Should investors care about biodiversity risk? The link between biodiversity and firm performance

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ABSTRACT

The objective of this research is to investigate the link between biodiversity risk exposure and management by firms and its ESG transparency/performance and financial performance. We analyze a cross-country sample of 973 individual firms with annual data from 2018 to 2022. Biodiversity risk exposure/management and ESG performance data are provided by MSCI. ESG transparency and financial variables are collected from the Bloomberg terminal. The results show that firms' engagement in biodiversity protection and risk management reduces its financial performance. However, it increases the MSCI ESG score of firms while decreasing its transparency in ESG reporting, according to the Bloomberg ESG disclosure scores. Surprisingly, firms' exposure to biodiversity risks increases its financial performance. This result may be attributed to firms' exploitation of biodiversity in its activities. Firms' governance metrics are disconnected from biodiversity metrics. However, corporate leverage and reputation have a moderating effect on the relationship between biodiversity scores and financial performance. These findings are robust to numerous sensitivity analyses.

JEL classification: G3

Keywords: Biodiversity risk; Corporate governance; ESG performance; Financial performance.

Highlights

- The biodiversity score has a negative effect on firm financial performance.
- The biodiversity risk exposure score has a positive effect on firm financial performance.
- The biodiversity management score and biodiversity weight have a different effect on ROA or ROE.
- The effect of biodiversity scores is different on the E, S, and G components of the ESG scores, especially there is no effect on the G pillar.
- The effect of biodiversity scores on the Bloomberg ESG disclosure scores is totally different from those with MSCI ESG scores.
- There is a disconnection between biodiversity scores and governance scores.
- There is no lagged effect from biodiversity scores to firms' financial performance.
- Being a firm in the US reduces the effect of biodiversity on financial performance.
- Institutional ownership does not have a moderating effect.
- Corporate leverage and reputation have a negative moderating effect.

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I. Introduction

Sustainability has become a hot topic in recent years. When raising the importance of the earth, country or business sustainability, governments, social organizations, business leaders and academics often emphasize the threats of climate change. However, there is another significant matter that draws the recent growing awareness but still a lack of clarity on what this means for corporations, and who they should response, called biodiversity risk[2]. The Global Risks Report 2023 produced by the World Economic Forum views "Biodiversity loss and ecosystem collapse" as one of the fastest deteriorating global risks over the next decade.

Biodiversity has the full form of "biological diversity". In 1992, the Earth Summit in Rio de Janeiro stimulated the interest in sustainable development, and the Convention on Biological Diversity framed the standards for corporate environmental accountability. The Convention on Biological Diversity (CBD) defines biodiversity as the variability among living organisms from all sources, including diversity within species, between species and of ecosystems (CBD, 1992). Later years, European Environment Agency[3] defined biodiversity as the name given to the variety of ecosystems (natural capital), species and genes in the world or in a particular habitat.

Biodiversity is essential to human wellbeing, as it delivers services that sustain our economies and societies. The ecosystem supported by abundant biodiversity brings blessings, which contribute to securing safe water and food that are indispensable for human survival, and support the safety and security of living.

However, since the early 2000s, numerous studies and reports have demonstrated that biodiversity world-wide is in crisis (TEEB, 2008; Wilkinson, 2004). Millennium Ecosystem Assessment (2005) reported that the rate of species extinction[4] caused by humans is 1,000 times faster than the typical rate of extinction in Earth history. Biological disasters and the rapid rate of species extinction raised concerns about the biodiversity loss and biodiversity risks faced by firms. Notably, large biological catastrophes caused by firms[5] not only extremely damaged

[2] It is noted that biodiversity risks and climate risks are related but conceptually distinct. It is distinct from each other as biodiversity risk focuses on the threats to the variety of life on Earth and its consequences, while climate risk focuses on the negative consequences of the climate changes (Giglio et al., 2023). However, the two risks are interconnected in that sense that biodiversity loss can drive climate change (ex. destruction of carbon sinks) and that climate change can exacerbate diversity loss (lives lost due to forest fires or extreme floods).

[3] https://www.eea.europa.eu/themes/biodiversity/intro

[4] Threatened and rare species are listed in the Red List. The Global Reporting Initiative named six categories for species based on their risk of extinction. The first Red List category is Near Threatened (NT), which is a category for species that may be threatened in the future. Vulnerable (VU) is the first of the three threatened categories on the Red List, followed by Endangered (EN) and Critically Endangered (CR). The category Regionally Extinct (RE) includes those species that have disappeared. The category Data Deficient (DD) is for all other categories in which insufficient information is available (SSIC, 2010; Rimmel & Jonall, 2013).

[5] For example, the British Petroleum oil spill in the Gulf of Mexico, the Exxon Valdez oil spill in Alaska or the Shell oil spill in the Niger Delta.

local biodiversity, it also significantly damaged the corporate reputation and caused firms to suffer from huge financial losses.

There is a growing awareness about biodiversity among policy makers world-wide. Released in 2020, the World Economic Forum's New Nature Economy Report provided the evidence that protecting and restoring natural ecosystems can lead to economic growth and create new business opportunities and the private sector played an important part in maintaining sustainable nature. As a result, in 2022 the Kunming-Montreal Global Biodiversity Framework (GBF) was adopted by some 200 countries during the fifteenth meeting of the Conference of the Parties (COP 15) which sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050.[6]

Given the policy interest on biodiversity risk and the roles of private sectors, it is important to provide facts and implications about the biodiversity risk exposures and its consequences on a firm's value quantitatively. However, biodiversity is a highly complex topic and the lack of data on biodiversity and direct measurements prevent academics and professionals from calculating and comparing biodiversity-related performance among companies. Our research aims to fill the literature gap by providing empirical evidence and justified implications for management, investors and policy makers about the biodiversity risk and its impact on firm performance.

In detail, we investigate the effects of *biodiversity risk exposure* and *biodiversity risk management* by using four Key Indicators provided by MSCI as main biodiversity-metrics. The first indicator (BIO_LAND_USE_SCORE) measures how well a company's operations and policies contribute to protecting biodiversity. The second indicator (BIODIV_LAND_USE_WEIGHT) indicates the weight of the first indicator in the final MSCI ESG ratings of a company. The third indicator (BIODIV_LAND_USE_EXP_SCORE) measures a firm's exposure risk to biodiversity. The fourth indicator (BIODIV_LAND_USE_MGMT_SCORE) measures how well a company is managing biodiversity risks.

In this study, we measure the effects of biodiversity risk exposure and biodiversity risk management on both firms' *financial* performance and *non-financial* performance. Financial performance is proxy by ROA and ROE while non-financial performance is proxy by ESG

[6] COP15 asks large and transnational companies and financial institutions to monitor, assess and transparently disclose their risks, dependencies and impacts on biodiversity through their operations, supply chains and portfolios.

rating and ESG disclosure scores. It is important to use non-financial KPIs[7] in the research related to biodiversity as accounting or market metrics can describe firms' financial risk management and profitability but fail to show firms' social performance or firms' sustainability. As with the MSCI database, we only have ESG rating data, to complete our data sample, we further collected financial and ESG disclosure score data from the Bloomberg terminal.

Overall, we built a sample of listed firms with annual data from 2018 to 2022, covering 973 individual companies of 71 countries and territories world-wide. The empirical results are obtained through panel data regressions with fixed or random effects where applicable. To determine whether our regression model suffers from the endogeneity issue, we also estimated the reverse regression in which biodiversity metrics are the dependent variable and ESG scores are the main independent variable. If the results of the reverse regression show that there is an endogeneity issue, we then use endogeneity-compatible estimation methods such as GMM or 2SLS. In addition, to understand the mechanism behind the relationship between biodiversity scores and financial performance, we further include interactive variables between biodiversity scores and other variables (governance, leverage, and institutional ownership). Furthermore, to check the robustness of our results, we then made various sensitivity analyses with additional control variables to the baseline ones (governance and CSR variables), with lagged-1 values of biodiversity scores, with the distinction between firms in the US and those which are not in the US.

Our main findings show that first, firms' *biodiversity risk management* (firm policies to protect biodiversity; the firm ability to manage biodiversity risks and opportunities) has a negative effect on firm financial performance. Second, however, the *biodiversity risk exposure* has a positive effect on firm financial performance. These findings suggest that engaging in biodiversity protection and management can be costly for firms and it can reduce firm's financial performance. However, exposition to biodiversity risks improves it. This surprising result suggests that firms exposed to biodiversity risks are also firms which can exploit biodiversity to increase its revenues. This therefore has a positive effect on firm financial performance. It is noted that this only applies to firms exposed to biodiversity risks. Third, another important finding of our research is that there is a disconnection between biodiversity scores and governance metrics. The effect of biodiversity scores is different on the E, S, and G components of the ESG scores, especially there is no effect on the G pillar. However, corporate

[7] Key Performance Indicators

leverage and reputation have a moderating effect on the relationship between biodiversity scores and financial performance.

We contribute related literature in several ways. First, current works mainly use findings from government reports and law reviews in general. There are few academic works on this topic. Our literature review shows that most attention goes to CSR, ESG policies in general, with relatively little attention given to the management of biodiversity. Our research fills the literature gap by providing empirical evidence for management, investors and policy makers.

Second, biodiversity risk can be difficult to quantify and study systematically. Our paper introduces the measures of biodiversity risk as well as measures of firms' and industries' exposures to these risks. Third, current literature uses textual information, cross-sectional pricing information or survey data while our research uses large-scale firm-level panel data which helps us measure both firms' financial and nonfinancial performance. Last, our biodiversity research not only focuses on the global context by using cross-country data, but also examined how companies manage these issues in their own business activities.

The remainder of this paper is structured as follows. In session 2, we provide a review about research on biodiversity risk exposures by firms and the relation between diversity risk exposures and firm performance. Section 3 describes the data while Session 4 explains our empirical methodology. Section 5 presents our baseline results while Section 6 presents robustness check analyses. Session 7 concludes the paper and provides several implications to governments, investors, and business leaders.

II. Literature review, theoretical framework, and research hypotheses

II.1. Why should firms care about biodiversity risk?

Given the recent academic and policy interest in biodiversity and its economic impacts on the countries and businesses, it is important to provide more facts and implications about the biodiversity risk exposures and its consequences on firms. *Should investors care about biodiversity risk? Is biodiversity risk material to firms?* We aim to answer these questions by reviewing the existing research on the impact of biodiversity on firm value. Below we present a summary of theoretical framework, firm behavior toward biodiversity protection and the relation between biodiversity risk and firm performance.

II.2. Theoretical framework

The value of biodiversity in the ecosystem is very important, yet it is not clear about its economic impact for businesses. We first review the theories relevant to this area to find out

the underlying assumptions of needed attention by businesses regarding biodiversity risk recognition and control.

We find several theories that explain the importance of biodiversity to firms' businesses and firm behaviors. The most significant one is *the resource-based theory* (Hart, 1995; Barney, 1991) which documented that a firm's long-term competitive advantage results from its control and effective management over valuable, non-substitutable and costly to replicate resources and capabilities. In general, the variety of ecosystems provide firms natural capital, non-replicable resources to specific firms or sectors. Therefore, biodiversity protection and biodiversity risk prevention are indeed to protect the firm's survival in the future.

The second related theory is *legitimacy theory* (Lindblom, 1994). According to legitimacy theory, companies are expected to provide more information because of societal pressure. Biodiversity disclosures are mainly voluntary disclosures. Previous literature examined what motivates organization to disclose environmental information and suggest that companies may use the promotional spin called green wash to promote a perception of environmental friendliness (e.g., Newton and Harte, 1997, Deegan, 2002; Luft Mobus, 2005; Owen, 2008: Laine, 2009; Islam and Deegan, 2010; Hopwood, 2009; Boiral et al., 2017). The researchers concluded that companies might engage in environmental reporting to increase their legitimacy or to promote a different company image.

