Law and Policy
GDP	Annual percentage growth rate of GDP per capita.	World Bank database

Appendix A3: Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CBF	1							
(2) CBF intensity	0.424***	1						
(3) Nature frequency	0.146***	-0.061*	1					
(4) Nature salience	0.132***	-0.063*	0.941***	1				
(5) ROA	-0.03	0.307***	-0.121***	-0.098***	1			
(6) CIR	0.025	0.049	0.086***	0.056*	-0.671***	1		
(7) Size	0.852***	0.034	0.196***	0.173***	-0.232***	0.024	1	
(8) Credit growth	-0.245***	-0.035	-0.161***	-0.124***	0.077**	-0.025	-0.378***	1
(9) TIER	-0.117***	0.021	0.060*	0.085**	0.274***	-0.223***	-0.120***	-0.149***
(10) Leverage	0.190***	-0.199***	0.206***	0.167***	-0.494***	0.238***	0.449***	-0.372***
(11) Board independence	0.142***	0.055*	0.208***	0.198***	0.045	-0.073**	0.142***	0.027
(12) Board female	0.119***	-0.055*	0.253***	0.251***	-0.228***	0.068**	0.199***	-0.073**
(13) Board size	0.295***	-0.022	0.160***	0.128***	-0.164***	0.202***	0.344***	-0.166***
(14) ESG score	0.381***	0.168***	0.205***	0.225***	0.011	0.025	0.356***	-0.137***
(15) GDP	0.111***	0.115***	0.139***	0.165***	0.113***	-0.117***	0.081**	-0.092***

Note: This table reports the pairwise correlation coefficients among all independent, dependent, and control variables used in the baseline analysis. All variables are defined in Appendix A2. Significance levels are indicated as follows: *p < 0.10; **p < 0.05; ***p < 0.01.

Appendix A3: Correlation matrix (continue)

Variable	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) CBF							
(2) CBF intensity							
(3) Nature frequency							
(4) Nature salience							
(5) ROA							
(6) CIR							
(7) Size							
(8) Credit growth							
(9) TIER	1						
(10) Leverage	-0.128***	1					
(11) Board independence	0.062*	0.057*	1				
(12) Board female	0.142***	0.422***	0.387***	1			
(13) Board size	-0.236***	0.178***	0.016	0.112***	1		
(14) ESG score	0.161***	0.149***	0.436***	0.415***	0.046	1	
(15) GDP	-0.062*	-0.022	-0.023	-0.059*	0.01	-0.041	1

Appendix A4: Entropy balancing diagnostics

Panel A: Entropy balancing weighting for Nature frequency						
	Treat			Control		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Before: Without weighting						
ROA	0.956	0.510	-0.171	1.163	0.687	0.459
CIR	67.286	389.483	1.742	62.837	303.064	1.578
Size	25.997	1.888	0.274	25.789	1.879	0.295
Credit growth	60.464	174.476	-0.872	61.759	137.534	-0.796
TIER	14.568	9.215	1.234	14.400	12.353	1.099
Leverage	12.970	20.650	0.861	12.407	16.888	0.693
Board independence	62.917	502.406	-0.389	53.225	616.542	-0.050
Board female	27.450	185.511	-0.072	21.535	229.949	0.366
Board size	2.560	0.080	-0.199	2.451	0.084	-0.988
ESG score	64.787	320.388	-0.774	60.607	329.735	-0.442
GDP	2.596	16.113	-0.340	2.000	15.518	-0.842
After: Weighting variables						
ROA	0.956	0.510	-0.171	0.956	0.510	-0.170
CIR	67.286	389.483	1.742	67.285	389.482	1.742
Size	25.997	1.888	0.274	25.997	1.888	0.274
Credit growth	60.464	174.476	-0.872	60.464	174.474	-0.872
TIER	14.568	9.215	1.234	14.568	9.215	1.234
Leverage	12.970	20.650	0.861	12.970	20.650	0.861
Board independence	62.917	502.406	-0.389	62.917	502.438	-0.389
Board female	27.450	185.511	-0.072	27.449	185.516	-0.072
Board size	2.560	0.080	-0.199	2.560	0.080	-0.203
ESG score	64.787	320.388	-0.774	64.787	320.402	-0.774
GDP	2.596	16.113	-0.340	2.596	16.113	-0.340
Panel B: Entropy balancing weighting for Nature salience						
	Treat			Control		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Before: Without weighting						
ROA	0.984	0.522	-0.598	1.145	0.683	0.597
CIR	67.640	429.769	1.665	62.798	286.405	1.555
Size	25.868	1.778	0.341	25.852	1.943	0.265
Credit growth	61.460	175.451	-0.952	61.277	138.620	-0.775
TIER	14.688	9.033	1.343	14.351	12.324	1.087
Leverage	12.633	20.591	0.940	12.573	17.116	0.673
Board independence	65.196	473.822	-0.608	52.464	606.044	0.024
Board female	28.660	173.562	-0.195	21.151	227.807	0.423
Board size	2.547	0.078	-0.137	2.459	0.086	-0.938
ESG score	66.909	254.249	-0.631	59.768	348.904	-0.457
GDP	2.012	18.945	-0.561	2.278	14.357	-0.704
After: Weighting variables						
ROA	0.984	0.522	-0.598	0.984	0.522	-0.597
CIR	67.640	429.769	1.665	67.640	429.775	1.665
Size	25.868	1.778	0.341	25.867	1.778	0.340
Credit growth	61.460	175.451	-0.952	61.460	175.445	-0.952

TIER	14.688	9.033	1.343	14.688	9.037	1.344
Leverage	12.633	20.591	0.940	12.633	20.591	0.940
Board independence	65.196	473.822	-0.608	65.195	473.823	-0.608
Board female	28.660	173.562	-0.195	28.660	173.563	-0.195
Board size	2.547	0.078	-0.137	2.547	0.078	-0.139
ESG score	66.909	254.249	-0.631	66.908	254.248	-0.631
GDP	2.012	18.945	-0.561	2.012	18.944	-0.561

Note: Panel A reports entropy balancing diagnostics for *Nature frequency*, while Panel B reports diagnostics for *Nature salience*. The table compares treated and control groups before and after weighting in terms of mean, variance, and skewness of the balancing covariates. After weighting, moments of the covariate distributions are closely matched between the treated and control groups. All variables are defined in Appendix A2.