II.3. Empirical evidence regarding firm behavior toward biodiversity

Regarding firm behavior toward biodiversity, literature shows that companies still use a reactive[8] approach to biodiversity. When companies began addressing environmental issues themselves, it was in terms of risks or costs, and their license to operate (Kolk & Van Tulder, 2010; Overbeek et al., 2013). Overbeek et al. (2013) interviewed sustainability representatives of twelve national and international companies in the Netherlands and found that firms protect

[8] There are four CSR approaches: inactive, reactive, active, and proactive. The *inactive approach* is an inward-looking business perspective, without stakeholder involvement aimed at efficiency and competitiveness in the immediate market environment, while the *reactive approach* is a liability orientation where entrepreneurs manage their external stakeholders' expectations by decreasing their environmental impact without fundamental changes in the business philosophy and primary production processes. The *active approach* represents entrepreneurs who are subsequently inward looking to realize their objectives in a socially responsible manner regardless of actual or potential social pressures by external stakeholders, while in a *proactive approach* an entrepreneur undertakes activities aimed at external stakeholders right at the beginning of an issue's life cycle within a socially responsible manner (Van Tulder et al., 2009; Overbeek et al., 2013).

biodiversity in those cases where public policies required them to do so, for example through the Natura 2000 regulation.

Second, many firms consider CSR an issue for strategic policy. Several firms have a CSR unit or a sustainability manager working under the Corporate Affairs division. They report on sustainability through the annual reports. Biodiversity is a new theme, which is being worked on at the corporate level (ex. Eneco, DSM, Shell, Ahold, & KLM), while activities for nature management are more often the responsibility of the managers at the location (ex. DSM, Heineken & IKEA). The SMEs that rely on natural products do not have a defined CSR policy, but refer to the intrinsic attention to sustainability, which is not on paper, but interwoven into the company.

Third, active biodiversity activities are led by ambitious CEOs and other executives. Several businesses are trying to move beyond traditional Corporate Social Responsibility (CSR) and environmental reporting to shape and transform the value chains and markets they operate in along with their company's internal organization (Loorbach et al., 2010). Businesses are searching for ways to deal with such unpredictable changes, especially in sectors like food, energy, and mobility where major societal changes are expected to occur in the coming decades.

Fourth, there is difference responses among sectors. Firms in sectors suffering more biodiversity risk tend to have high levels of response, but there is poor responsiveness to material biodiversity dependency risks. Three sectors most reliant on natural capital are construction, agriculture, and food and beverages (World Economic Forum, 2022). Agriculture and logging, for example, both present much greater threats to both threatened and non-threatened species than extractive industry, The IUCN Red List shows that agriculture and logging threaten 11,505 and 10,419 species, respectively, including 5,000 threatened species each, whereas extractive industry threatens 2,698 species, of which 1,293 are already categorized as threatened (IUCN, 2012; Rainey et al., 2015). Rainey et al. (2015) documented that the 32 global corporations built their goals of no net loss (NNL) and net positive impact (NPI), 18 have explicitly included biodiversity, of which 12 were from the mining sector.

Last, employee involvement is essential to improve firms' biodiversity practices, especially for the natural resource companies. The specific focus on natural resource companies such as the ones from the mining, energy, and forestry sectors is justified by their direct and very relevant impacts on biodiversity (Boiral et al, 2018). Nevertheless, in most organizations, employee behaviors for biodiversity conservation are relatively underdeveloped for reasons related to the inherent complexity of biodiversity issues and some organizational deficiencies, particularly lack of clarity in corporate commitment, the externalization of initiatives, and a

shortage of employee training and skills. Such involvement largely depends on voluntary initiatives. Those initiatives are associated with the tacit knowledge of employees in direct contact with the ecosystems that may be affected by corporate activities, the importance of preventing harmful behaviors related to daily activities, particularly the use and maintenance of equipment.

II.4. Empirical evidence regarding the effects of biodiversity on firm value.

Regarding the effects of biodiversity risk/biodiversity loss on firm value, as far as we know, no companies reported quantitative biodiversity outcomes, making it difficult to determine whether business actions were of sufficient magnitude to address impacts and were achieving positive out- comes for nature. There are few research attempts to measure the effects of biodiversity risk on firm value.

First, the capital markets show increasing interest in biodiversity. The F&C Asset Management (2004) developed a methodology that assigns the biodiversity risk level for each sector represented on the London Stock Exchange (FTSE) into one of three groups: red, amber, or green. The F&C report examined the biodiversity risks that the FTSE sectors are exposed to and concluded that biodiversity disclosure is directly relevant to the capital markets' assessment of companies' value. The three groups are defined respectively as below:

1. the red-zone sectors are those in which most companies are likely to be exposed to biodiversity risks and in which risks are likely to be significant.
2. the amber-zone sectors are those in which some companies are likely to be exposed to biodiversity risks and in which risks may be significant; and
3. the green-zone sectors are those in which fewer companies are likely to be exposed to biodiversity risks and in which it is harder to identify how risks may affect the companies.

Several research used event study method to examine the market reactions to the news about biodiversity risk. When negative biodiversity news arrives, the valuations of highly exposed industries/ firms should drop, while the valuation of less exposed industries should drop by less or even increase.

Second, research shows the financial values of ecosystem services and costs of environmental crises (Costanza et al., 1997; Stern, 2006; TEEB, 2010) to firms. Companies increasingly see a business case for improved corporate social responsibility, including management of environmental impacts (Robinson, 2012). Ineffective environmental management drives risks to business while effective management brings more opportunities to

firms (PWC, 2010; Hanson et al., 2012). As each of these risks and opportunities toward biodiversity has financial consequences, and these can provide firms the financial incentives to set environmental goals. Corporate environmental goals have been encouraged by the International Finance Corporation Performance Standard 6 (IFC, 2012)9, which is one of the most influential environmental safeguards in finance (Morgera, 2012).

Third, literature shows that not all shareholders have the same view on biodiversity risk (Fisher- Vanden & Thorburn, 2011). Carvalho et al (2022) provided the first quantitative assessment of biodiversity risk exposure across the world's largest listed companies, compared with their adoption of biodiversity policies. They use the disclosures from 11,812 companies from 2004 to 2018. The authors found that only 29% of firms in their sample have adopted a biodiversity policy by 2018, which means around $7.2 trillion of the total enterprise value have not responded or managed their potential biodiversity risk.

Addison et al. (2018) assessed the top 100 of the 2016 Fortune 500 Global companies' (the Fortune 100) sustainability reports to gauge the current state of corporate biodiversity accountability. Authors found that almost half (49) of the Fortune 100 mentioned biodiversity in reports, and 31 made clear biodiversity commitments, of which only 5 were specific, measurable, and time bound. In addition, a variety of biodiversity-related activities were disclosed (e.g., managing impacts, restoring biodiversity, and investing in biodiversity), but only 9 companies provided quantitative indicators to verify the magnitude of their activities (e.g., area of habitat restored).

III. Data

III.1. MSCI data

To complete the database for this research, our starting point is with the MSCI ESG Ratings with Time Series database. We purchased this dataset for the period from 2013 to 2022. The dataset was delivered per year while the number of firms and the number of variables changes each year. Therefore, our first step was to determine a sample of firms with complete available data on four metrics related to biodiversity risk exposure and management over the period from 2013 to 2022. After the first investigation, we noticed that most of data on biodiversity metrics is available from 2018 while there were a lot of missing data between 2013 and 2017. Therefore, we decided to conduct our empirical research on the 2018-2022 period to have the largest data

[9] https://www.ifc.org/content/dam/ifc/doc/mgrt/gn-english-2012-full-document-updated-june-14-2021.pdf

sample and accurate empirical results. The four biodiversity-metrics provided by MSCI and used in this present research are presented in Table 1 below.

Table 1: The four MSCI biodiversity metrics

Indicators	MSCI Definition
Bio_Score (BIODIV_LAND_USE_SCORE)	This key issue is relevant to companies whose operations risk having a high negative impact on fragile ecosystems. Companies that have policies and programs designed to protect biodiversity and address community concerns on land use, score well on this benchmark. Companies with operations that disturb large and/or fragile, bio-diverse areas and lack strategies to minimize and mitigate biodiversity losses, score poorly. (Score: 0-10)
Bio_Exp_Score (BIODIV_LAND_USE_EXP_SCORE)	Exposure indicators capture to what extent a company's business is vulnerable to the ESG risk covered in a Key Issue. Examples of criteria assessed include: the products and services a company provides; location of company operations; and the nature of those operations. Higher scores on exposure indicate greater risk on the Key Issue. See the IVA Methodology for details. (Score: 0-10)
Bio_Mmgt_Score (BIODIV_LAND_USE_MGMT_SCORE)	Management indicators measure how well a company manages ESG risk and opportunities. These metrics are grouped into the following broad categories: Strategies & Policies, Targets & Implementation, and Demonstrated Performance. Higher scores on management indicate greater capacity to manage risk. See the IVA Methodology for details. (Score: 0-10)
Bio_Weight (BIODIV_LAND_USE_WEIGHT)	This variable indicates the weight of the BIODIV_LAND_USE_SCORE in the final MSCI ESG ratings of each company.

Therefore, our first focus is to investigate the importance of firm exposure and management of risks related to biodiversity. The first indicator (BIO_LAND_USE_SCORE) measures how well a company's operations and policies contribute to protect biodiversity. The score spreads from 0 to 10 and the higher is the score, the less the company is impacting biodiversity. The second indicator (BIODIV_LAND_USE_WEIGHT) indicates the weight of the first indicator in the final MSCI ESG ratings of a company. The third indicator (BIODIV_LAND_USE_EXP_SCORE) measures a firm's exposure risk to biodiversity. The score spreads from 0 to 10 and the higher is the score, the more a company is exposed to biodiversity risk. The fourth indicator (BIODIV_LAND_USE_MGMT_SCORE) measures how well a company is managing biodiversity risks. The score spreads from 0 to 10 and the higher is the score, the higher is the firm's capacity to manage biodiversity.

Table 2: The distribution of firms in the final data set per country and industry.

Country	Number of firm-year observation	Country	Number of firm-year observation	Industry	Number of firm-year observation
AE	10	KE	5	Commercial Services & Supplies	10
AR	30	KR	40	Commodity Chemicals	19
AT	10	KY	10	Construction & Engineering	11
AU	248	KZ	15	Construction Materials	90
BD	5	LB	5	Containers & Packaging	8
BE	25	LK	10	Diversified Chemicals	5
BM	47	LU	20	Energy Equipment & Services	489
BR	135	MA	15	Food Products	214
CA	598	MX	50	Industrial Conglomerates	9
CH	31	MY	107	Integrated Oil & Gas	193
CL	70	NG	10	Marine Transport	7
CN	350	NL	48	Metals and Mining - Non-Precious Metals	681
CO	45	NO	50	Metals and Mining - Precious Metals	426
CR	5	NZ	15	Multi-Line Insurance & Brokerage	2
CY	13	PE	45	Oil & Gas Exploration & Production	660
DE	50	PG	5	Oil & Gas Refining, Marketing, Transportation & Storage	415
DK	10	PH	20	Paper & Forest Products	95
EG	5	PK	10	Pharmaceuticals	10
ES	45	PL	25	Professional Services	11
FI	10	PT	15	Property & Casualty Insurance	13
FR	97	QA	10	Real Estate Development & Diversified Activities	14
GA	5	RO	5	Real Estate Management & Services	5
GB	237	RS	10	Retail - Consumer Discretionary	6
GG	5	RU	194	Retail - Food & Staples	5
HK	130	SE	25	Road & Rail Transport	12
HU	5	SG	35	Semiconductors & Semiconductor Equipment	1
ID	120	SK	5	Software & Services	5
IE	17	TH	50	Specialty Chemicals	20
IL	15	TR	15	Steel	145
IN	175	TT	10	Technology Hardware, Storage & Peripherals	2
IT	80	TW	5	Tobacco	120
JE	21	UA	5	Trading Companies & Distributors	9
JM	5	US	1116	Transportation Infrastructure	264
JO	5	VG	5	Utilities	893
JP	130	ZA	65		
		ZM	5		

Given the main objective of the study to investigate the impact of biodiversity risk exposure and biodiversity risk management on firms' financial and ESG performance, our priority is to have sampled firms with biodiversity data available from MSCI. Therefore, we started with firms having the four biodiversity-metrics available in 2018. With this condition, the initial number of companies considered is 2,095 companies all over the world. We then match these

companies with biodiversity data available in 2018 with the MSCI data sample of 2019, 2020, 2021, and 2022. After excluding all companies with unavailable or incomplete data in the following years, we have a final MSCI data sample of 1,508 companies. As our MSCI database does not include any financial data, we need to match our MSCI dataset with data that we can collect from the Bloomberg terminal. The ISIN code is used to identify companies in the two databases. After cleaning the dataset with unavailable ISIN codes on the Bloomberg terminal, our final dataset is composed of 973 individual companies of 71 countries and territories world-wide, with MSCI available data on biodiversity and Bloomberg available data on financial aspects. Composition of the final data sample is presented in Table 2.

Figure 1 presents the distribution of firms by country with an earth map performed with Power BI.

Figure 1: Sampled firms' distribution by country

Figure 1 shows that the most of companies in our sample are in North America and Europe. Few companies can be found in Asia and Africa. Australia and New Zealand are also present in the final sample.

Figure 2 shows that the industry with the most of firms in our sample is the Utilities sector (with 893 firms). This is followed by the Metals and Mining sector for non-precious metals (with 681 companies), then by the Oil & Gas Exploration & Production sector (with 660 companies). The sector with the less companies is Semiconductors & Semiconductor Equipment (with 1 company).

Figure 2: Sampled firms' distribution by industry

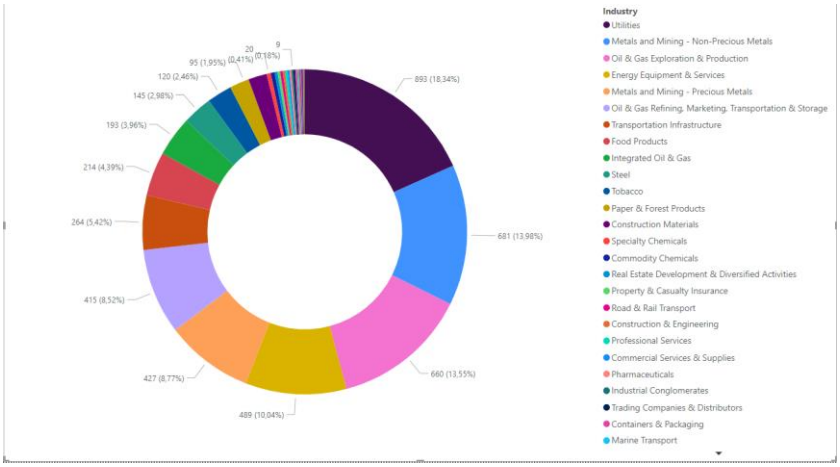


Figure 3: Biodiversity risk exposure score per country

Figure 4: Biodiversity risk management score per country

Figure 3 shows the minimum biodiversity exposure risk of firms per country. Our first observation shows that firms in Asia and South America seem to have the highest exposure to biodiversity risk.

Figure 4 shows the minimum value of the biodiversity risk management score of firms per country. Our first observation shows that firms in Europe and North America countries seem to have the highest quality in the management of biodiversity risks.

Figure 5: The average value of BIODIV_LAND_USE_EXP_SCORE per industry

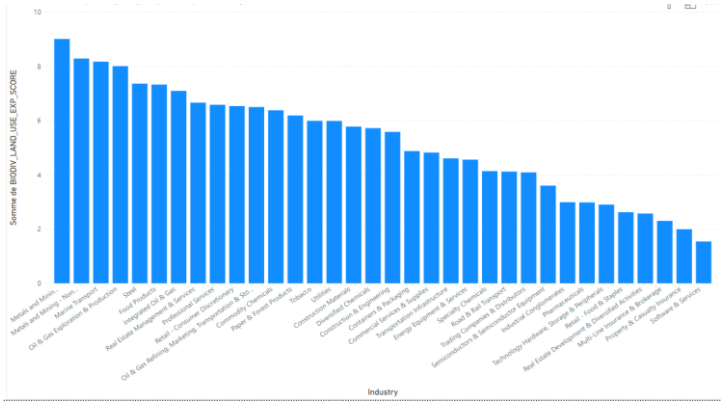


Figure 6: The average value of BIODIV_LAND_USE_MGMT_SCORE per industry

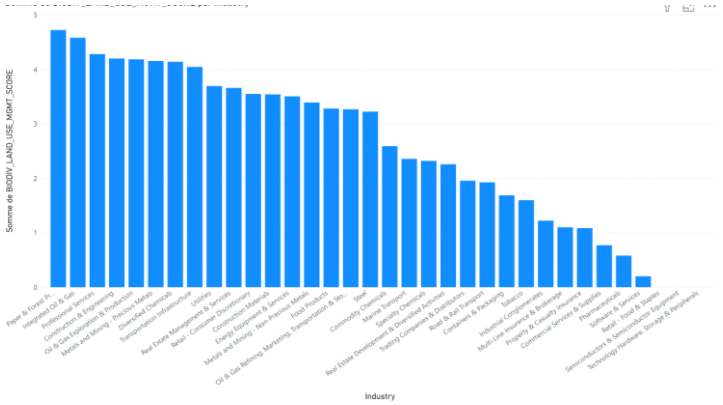


Figure 5 shows that the sector with the highest biodiversity risk exposure are Metals and Mining, followed by Marine Transport, Oil & Gas exploration, Steel, Food products, and Integrated Oil & Gas. Figure 6 shows that the sector with the highest biodiversity risk management score is Paper & forest production, Integrated Oil & Gas, Professional services, Construction & Engineering, Oil & Gas exploration & production, and Metals & Mining. Overall, Figures 5 and 6 show that it is important to consider the industry effect when investigating the effect of biodiversity on firm performance.

In addition to the four biodiversity-metrics provided by MSCI, we also consider other MSCI variables. Table 3 presents the MSCI variables that we consider.

Table 3: Other MSCI ESG variables

Other MSCI variables
1- ESG score
2-Environmental score
3-Social score
4-Governance score
5-Climate change score
6-Natural resource score
7-Waste management score
8-Water stress score
6-Carbon emissions score
9-Toxic emissions waste score
10-Human capital score
11-Health & Safety score
12-Corporate governance score
13-Business ethics score

Table 4: MSCI ESG rating methodology – ESG metrics

3 Pillars	10 Themes	33 ESG Key Issues
Environmental	Climate Change	Carbon Emissions
		Climate Change Vulnerability
		Financing Environmental Impact
		Product Carbon Footprint
	Natural Capital	Biodiversity & Land Use
		Raw Material Sourcing
		Water Stress
	Pollution & Waste	Electronic Waste
		Packaging Material & Waste
		Toxic Emissions & Waste
	Environmental Opportunities	Opportunities in Clean Tech
		Opportunities in Green Building
		Opportunities in Renewable Energy
Social	Human Capital	Health & Safety
		Human Capital Development
		Labor Management
		Supply Chain Labor Standards
	Product Liability	Chemical Safety
		Consumer Financial Protection
		Privacy & Data Security
		Product Safety & Quality
		Responsible Investment
	Stakeholder Opposition	Community Relations
		Controversial Sourcing
	Social Opportunities	Access to Finance
		Access to Health Care
		Opportunities in Nutrition & Health
Governance	Corporate Governance	Board
		Pay
		Ownership & Control
		Accounting
	Corporate Behavior	Business Ethics
		Tax Transparency

Source: MSCI ESG Ratings Methodology.

These MSCI variables are part of ESG measures considered in the calculation of the ESG ratings. What we need to know about MSCI ESG ratings is that they measure how well a company manages its ESG risks. In addition, the MSCI ESG score is industry relative, meaning that it is adjusted to the level of firms in the same industry. The final ESG score is calculated

as a weighted average value of metrics in the three pillars E, S, and G. In each of these three pillars, there are various indicators and in each of these indicators, there are four different measures like the biodiversity theme presented above, meaning "score", "weight", "exposure score", and "management score". As a reminder, the "score" spreads from 0 to 10 and shows how well a company is managing risk related to biodiversity. The "weight" shows the proportion of this score in the global ESG score of a company. The "exposure score" shows to what extent a company's business is vulnerable to the considered ESG risk. The higher is the "exposure score", the more a company is exposed to the considered risk. Finally, the "management score" shows how well a company manages ESG risks and opportunities. The higher is the score, the higher is the firm capacity to manage the related risk. The Table 4 shows the metrics MSCI considers in each of the three pillars.

Therefore, from the metrics shown in Table 4, we selected some important ones in each of the three ESG pillars to have the metrics shown in Table 3. These metrics are from the E pillar (climate change, natural resource, waste management, water stress, carbon emissions, toxic emissions waste); from the S pillar (human capital, health & safety); and from the G pillar (corporate governance, business ethics). To simply, for each of these metrics, we only consider the global score, not the weight, exposure score, and management score. Indeed, the global score allows us to capture the ability of a firms to manage the related risk, which is of interest for our study.

Among metrics indicated in Table 3, the first ones are related to the global ESG score and the three pillar scores (E, S, and G). As a reminder, the MSCI ESG ratings show how well a company is managing its ESG risks. In addition, these ratings are industry relative. According to the MSCI methodology, "the top-level assessment is the overall company ESG rating, an industry-relative seven-point letter rating scale from AAA to CCC. These assessments are not absolute but are explicitly intended to be interpreted relative to a company's industry peers. The company ESG rating is derived from the final Industry-Adjusted Company Score, based on an assessment of the underlying data available at the last ESG rating action date." Table 5 shows the MSCI ESG rating letter scale. Therefore, to be able to make calculations with MSCI ESG ratings, we transform it into figures with AAA equals 7 while CCC equals 1.

Table 5: MSCI ESG ratings scale

Letter Rating	Leader/Laggard	Final Industry-Adjusted Company Score
AAA	Leader	8.571* - 10.0
AA	Leader	7.143 – 8.571
A	Average	5.714 – 7.143
BBB	Average	4.286 – 5.714
BB	Average	2.857 – 4.286
B	Laggard	1.429 – 2.857
CCC	Laggard	0.0 – 1.429

**Appearance of overlap in the score ranges is due to rounding error. The 0-to-10 scale is divided into seven equal parts, each corresponding to a letter rating.*

Source: MSCI ESG Ratings Methodology.

III.2. Bloomberg data

To complete our data sample, we further collected other financial and ESG data from the Bloomberg terminal as with the MSCI database, we only have ESG rating data. Table 6 presents the variables collected from the Bloomberg terminal for the 973 companies in our data sample.

Table 6: Data collected from the Bloomberg terminal for the sampled firms.

Name of the variable	Definition
Group 1: ESG disclosure scores	
ESG disclosure score	The score of ESG information disclosed (100 is the highest value). The higher is the score, the higher is the quantity of ESG information disclosed.
Environmental disclosure score	The score of environmental information disclosed (100 is the highest value). The higher is the score, the higher is the quantity of E information disclosed.
Social disclosure score	The score of social information disclosed (100 is the highest value). The higher is the score, the higher is the quantity of S information disclosed.
Governance disclosure score	The score of governance information disclosed (100 is the highest value). The higher is the score, the higher is the quantity of G information disclosed.
Group 2: Financial performance	
Return on assets	Net income / Total assets
Return on equity	Net income / Total equity
Group 3: Governance variables	
Percentage of women on board	The percentage of members of the board who are female.
Percentage of women in the management team	The percentage of members in the management team who are women.
Duality	1 if one person is both director and chair of the board, 0 if not.
Age	Average age of board members
Insider holdings	Percentage of change of shares held by insiders during the last six months. Based on holdings data collected by Bloomberg.

Institutional holdings	Percentage of change of shares held by institutional owners from the previous filing to the current filing.
Group 4: CSR variables	
Employee CSR training	1 if Yes, 0 if No.
CSR Sustainability Committee	1 if Yes, 0 if No.
Group 5: Corporate reputation variables	
News heat	
Analyst recommendation	
ESG news positive	
ESG news negative	
Group 6: Control variables	
Total assets	The value of total assets in the USD.
Total liabilities	The value of total liabilities in the USD.
Price to book ratio	Market value / Book value.
Ln(Cap)	Log value of market capitalization.

Note: This table presents ESG and financial variables for the firms in our sample.

Table 6 shows there are 6 categories of variables that we collected from the Bloomberg terminal. The first group of variables is related to the ESG disclosure score and its three pillars. These scores show to which extent a company is transparent in terms of ESG reporting. These are proprietary data from Bloomberg ESG team and spread from 0 to 100 with 100 the highest score. The second group of variables is related to the financial performance firms which is measured by traditional measures such as the return on assets (ROA) and the return on equity (ROE). The third group of variables is governance variables with the percentage of women in the board of directors, the percentage of women in the management team, the percentage of women among employees, duality (whether the chair of the board and the CEO is the same person), the average age of board members, the percentage of change of shares held by insiders during the last six months, and percentage of change of shares held by institutional owners from the previous filing to the current filing. The fourth group of variables is related to CSR dummy variables for the existence of employees' CSR training and of CSR & sustainability committee. The fifth group of variables is related to corporate reputation with four variables which are news heat, analyst recommendation, ESG news positive, and ESG news negative. Finally, the sixth group of variables includes usual control variables such as total assets, total liabilities, price to book ratio, and market capitalization.

Table 7 presents the main descriptive statistics of the sampled variables and firms. From Table 7, we see that the average MSCI ESG score of sampled firms is 4.59 over 10. The MSCI Governance score is the highest among the three pillars, with a value of 4.64. Regarding the biodiversity scores, we note that the sampled firms have a high exposure to biodiversity risks, with a value of 6.76 over 10. However, the biodiversity score is still low, with a value of 3.73 over 10. This result means firms' policies and programs designed to protect biodiversity are still low. In addition, the biodiversity management score is also low, with a value of 3.63. This

result means that the ability of sampled firms to manage biodiversity risks and opportunities is still low. Among the other MSCI scores that follow, the climate change score is the highest while the toxic emissions waste score is the lowest. This result means that firms' policies to fight against climate change are better implemented than policies to reduce toxic emissions waste. This is also the case for policies on waste management (with a score of 3.23), health and safety score (3.87), and business ethics score (3.37). Regarding the Bloomberg ESG disclosure scores, sampled firms report on average 50% of ESG metrics considered by Bloomberg, following the Global Reporting Initiative (GRI). The governance metrics are the most reported (80%) while the scores for the E and S pillars are much lower.

Table 7: Descriptive statistics

Variable	Mean	Median	S.D.	Min	Max
MSCI ESG Rating Industry	4.59	4.50	2.27	0.00	10.0
MSCI E_Score	4.22	4.00	1.92	0.00	10.0
MSCI S_Score	4.64	4.70	1.82	0.00	10.0
MSCI G_Score	4.82	4.90	1.68	0.00	9.00
Bio_Score	3.73	3.60	2.41	0.00	10.0
Bio_Weight	15.1	14.0	6.13	0.00	40.0
Bio_Exp_Score	6.76	6.90	2.15	0.60	10.0
Bio_Mmgt_Score	3.63	3.70	1.79	0.00	9.10
Climate_Change_Score	5.07	5.00	2.86	0.00	10.0
Natural_Resource_Score	4.05	3.90	2.16	0.00	10.0
Waste_Management_Score	3.23	3.10	2.50	0.00	10.0
Water_Stress_Score	3.49	3.30	3.04	0.00	10.0
Carbon_Emissions_Score	5.09	5.00	2.86	0.00	10.0
Toxic_Emissions_Waste_Score	3.11	3.00	2.47	0.00	10.0
Human_Capital_Score	4.55	4.60	1.97	0.00	10.0
Health_Safety_Score	3.87	4.10	2.57	0.00	10.0
Corporate_Governance_Score	5.56	5.80	1.80	0.00	9.30
Business_Ethics_Score	3.37	3.50	2.52	0.00	10.0
ESG_Dis_Score	51.2	52.0	13.7	3.57	85.7
E_Dis_Score	36.3	38.2	22.9	0.00	88.0
S_Disclosure_Score	34.0	33.2	15.1	0.00	78.9
G_Disclosure_Score	80.4	84.9	13.0	0.00	100.0
ROA	3.69	3.50	14.5	-161.0	322.0
ROE	8.05	8.55	32.6	-223.0	455.0
Women_Board	22.0	22.2	13.8	0.00	75.0
Women_Management	20.7	20.0	9.96	0.00	60.0
Women_Employees	22.5	22.0	10.4	0.00	75.0
Duality_Chair_CEO	0.19	0.00	0.40	0.00	1.00
Board_Age	60.2	60.7	4.97	41.0	77.7
Insider_Holdings	541.0	0.00	3.4e+4	-100.0	2.2e+6
Institutional_Holdings	2.2e+4	20.2	8.1e+5	-100.0	4.8e+7
CSR_Training	0.29	0.00	0.45	0.00	1.00
CSR_Committee	0.56	1.00	0.49	0.00	1.00

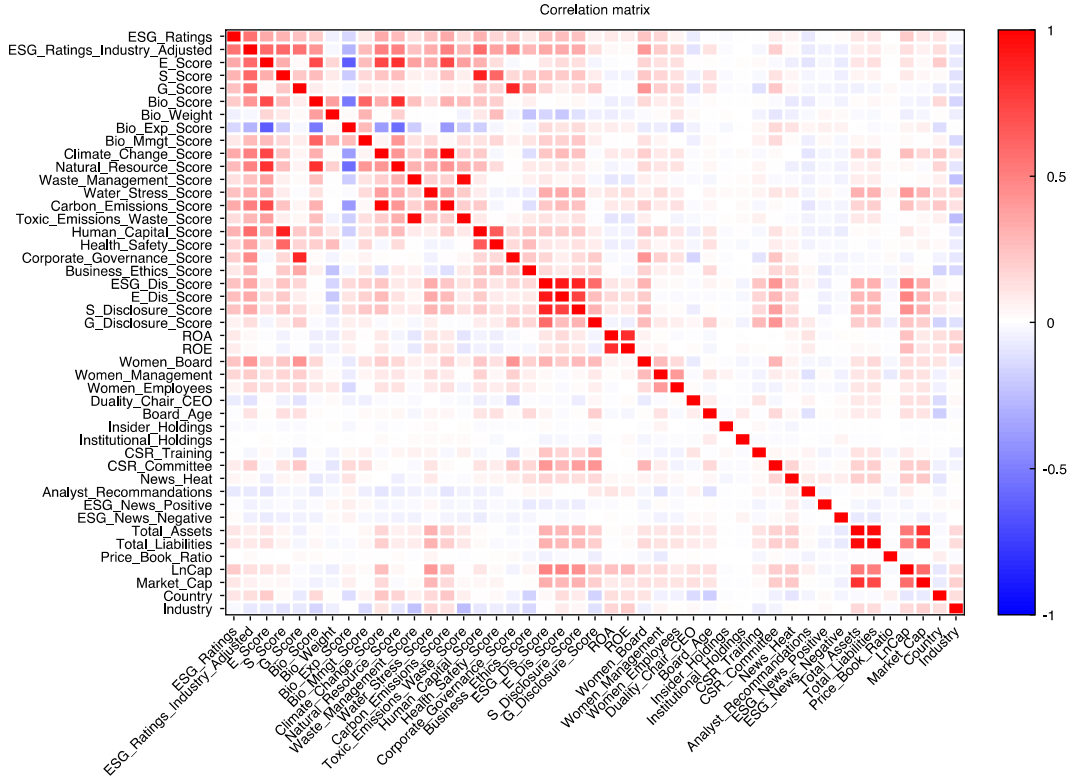
News_Heat	0.20	0.083	0.30	0.00	3.30
Analyst_Recommandations	3.95	4.07	0.80	1.00	5.00
ESG_News_Positive	-0.03	0.00	0.39	-1.58	5.39
ESG_News_Negative	-0.04	0.00	0.36	-0.75	5.39
Total_Assets	1.6e+4	4.3e+3	4.1e+4	0.04	4.4e+5
Total_Liabilities	9.4e+3	1.9e+3	2.5e+4	0.02	3.7e+5
Price_Book_Ratio	428.0	1.59	1.6e+4	0.03	6.4e+5
LnCap	7.85	7.91	1.82	-4.89	13.0
Market_Cap	1.1e+4	2.7e+3	2.42e+4	0.01	4.5e+5

Regarding the other firm factors, the ROA has an average value of 3.69 while that of ROE is 8.05. This result means that the profit represents 3.69% of total assets while it represents 8.05% of total equity. This is because in most cases, the value of total assets is much higher than the value of total equity. In addition, we note that in sampled firms, 22% of board members ware women, 20% of managers are women, and 22% of employees are women. In addition, 19% of CEO are also chairman of the board (the duality variable). The average age of board members is 60 years old. Furthermore, 29% of firms propose CSR training to employees while 56% of firms have a CSR committee. Another important fact of our data sample is that the price to book ratio has a very high average value which is 428. This figure means that on average, the market price can be 428 times higher than the book value.

To conclude, descriptive statistics show that firms are highly exposed to biodiversity risks. However, firm policies to project biodiversity are still low. The same is true for firm management of biodiversity risks. In the meanwhile, we can see that the weight of the biodiversity score in the global MSCI ESG score is quite high, 15%, given that there are 33 key issues considered in the MSCI ESG score.

Figure 6 shows the correlation matrix among all the considered variables. Figure 6 shows that the variables have low correlations among them, except for those between the same family such as MSCI ESG Scores and Bloomberg ESG disclosure scores. In addition, the four biodiversity scores also have high correlations among them. Therefore, to prevent from the multicollinearity issue, we include the four biodiversity scores in four different regressions.

Figure 6: Correlation matrix



IV. Empirical methodology

Our main objective is to understand whether biodiversity risk exposure and biodiversity risk management of firms have an impact on the financial performance, ESG performance, and ESG transparency of firms, our baseline panel data regressions are as follows.

(1) $$ROA_{i,t} = \alpha + \beta_1 Bio\_Score_{i,t} + \beta_2 Total\_Assets_{i,t} + \beta_3 Total\_Liabilities_{i,t} + \beta_4 Price\_Book_{i,t} + \beta_5 Ln(Cap)_{i,t} + \varepsilon_{i,t}$$

(2) $$ROE_{i,t} = \alpha + \beta_1 Bio\_Score_{i,t} + \beta_2 Total\_Assets_{i,t} + \beta_3 Total\_Liabilities_{i,t} + \beta_4 Price\_Book_{i,t} + \beta_5 Ln(Cap)_{i,t} + \varepsilon_{i,t}$$

(3) $$ESG\_Ratings\_MSCI_{i,t} = \alpha + \beta_1 Bio\_Score_{i,t} + \beta_2 Total\_Assets_{i,t} + \beta_3 Total\_Liabilities_{i,t} + \beta_4 Price\_Book_{i,t} + \beta_5 Ln(Cap)_{i,t} + \varepsilon_{i,t}$$

(4) $$ESG\_Dis\_Score_{i,t} = \alpha + \beta_1 Bio\_Score_{i,t} + \beta_2 Total\_Assets_{i,t} + \beta_3 Total\_Liabilities_{i,t} + \beta_4 Price\_Book_{i,t} + \beta_5 Ln(Cap)_{i,t} + \varepsilon_{i,t}$$

With $ROA_{i,t}$ refers to the return on assets of firm *i* in year *t*; $ROE_{i,t}$ refers to the return on equity of firm i in year *t*; $ESG\_Ratings\_MSCI_{i,t}$ refers to the MSCI ESG score of firm i in year *t*; including the individual E, S, and G scores; $ESG\_Dis\_Score_{i,t}$ refers to the Bloomberg ESG disclosure score of firm i in year *t*, including the three individual E, S, and G scores; $Bio\_Score_{i,t}$ refers to the MSCI biodiversity score of firm *i* in year *t*; $Total\_Assets_{i,t}$ refers to the log value of total assets of firm *i* in year *t*; $Total\_Liabilities_{i,t}$ refers to the log value of total liabilities of firm *i* in year *t*; $Price\_Book_{i,t}$ refers to the price to book ratio of firm *i* in year *t*; $Ln(Cap)_{i,t}$ refers to the log value of market capitalization of firm *i* in year *t*; $\varepsilon_{i,t}$ refers to the error terms.

The empirical results are obtained through panel data regressions with fixed or random effects, depending on the result of the Hausmann test. If the Hausman test rejects the null hypothesis, the Generalized Least Square (GLS) estimations are more consistent than Ordinary Least Square (OLS) estimations. Therefore, if the Hausman statistic rejects the null hypothesis of the Hausman test, we use the standard fixed-effects (FE) approach. Conversely, if the Hausman test does not reject the null hypothesis, we estimate the model via random-effect (RE) estimations with the OLS approach. To determine whether our regression model suffers from the endogeneity issue, we also estimated the reverse regression in which biodiversity scores are the dependent variable and ESG scores are the main independent variable (more details below). If the results of the reverse regression show that there is an endogeneity issue, we then use endogeneity-compatible estimation methods such as GMM or 2SLS (more details below). In addition, to understand the mechanism behind the relationship between biodiversity scores and financial performance, we further include interactive variables between biodiversity scores and other variables (governance, leverage, and institutional ownership). Furthermore, to check the robustness of our results, we then made various sensitivity analyses with additional control variables to the baseline ones (governance and CSR variables), with lagged-1 values of biodiversity scores, with the distinction between firms in the US and those which are not in the US.

Section V presents our baseline results while Section VI presents robustness check analyses.

V. Baseline results

V.1. Baseline results with ROA and ROE as the dependent variables

Table 8a shows the effect of the four MSCI biodiversity scores on the firm financial performance measured by the return on assets (ROA) while Table 8b considers the return on equity (ROE).

Table 8a: Baseline results – Effects of biodiversity scores on ROA

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	3.6142	-0.5922	2.4391	1.2999
	(6.2683)	(6.0696)	(6.0574)	(6.6119)
Biodiversity Score (1)	-0.3238**	-	-	-
	(0.1520)			
Biodiversity Exposure Score (2)	-	0.4823**	-	-
		(0.2067)		
Biodiversity Management Score (3)	-	-	-0.0998	-
			(0.2197)	
Biodiversity Weight (4)	-	-	-	0.0434
				(0.0508)
Ln Total Assets	-0.4442	-0.5927	-0.4193	-0.4313
	(2.9126)	(2.9055)	(2.9495)	(2.9308)
Ln Total Liabilities	-4.0598**	-3.9743**	-4.0519**	-4.0261**
	(2.0011)	(1.9924)	(2.0270)	(2.0176)
Price to Book Ratio	-6.3e-5***	-6.4e-5***	-6.3e-5***	-6.3e-5***
	(2.1e-5)	(2.1e-5)	(2.1e-5)	(2.1e-5)
Ln Market Capitalization	4.6659***	4.7036***	4.6988***	4.6992***
	(0.9672)	(0.9532)	(0.9739)	(2.178)
Observations	4865	4865	4865	4865
Joint test on regressors	52.478***	61.3805***	49.938***	48.5161***
Robust test for different intercepts	4.5930***	5.20841***	4.34518***	4.7656***
Wald joint test on time dummies	74.0264***	79.1266***	77.5625***	69.4518***
Hausmann test	6.46746	10.0274*	7.04255	10.5211*
Estimation	RE	RE	RE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 8a shows that the biodiversity score, which shows the level of impact of the company on biodiversity (the higher is the score, the better it is, the lower the company has negative impacts on biodiversity), has a significant and negative effect on the ROA. It means that the more the company makes efforts to protect the biodiversity, the lower is its financial

performance measured by ROA. This result may be logical as the protecting biodiversity may incur higher investment costs for the company. In the meanwhile, the biodiversity exposure score, which shows how a company is vulnerable to biodiversity risk, has a significant and positive coefficient. This result means that the more a company is vulnerable to biodiversity risk, the higher is its financial performance measured by the ROA. This result may be because a company which is vulnerable to biodiversity risk also means a company which currently exploits biodiversity in its activities. This latter therefore helps increase the revenue of the company and therefore its ROA. Regarding the biodiversity management score, which shows how well a company manages biodiversity risks and opportunities, its coefficient is not statistically significant. Finally, the weight of the biodiversity score in the global MSCI ESG score has no significant effect on the firm financial performance measured by ROA. Combining both results, we can see that biodiversity exposure score has a positive effect on ROA while biodiversity management score has a negative effect on ROA. This result means that when firms engage in biodiversity protection, it can contribute to higher expenses and therefore lower the financial performance measured by ROA.

When it comes to Table 8b, the results are quite different. As the biodiversity exposure score has a significant and positive effect on the firm financial performance, measured by the return on equity (ROE). However, the negative effect of the biodiversity score remains true. Another difference compared to the results with ROA is the significant and positive effect of the biodiversity weight in the global MSCI ESG score. Furthermore, the biodiversity management score has no significant effect on the ROE while it was the case for ROA. These differences may be due to the different nature of ROA and ROE. Indeed, the ROA is the ratio between profit and total assets while the ROE is the ratio between profit and total equity. Therefore, ROA is a financial performance measure which is more important to internal stakeholders while ROE is a financial performance measure which is more important to shareholders.

Given this difference, we can better understand the difference in the effect of biodiversity scores on ROA and ROE. Concretely, the biodiversity score has a negative effect on ROE while the biodiversity exposure score has a positive effect on ROE, like on ROA. Furthermore, the results in Table 8b further show that the weight of the biodiversity score in the global MSCI ESG score has a positive effect on the ROE. Does this result mean that the higher is the weight of the biodiversity score in the ESG score, the higher can be the MSCI ESG score, and the higher is the company valued by investors, and the higher is the return on equity? In all cases, we can understand that the weight of biodiversity in the global MSCI ESG score has a

significant effect on the return on equity, which is an important measure for shareholders. To conclude, the common result from Table 8a and Table 8b is the negative effect of the biodiversity score and the positive effect of the biodiversity exposure score on both ROA and ROE. However, the result is different between ROA and ROE regarding the effect of the biodiversity management score and the biodiversity weight.

Table 8b: Baseline results – Effects of biodiversity scores on ROE

Dependent Variable	ROE			
	(1)	(2)	(3)	(4)
Constant	9.2579	1.3057	5.2944	7.8889
	(18.5655)	(19.1446)	(18.7169)	(18.4243)
Biodiversity Score (1)	-0.6313*	-	-	-
	(0.4506)			
Biodiversity Exposure Score (2)	**-**	**0.8880***	-	-
		(0.6270)		
Biodiversity Management Score (3)	-	-	0.1873	-
			(0.5777)	
Biodiversity Weight (4)	-	-	-	-0.1015
				(0.1881)
Ln Total Assets	-7.2466	-7.5611	-7.3016	-7.2466
	(6.7895)	(6.7267)	(6.7807)	(6.7895)
Ln Total Liabilities	-5.9116*	-5.6787*	-5.8195*	-5.9116*
	(4.4224)	(4.3562)	(4.3961)	(4.4224)
Price to Book Ratio	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ln Market Capitalization	14.1093***	14.0487***	14.1023***	14.1093***
	(2.3596)	(2.3374)	(2.3586)	(2.3596)
Observations	4865	4865	4865	4865
Joint test on regressors	52.2465***	52.7922***	52.0352***	52.3825***
Robust test for different intercepts	334.904***	334.402***	333.901***	335.006***
Wald joint test on time dummies	66.3894***	72.3205***	68.5497***	58.504***
Hausmann test	5.3079	5.1974	7.12199	5.60731
Estimation	RE	RE	RE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

V.2. Baseline results with MSCI ESG scores as the dependent variables

Tables 9a, 9b, 9c, and 9d show the results related to the effect of biodiversity scores on the MSCI ESG, E, S, and G scores. Table 9a shows that the biodiversity score has a positive effect on the MSCI ESG score while the biodiversity exposure score and the biodiversity management

score have a positive effect on the MSCI ESG score while the biodiversity exposure score and the biodiversity weight have a negative effect. Table 9b shows that the results remain the same with the E component of ESG score is considered. Table 9c shows that the results remain the same when it comes to the E component of the MSCI score. Table 9c shows that there remains a positive effect from biodiversity score and biodiversity management score on the S component of the MSCI ESG score. However, neither the biodiversity exposure score nor the biodiversity weight has a significant effect on the S component. This result suggests that biodiversity risk exposure has less interaction with social metrics than with environmental metrics.

Table 9a: Effects of biodiversity scores on MSCI ESG scores

Dependent Variable	**MSCI ESG Score**			
	(1)	(2)	(3)	(4)
Constant	1.8375**	3.4813***	2.3639***	3.6384***
	(0.8266)	(0.9414)	(0.8742)	(0.8405)
Biodiversity Score	0.1291***	-	-	-
	(0.0385)			
Biodiversity Exposure Score	-	-0.1324***	-	-
		(0.0421)		
Biodiversity Manag. Score	-	-	0.1227***	-
			(0.0452)	
Biodiversity Weight	-	-	-	-0.0264**
				(0.0123)
Ln Total Assets	-0.0565	-0.0915	-0.1167	(0.1873)
	(0.1851)	(0.1919)	(0.1873)	0.1774
Ln Total Liabilities	0.1440	0.1512	0.1699	(0.1433)
	(0.1476)	(0.1478)	(0.1461)	-0.0000
Price to Book Ratio	0.0000	0.0000	0.0000	(0.0000)
	(0.0000)	(0.0000)	(0.0000)	0.0964
Ln Market Capitalization	0.1190*	0.1132*	0.0962*	0.0733*
	(0.0733)	(0.0751)	(0.0733)	(-0.0264)
Observations	4865	4865	4865	4865
Joint test on regressors	14.4735***	9.9211***	11.3461***	8.2464***
Robust test for different intercepts	515.125***	194.646***	700.107***	230.486***
Wald joint test on time dummies	46.8135***	36.4441***	45.6203***	32.6541***
Hausmann test	144.677***	126.412***	133.84***	130.403***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *ESG Rating from MSCI* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 9b: Effects of biodiversity scores on MSCI E scores

Dependent Variable	**MSCI E Score**			
	(1)	(2)	(3)	(4)
Constant	2.3826***	5.2157***	3.3653***	4.7525***
	(0.6095)	(0.6726)	(0.6649)	(0.7066)
Biodiversity Score	0.2214***	-	-	-
	(0.0293)			
Biodiversity Exposure Score	-	-0.2301***	-	-
		(0.0336)		
Biodiversity Management Score	-	-	0.1919***	-
			(0.0350)	
Biodiversity Weight	-	-	-	-0.0198**
				0.0091
Ln Total Assets	0.0894	0.0303	-0.0159	-0.0686
	(0.1048)	(0.1217)	(0.1180)	(0.1301)
Ln Total Liabilities	-0.0006	0.0112	0.0454	0.0588
	(0.0600)	(0.0666)	(0.0698)	(0.0737)
Price to Book Ratio	0.0000	0.0000	0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ln Market Capitalization	0.0097	0.0004	-0.0309	-0.0387
	(0.0465)	(0.0486)	(0.0478)	(0.0490)
Observations	4865	4865	4865	4865
Joint test on regressors	14.477***	10.05***	7.4627***	1.8131
Robust test for different intercepts	140.915***	475.18 ***	331.218***	742.529***
Wald joint test on time dummies	61.8766***	38.0544***	55.9934***	26.657***
Hausmann test	259.935***	77.8248***	16.7651***	23.2851***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the E *Rating from MSCI* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 9c: Effects of biodiversity scores on MSCI S scores

Dependent Variable	**MSCI S Score**			
	(1)	(2)	(3)	(4)
Constant	3.3048***	4.0980***	3.5733***	3.7704***
	(0.9205)	(0.8593)	(0.8933)	(0.8833)
Biodiversity Score	0.0646**	-	-	-
	(0.0322)			
Biodiversity Exposure Score	-	-0.0595	-	-
		(0.0470)		
Biodiversity Management Score	-	-	0.0603*	-
			(0.0387)	
Biodiversity Weight	-	-	-	0.0022
				(0.0106)
Ln Total Assets	-0.0416	-0.0611	-0.0719	-0.0750
	(0.1971)	(0.1945)	(0.1956)	(0.1932)
Ln Total Liabilities	0.1149	0.1200	0.1280	0.1329
	(0.1257)	(0.1243)	(0.1241)	(0.1242)
Price to Book Ratio	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ln Market Capitalization	0.0039	-0.0004	-0.0076	-0.0132
	(0.0646)	(0.0660)	(0.0648)	(0.0658)
Observations	4865	4865	4865	4865
Joint test on regressors	1.3194	0.7769	1.0755	0.4575
Robust test for different intercepts	87.415***	145.486***	89.1321***	80.5296***
Wald joint test on time dummies	33.2779***	30.4309***	31.2494***	31.1801***
Hausmann test	16.2063***	8.8253***	7.5898***	9.9249**
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *S Rating from MSCI* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 9d: Effects of biodiversity scores on MSCI G scores

Dependent Variable	MSCI G Score			
	(1)	(2)	(3)	(4)
Constant	6.4497***	6.7042***	6.6077***	6.0216***
	(0.990)	(1.039)	(1.019)	(1.035)
Biodiversity Score	0.0002	-	-	-
	(0.0288)			
Biodiversity Exposure Score	-	-0.0568	-	-
		(0.0454)		
Biodiversity Management Score	-	-	-0.0363	-
			(0.0315)	
Biodiversity Weight	-	-	-	0.0152*
				(0.0100)
Ln Total Assets	-0.4133**	-0.3968**	-0.4175**	-0.3892**
	(0.2030)	(0.2016)	(0.2050)	(0.2043)
Ln Total Liabilities	0.0977	0.0856	0.1006	0.0990
	(0.1430)	(0.1426)	(0.1433)	(0.1445)
Price to Book Ratio	-0.0000**	-0.0000**	-0.0000**	-0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ln Market Capitalization	0.1050**	0.1164**	0.1021**	0.0992*
	(0.0610)	(0.0625)	(0.0620)	(0.0629)
Observations	4865	4865	4865	4865
Joint test on regressors	13.9953***	14.0536***	14.018***	14.6613***
Robust test for different intercepts	271.949***	447.242***	186.979***	416.145***
Wald joint test on time dummies	55.5682***	59.6311***	54.8464***	49.7869***
Hausmann test	53.1292***	54.1956***	64.997***	61.6099***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *G Rating from MSCI* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 9d shows that the effect of biodiversity scores is very different on the governance pillar of the MSCI ESG score as they have no significant effect, except for the biodiversity weight. This result suggests that governance metrics are less impacted by biodiversity scores. This result may be because biodiversity is more related to environmental metrics while governance metrics are less related to biodiversity. We may question further this finding as governance decisions can indeed play an important role in the biodiversity protection policy of firms. However, the reverse is not true as biodiversity scores have no effect on the governance score.

V.3. Baseline results with Bloomberg ESG disclosure scores as the dependent variables

Tables 10a, 10b, 10c, and 10d present the results related to the effect of biodiversity scores on the Bloomberg ESG, E, S, and G disclosure scores.

Table 10a: Effects of biodiversity scores on Bloomberg ESG scores

Dependent Variable	**Bloomberg ESG Score**			
	(1)	(2)	(3)	(4)
Constant	32.5983***	29.6340***	30.3786***	28.7829***
	(8.984)	(9.008)	(8.824)	(8.934)
Biodiversity Score	-0.1791*	-	-	-
	(0.1340)			
Biodiversity Exposure Score	-	0.3256*	-	-
		(0.2290)		
Biodiversity Management Score	-	-	0.0315	-
			(0.1511)	
Biodiversity Weight	-	-	-	0.0540
				(0.0481)
Ln Total Assets	0.3521	0.4972	0.6519	0.8447
	(2.1171)	(2.1124)	(2.0805)	(2.1061)
Ln Total Liabilities	0.9441	0.8638	0.7780	0.7073
	(1.6395)	(1.6385)	(1.6174)	(1.6389)
Price to Book Ratio	0.0111	0.0141*	0.0154*	0.0175*
	(0.0098)	(0.0102)	(0.0101)	(0.0113)
Ln Market Capitalization	0.2995	0.2593	0.3582	0.3139
	(0.4104)	(0.4165)	(0.4093)	(0.4181)
Observations	4865	4865	4865	4865
Joint test on regressors	3.4137***	2.8265**	2.5203**	2.4755**
Robust test for different intercepts	206.991***	300.267***	123.021***	297.917***
Wald joint test on time dummies	101.627***	104.883***	89.295***	83.6276***
Hausmann test	11.6659**	16.0259***	25.4111***	19.1531***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *ESG Rating from Bloomberg* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 10b: Effects of biodiversity scores on Bloomberg E scores

Dependent Variable	**Bloomberg E Score**			
	(1)	(2)	(3)	(4)
Constant	5.5040	-3.2537	0.8093	0.0407
	(10.5348)	(10.0286)	(10.2244)	(10.4720)
Biodiversity Score	-0.5802**	-	-	-
	(0.3073)			
Biodiversity Exposure Score	-	0.8549**	-	-
		(0.4637)		
Biodiversity Management Score	-	-	-0.1499	-
			(0.3422)	
Biodiversity Weight	-	-	-	0.0010
				(0.1082)
Ln Total Assets	1.6104	1.8247	2.1093	2.1543
	(2.7020)	(2.6523)	(2.6783)	(2.6955)
Ln Total Liabilities	0.2150	0.1367	-0.0588	-0.0873
	(2.0246)	(2.0121)	(2.0344)	(2.0338)
Price to Book Ratio	0.0011	0.0112	0.0131	0.0148
	(0.0222)	(0.0242)	(0.0237)	(0.0240)
Ln Market Capitalization	0.6094	0.5667	0.7376	0.7488
	(0.5703)	(0.5815)	(0.5755)	(0.5916)
Observations	4865	4865	4865	4865
Joint test on regressors	2.6735**	2.5045**	1.9607*	1.9020*
Robust test for different intercepts	133.153***	135.579***	323.04***	300.292***
Wald joint test on time dummies	114.585***	118.276***	109.241***	95.3067***
Hausmann test	22.7136***	24.9488***	38.9571***	28.9474***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the E *Rating from Bloomberg* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 10c: Effects of biodiversity scores on Bloomberg S scores

Dependent Variable	**Bloomberg S Score**			
	(1)	(3)	(4)	(5)
Constant	25.4716***	23.8125***	24.2162***	25.0610***
	(7.6659)	(7.6007)	(7.5856)	(7.5502)
Biodiversity Score	-0.0156	-	-	-
	(0.1475)			
Biodiversity Exposure Score	-	0.3890*	-	-
		(0.2894)		
Biodiversity Management Score	-	-	0.2248*	-
			(0.1689)	
Biodiversity Weight	-	-	-	0.0093
				(0.0515)
Ln Total Assets	-1.8432	-1.9774	-1.7652	-1.8038
	(1.9592)	(1.9352)	(1.9286)	(1.9313)
Ln Total Liabilities	1.7209	1.8144	1.6713	1.7053
	(1.5261)	(1.5034)	(1.5100)	(1.5091)
Price to Book Ratio	0.0060	0.0047	0.0088	0.0068
	(0.0148)	(0.0136)	(0.0142)	(0.0144)
Ln Market Capitalization	0.6396*	0.5602*	0.6611*	0.6368*
	(0.4298)	(0.4271)	(0.4308)	(0.4378)
Observations	4865	4865	4865	4865
Joint test on regressors	1.0079	1.3150	1.3785	1.0225
Robust test for different intercepts	2072.57***	445.027***	120.868***	457.807***
Wald joint test on time dummies	88.0072***	90.468***	89.1917***	79.6085***
Hausmann test	23.7854***	26.6774***	51.299***	27.0053***
Estimation	FE	FE	FE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *S Rating from Bloomberg* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 10d: Effects of biodiversity scores on Bloomberg G scores

Dependent Variable	**Bloomberg G Score**			
	(1)	(2)	(3)	(4)
Constant	53.0825***	53.9685***	52.9203***	53.4536***
	(6.4773)	(6.6622)	(6.4323)	(6.5210)
Biodiversity Score	0.1103	-	-	-
	(0.1560)			
Biodiversity Exposure Score	-	-0.0179	-	-
		(0.1761)		
Biodiversity Management Score	-	-	0.2441	-
			(0.2197)	
Biodiversity Weight	-	-	-	0.0178
				(0.0446)
Ln Total Assets	2.2120	2.1459	2.1696	2.1694
	(1.9630)	(1.9627)	(1.9752)	(1.9755)
Ln Total Liabilities	0.6352	0.6790	0.6442	0.6762
	(1.6963)	(1.6995)	(1.6988)	(1.7114)
Price to Book Ratio	-0.0187	-0.0211	-0.0188	-0.0204
	(0.0301)	(0.0299)	(0.0300)	(0.0301)
Ln Market Capitalization	0.1193	0.0993	0.1219	0.0865
	(0.5578)	(0.5611)	(0.5584)	(0.5700)
Observations	4865	4865	4865	4865
Joint test on regressors	22.2096***	21.1265***	23.8696***	21.1428***
Robust test for different intercepts	1435.19***	1427.07***	1431.78***	1433.39***
Wald joint test on time dummies	30.99***	30.8063***	29.9143***	28.1815***
Hausmann test	4.4923	5.3324	5.1652	5.5269
Estimation	RE	RE	RE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *G Rating from Bloomberg* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, and 10% respectively.

Table 10a shows that the results are quite different when it comes to Bloomberg ESG disclosure scores which do not measure ESG performance but the transparency in firms' ESG reporting. For the ESG disclosure score in Table 10a, the effect of the biodiversity score is negative whole the effect of the biodiversity management score is positive, significantly. This is totally the inverse of the results with MSCI ESG scores. This result can be justified by the difference between MSCI ESG scores and Bloomberg ESG disclosure scores. Indeed, MSCI ESG scores measure how firms are good at managing ESG risks while Bloomberg ESG disclosure scores measure the transparency of firms' ESG reporting. Therefore, the higher is the biodiversity score, the lower is the transparency in ESG reporting. This result may be because biodiversity metrics are not well integrated in ESG reporting. Therefore, even if the company manages better biodiversity protection, it reduces the transparency in ESG reporting. However, a higher biodiversity exposure score increases the transparency in ESG reporting. This result may be because a higher biodiversity risk exposure also means a higher requirement and availability of ESG data from firms. Furthermore, neither biodiversity management score nor biodiversity weight has a significant effect on the Bloomberg ESG disclosure score. This result suggests that the way a firm manages biodiversity risks and opportunities has no effect on the transparency of its ESG reporting.

Table 10b shows that the results remain the same when it comes to the E pillar of the Bloomberg ESG disclosure score. Table 10c shows that the results change when it comes to the social pillar as the biodiversity score has no significant effect anymore while the biodiversity management score has a significant and positive effect. This result shows that biodiversity can influence social reporting of firms. The higher is the biodiversity exposure score, the more firms are transparent in social reporting. In addition, the higher is the biodiversity management score, the higher is the transparency of social reporting as well. This result may suggest that biodiversity constitutes the living conditions of firms' employees and other stakeholders. Therefore, the way firms are exposed to biodiversity risk and the way firms manage biodiversity risks and opportunities can influence the social atmosphere and therefore social metrics' reporting of firms. When it comes to the governance pillar, Table 10d shows that biodiversity scores have no significant effect on the transparency of governance metrics reporting. This result confirms that with the G pillar of the MSCI ESG score. It shows again that there is still a disconnection between biodiversity protection and corporate governance, and this may be further studied in the future.

V.4. The mechanism behind the relationship between biodiversity and financial performance

In this section, we investigate which firm factors can have a moderating effect on the relationship between biodiversity and financial performance. The firm factors that we consider are corporate governance, institutional ownership, corporate leverage, and corporate reputation. Corporate governance is considered because it is essential in firm decisions to manage biodiversity risks and ESG engagement. The part of institutional ownership is also considered because institutional investors can use shareholder engagement pressure to influence firms in the management of biodiversity risks and ESG engagement. Corporate leverage is considered because creditors can also have an influence on firms' biodiversity and ESG management. Finally, we also include firms' reputation, measured by variable "news heat", which shows how often the company is cited in newspapers. Tables 11a and 11b present the results related to institutional ownership. Tables 12a and 12b show the results related to corporate leverage. Tables 13a and 13b are related to corporate reputation.

Table 11a: Moderating effect of institutional ownership (ROA)

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	-4.2574	-10.3021	-6.2690	-12.6812
	(45.6967)	(45.9870)	(45.6554)	(47.0074)
Biodiversity Score (1)	-0.3555*	-	-	-
	(0.2165)			
Biodiversity Exposure Score (2)	-	0.8110***	-	-
		(0.347)		
Biodiversity Manag. Score (3)	-	-	-0.3553	-
			(0.3362)	
Biodiversity Weight (4)	-	-	-	0.1359*
				(0.0908)
(1)*Inst. Ownership	0.0004**	0.0001	0.0003**	0.0002
	(0.0002)	(0.0001)	(0.0002)	(0.0001)
(2)*Inst. Ownership	-0.0004**	-0.0001	-0.0003**	-0.0002
	(0.0002)	(0.0001)	(0.0002)	(0.0001)
(3)*Inst. Ownership	0.0004**	0.0001	0.0003**	0.0002*
	(0.0002)	(0.0001)	(0.0002)	(0.0001)
(4)*Inst. Ownership	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Inst. Ownership	-0.0027**	-0.0007	-0.0024**	-0.0012*
	(0.0012)	(0.0010)	(0.0013)	(0.0009)
Ln Total Assets	7.1158	7.1658	7.3364	7.8610
	(8.6706)	(8.7000)	(8.6497)	(8.8248)
Ln Total Liabilities	-10.3516**	-10.3592**	-10.4433**	-10.6090**
	(6.1492)	(6.1694)	(6.1419)	(6.2240)
Price to Book Ratio	-0.0000	-0.0000	-0.0000	-0.0000

	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ln Market Capitalization	4.9405***	4.8559***	5.0224***	5.0233***
	(1.320)	(1.308)	(1.323)	(1.323)
Observations	4865	4865	4865	4865
Joint test on regressors	16.6798***	16.5257***	17.6743***	16.1784***
Robust test for different intercepts	3.7631***	3.8234***	3.7755***	3.7959***
Wald joint test on time dummies	67.3301***	72.3898***	72.1612***	64.7477***
Hausmann test	78.2436***	80.3422***	74.409***	72.1612***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively. The coefficients for the interaction term between the biodiversity variables and the institutional holdings have 9 zeros before the first number and therefore, merged with the significance test, they can be considered as zeros. The result is the same even if we consider for each regression only the interaction between the biodiversity variable and the institutional ownership.

Table 11b: Moderating effect of institutional ownership (ROE)

Dependent Variable	**ROE**			
	(1)	(2)	(3)	(4)
Constant	89.5960	80.5472	84.5250	91.1890
	(119.7778)	(120.8813)	(120.2877)	(121.8122)
Biodiversity Score (1)	-0.7639	-	-	-
	(0.6234)			
Biodiversity Exposure Score (2)	-	0.7007	-	-
		(0.9538)		
Biodiversity Manag. Score (3)	-	-	-0.3047	-
			(0.7351)	
Biodiversity Weight (4)	-	-	-	-0.2668
				(0.2411)
(1)*Inst. Ownership	0.0002	-0.0002	-0.0000	0.0001
	(0.0006)	(0.0005)	(0.0005)	(0.0005)
(2)*Inst. Ownership	-0.0002	0.0002	-0.0000	-0.0002
	(0.0006)	(0.0005)	(0.0006)	(0.0005)
(3)*Inst. Ownership	0.0002	-0.0002	0.0000	0.0001
	(0.0006)	(0.0005)	(0.0005)	(0.0005)
(4)*Inst. Ownership	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Inst. Ownership	-0.0012	0.0017	0.0002	-0.0008
	(0.0038)	(0.0037)	(0.0038)	(0.0034)
Ln Total Assets	-9.7609	-9.5724	-9.3771	-9.7775
	(19.8619)	(19.8388)	(19.8943)	(19.9062)
Ln Total Liabilities	-16.1983*	-16.2558*	-16.3837*	-16.4238*
	(10.2804)	(10.2754)	(10.2785)	(10.2202)
Price to Book Ratio	-0.0004**	-0.0004**	-0.0004**	-0.0004**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Ln Market Capitalization	15.9829***	16.0463***	16.1613***	16.2798***
	(2.897)	(2.927)	(2.954)	(2.958)

Observations	4865	4865	4865	4865
Joint test on regressors	93.8504***	96.8699***	93.4456***	97.6836***
Robust test for different intercepts	12.9608***	21.7967***	44.7724***	22.2097***
Wald joint test on time dummies	50.5802***	53.8563***	51.934***	48.6834***
Hausmann test	615.557***	801.158***	538.204***	687.841***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively. The coefficients for the interaction term between the biodiversity variables and the institutional holdings have 9 zeros before the first number and therefore, merged with the significance test, they can be considered as zeros. The result is the same even if we consider for each regression only the interaction between the biodiversity variable and the institutional ownership.

Results in Table 11a show that the interactive variables between institutional ownership and the four biodiversity scores have no significant impact on ROA. Table 11b shows the same result when it comes to ROE. In addition, the variable related to institutional ownership is not statistically significant. This result shows that institutional ownership does not have a moderating effect on the relationship between biodiversity and financial performance.

Tables 12a and 12b present the results on the moderating effect of corporate leverage.

Table 12a: Moderating effect of leverage (ROA)

Dependent Variable	**ROA**			
	(1)	(2)	(3)	(4)
Constant	50.0045	41.6453	50.7946	45.7044
	(48.1246)	(55.6853)	(49.9775)	(49.6922)
Biodiversity Score (1)	-0.7300	-	-	-
	(1.3107)			
Biodiversity Exposure Score (2)	-	0.7017	-	-
		(1.6131)		
Biodiversity Manag. Score (3)	-	-	-1.0282	-
			(1.3921)	
Biodiversity Weight (4)	-	-	-	0.0212
				(0.3127)
(1)*TL_TA	1.7988	0.8595	0.6705	0.7768
	(2.3142)	(0.9130)	(0.7969)	(0.8398)
(2)*TL_TA	-1.5538*	-1.6869*	0.0304	-1.5810*
	(1.0592)	(1.1719)	(2.2494)	(1.0900)
(3)* TL_TA	1.6426***	0.7031	1.6279***	1.6667***
	(0.693)	(2.5443)	(0.681)	(0.684)
(4)* TL_TA	0.1467	0.1459	0.1641	0.1287
	(0.1719)	(0.1733)	(0.1751)	(0.5529)
TL_TA	-69.8249***	-59.0258**	-72.1810***	-65.7846***
	(17.48)	(26.294)	(20.22)	(16.56)
Ln Total Assets	-8.3357	-8.1327	-8.4753	-8.1951
	(8.4068)	(8.6119)	(8.3910)	(8.4808)

Ln Total Liabilities	4.2664	4.1253	4.4844	4.2362
	(4.0536)	(4.2528)	(3.9942)	(4.1649)
Price to Book Ratio	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ln Market Capitalization	3.9447***	3.9447***	3.9362***	3.9792***
	(1.346)	(1.348)	(1.354)	(1.37)
Observations	4865	4865	4865	4865
Joint test on regressors	8.2636***	8.1772***	8.6483***	8.1372***
Robust test for different intercepts	4.4264***	4.7958***	4.4668***	4.3358***
Wald joint test on time dummies	67.0204***	66.9778***	69.0987***	69.4652***
Hausmann test	52.5118***	56.5311***	47.6795***	56.8888***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 12b: Moderating effect of leverage (ROE)

Dependent Variable	**ROE**			
	(1)	(2)	(3)	(4)
Constant	201.8380*	208.3390*	213.9616*	172.5266
	(129.955)	(151.133)	(134.969)	(135.2965)
Biodiversity Score (1)	-0.3074	-	-	-
	(2.9261)			
Biodiversity Exposure Score (2)	-	-1.1403	-	-
		(4.2813)		
Biodiversity Manag. Score (3)	-	-	-2.9610	-
			(3.3128)	
Biodiversity Weight (4)	-	-	-	1.4440*
				(0.9139)
(1)*TL_TA	-1.4822	-2.0656	-2.1404	-1.0410
	(5.1017)	(2.5539)	(2.4054)	(2.7012)
(2)*TL_TA	2.2438	2.4046	6.7499	1.2904
	(2.9180)	(3.1614)	(6.6792)	(3.1865)
(3)* TL_TA	1.2240	2.7672	1.1274	1.7208
	(1.8926)	(6.8929)	(1.8871)	(1.9713)
(4)* TL_TA	-0.6212	-0.5953	-0.6103	-2.7120*
	(0.5194)	(0.5205)	(0.5271)	(1.6844)
TL_TA	-114.693***	-124.5813*	-130.729***	-85.9938**
	(43.91)	(79.1151)	(54.19)	(47.959)
Ln Total Assets	-41.9984**	-42.1244**	-42.6587**	-41.3169**
	(21.992)	(22.371)	(22.031)	(22.105)
Ln Total Liabilities	15.2055*	15.3515*	15.9359**	15.5063**
	(9.3369)	(9.7035)	(9.2959)	(9.3947)
Price to Book Ratio	-0.0004**	-0.0004**	-0.0004**	-0.0004**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Ln Market Capitalization	12.9694***	13.0331***	12.8652***	12.8236***
	(3.013)	(3.016)	(3.047)	(3.068)

Observations	4865	4865	4865	4865
Joint test on regressors	4.7895***	4.7656***	4.7508***	4.8063***
Robust test for different intercepts	65.0835***	271.009***	29.7204***	117.379***
Wald joint test on time dummies	52.7244***	53.1021***	53.0424***	54.7641***
Hausmann test	25.5068***	23.9729**	24.7406***	24.3949***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Results in Table 12a show that the coefficients related to the interactive variables are significant in some cases and in most cases they are negative. This result means that when biodiversity scores increase, an increase in the leverage of firms reduces its financial performance measured by ROA. The same result is found with ROE in Table 12b.

Table 13a: Moderating effect of firm reputation – News heat (ROA)

Dependent Variable	**ROA**			
	(1)	(2)	(3)	(4)
Constant	3.7648	-14.1582	-9.0231	-16.5047
	(6.7485)	(54.2223)	(53.4636)	(55.4352)
Biodiversity Score (1)	-0.3681**	-	-	-
	(0.2160)			
Biodiversity Exposure Score (2)	-	1.2153***	-	-
		(0.428)		
Biodiversity Manag. Score (3)	-	-	0.0026	-
			(0.4096)	
Biodiversity Weight (4)	-	-	-	0.2003**
				(0.1103)
(1)*News_Heat	0.6740	0.6025	0.9914	1.4067
	(1.5839)	(1.3798)	(1.5759)	(1.5492)
(2)*News_Heat	-1.8039	-2.7008	-3.1763	-3.6248*
	(2.2383)	(2.2451)	(2.4896)	(2.3860)
(3)*News_Heat	1.2509	0.9729	1.7285	1.9663*
	(1.3650)	(1.2796)	(1.4577)	(1.3866)
(4)*News_Heat	0.1570	0.2875	0.3246	0.0567
	(0.2049)	(0.2477)	(0.2631)	(0.2698)
NEWS_HEAT	-6.3066	-1.6444	-6.9967	-4.5319
	(8.1043)	(6.5002)	(7.9036)	(6.9988)
Ln Total Assets	0.0214	7.5791	7.7787	8.3527
	(3.2721)	(9.8050)	(9.7733)	(9.9580)
Ln Total Liabilities	-4.1625**	-10.4159*	-10.5969*	-10.7187*
	(2.2963)	(6.9082)	(6.9090)	(6.9768)
Price to Book Ratio	-0.0001***	-0.0000	-0.0000	-0.0000
	(0.001)	(0.0001)	(0.0001)	(0.0001)
Ln Market Capitalization	4.6877***	4.7075***	5.0148***	4.9977***

	(1.061)	(1.376)	(1.388)	(1.396)
Observations	4865	4865	4865	4865
Joint test on regressors	78.9269***	7.1157***	6.2059***	6.4674***
Robust test for different intercepts	113.438***	3.4255***	3.5960***	3.6032***
Wald joint test on time dummies	63.3137***	51.9223***	47.173***	48.0565***
Hausmann test	18.2508*	27.6558***	19.7787***	24.8349***
Estimation	RE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 13b: Moderating effect of firm reputation – News heat (ROE)

Dependent Variable	**ROE**			
	(1)	(2)	(3)	(4)
Constant	11.7392	2.1381	6.9380	8.1897
	(192.2003)	(197.0108)	(195.2803)	(201.4163)
Biodiversity Score (1)	-0.0607	-	-	-
	(0.8224)			
Biodiversity Exposure Score (2)	-	2.1281**	-	-
		(1.2442)		
Biodiversity Manag. Score (3)	-	-	0.7845	-
			(1.0538)	
Biodiversity Weight (4)	-	-	-	0.0778
				(0.3263)
(1)*News_Heat	1.4742	0.7907	1.4435	1.5871
	(3.6115)	(3.3224)	(3.5693)	(3.6240)
(2)*News_Heat	-7.3927*	-6.6692	-8.1473*	-7.5819*
	(5.5686)	(5.2998)	(5.7704)	(5.4885)
(3)*News_Heat	3.7854	2.4563	3.9030	3.8624
	(3.1839)	(3.0749)	(3.1736)	(3.1468)
(4)*News_Heat	-0.0146	-0.0768	-0.0457	-0.1177
	(0.9910)	(0.9593)	(0.9861)	(0.9450)
NEWS_HEAT	-6.0071	3.6264	-3.5821	-4.7384
	(15.4563)	(13.5606)	(14.2991)	(14.3401)
Ln Total Assets	2.3767	2.1446	2.6613	2.6311
	(29.0860)	(29.1521)	(29.2754)	(29.6950)
Ln Total Liabilities	-17.2865*	-17.0240	-17.4756*	-17.3538*
	(13.3932)	(13.3714)	(13.4397)	(13.4071)
Price to Book Ratio	-0.0002	-0.0002	-0.0002	-0.0002
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Ln Market Capitalization	13.0051***	12.4842***	13.1467***	13.0225***
	(3.22)	(3.193)	(3.251)	(3.26)
Observations	4865	4865	4865	4865
Joint test on regressors	3.2344***	3.4252***	3.2296***	3.2662***
Robust test for different intercepts	48.982***	67.7168***	16.0145***	26.3803***
Wald joint test on time dummies	45.8066***	50.2685***	45.1894***	41.6157***

Hausmann test	21.7556**	28.7059***	25.5389***	26.7745***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

In addition, the variable related to the structure capital itself is also negatively related with financial performance. This result may be because a higher value of debt leads to a higher cost of capital. Together with higher biodiversity scores, which also require capital investment from firms, this leads to a decrease in firms' financial performance. Therefore, we conclude that corporate leverage has a negative moderating effect on the relationship between biodiversity and financial performance.

Tables 13a and 13b present the results related to corporate reputation, measured by variable news heat.

Results in Table 13a and 13b show that most of coefficients related to the interaction variables between news heat and biodiversity scores are negative, especially when ROE is the dependent variable. In addition, the news heat variable itself is not statistically significant. This result means that when firms are more cited in newspapers, together with higher biodiversity scores, the financial performance decreases. This result may be because citations in newspapers are more often related to bad news on firms. Given that engagement in biodiversity is also costly for firms, together with potential bad news in newspapers, this reduces the financial performance of firms.

VI. Robustness check analyses

VI.1. Robustness check 1: Lagged effect of biodiversity scores on ROA and ROE

Table 14a shows the results related to the first robustness check about the lagged effect of biodiversity scores on the return on assets (ROA) while Table 14b is with the return on equity (ROE). Table 14a shows that the results change when it comes to the lagged effect of biodiversity scores on ROA. Only the coefficient related to the biodiversity management score is significant. The results are a bit different with ROE (Table 14b) as the biodiversity exposure score has a significant and positive coefficient as well.

Table 14a: Robustness check 1 - Effects of *lagged* biodiversity scores on ROA

Dependent Variable	**ROA**			
	(1)	(2)	(3)	(4)
Constant	6.0083	2.4391	4.5382	5.8150
	(6.8094)	(6.0574)	(6.4486)	(6.7297)
Biodiversity Score (T-1)	-0.0238	-	-	-
	(0.1630)			
Biodiversity Exposure Score (T-1)	-	-0.0889	-	-
		(0.2197)		
Biodiversity Manag. Score (T-1)	-	-	0.3569*	-
			(0.2512)	
Biodiversity Weight (T-1)	-	-	-	0.0045
				(0.0520)
Ln Total Assets	-0.4607	-0.4193	-0.5175	-0.4553
	(2.9310)	(2.9495)	(2.9241)	(2.9303)
Ln Total Liabilities	-4.0266**	-4.0520**	-3.9970**	-4.0277**
	(2.0125)	(2.0270)	(2.0124)	(2.0145)
Price to Book Ratio	-0.0001***	-0.0001***	-0.0001***	-0.0001***
	(0.001)	(0.001)	(0.001)	(0.0000)
Ln Market Capitalization	4.7103***	4.6988***	4.7484***	4.7113***
	(0.9688)	(0.9740)	(0.9608)	(0.9704)
Observations	4865	4865	4865	4865
Joint test on regressors	48.4326***	49.938***	54.7339***	48.0927***
Robust test for different intercepts	155.196***	155.805***	156.639***	155.864***
Wald joint test on time dummies	76.7514***	77.5625***	73.3433***	68.1892***
Hausmann test	7.5209	7.0425	9.5012*	7.20271
Estimation	RE	RE	RE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 14b: Robustness check 1 - Effects of *lagged* biodiversity scores on ROE.

Dependent Variable	**ROE**			
	(1)	(2)	(3)	(4)
Constant	5.9930	-3.4810	0.6284	6.0233
	(18.9166)	(18.7100)	(18.7785)	(18.5144)
Biodiversity Score (T-1)	-0.3317	-	-	-
	(0.4432)			
Biodiversity Exposure Score (T-1)	-	1.5340***	-	-
		(0.6281)		
Biodiversity Manag. Score (T-1)	-	-	0.9600*	-
			(0.6228)	
Biodiversity Weight (T-1)	-	-	-	-0.1390
				(0.2018)

Ln Total Assets	-3.9925	-4.4373	-4.1421	-3.9465
	(7.1438)	(7.0164)	(7.1025)	(7.1542)
Ln Total Liabilities	-6.9811*	-6.7688*	-6.8660*	-7.0208*
	(4.9645)	(4.8655)	(4.9388)	(4.9881)
Price to Book Ratio	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ln Market Capitalization	12.8829***	12.9060***	12.9955***	12.9336***
	(2.1718)	(2.1414)	(2.1597)	(2.1692)
Observations	4865	4865	4865	4865
Joint test on regressors	57.9703***	62.6886***	64.0572***	58.0664***
Robust test for different intercepts	204.92***	206.515***	206.295***	205.715***
Wald joint test on time dummies	68.1688***	71.2041***	59.5728***	51.6245***
Hausmann test	2.1117	6.4723	2.5044	2.3858
Estimation	RE	RE	RE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

VI.2. Robustness check 2: The effect of being US firms

Tables 15a and 15b proceeds the second robustness check to know whether US firms can have a different behavior compared to those in other countries.

For that, we include a dummy variable which is equal to 1 if a firm is in the US and 0 otherwise. In addition, in the same regression, we also include interactive variables between the four MSCI biodiversity scores and the US dummy variable to know whether US location can have a moderating effect on the relationship between biodiversity scores and financial performance (measured by both ROA and ROE). With ROA, Table 15a shows that the interactive variables have a significant effect on the ROA, significantly positive with the biodiversity score, biodiversity management score, and the biodiversity weight. This result means that the US location of firms tends to decrease the effect of biodiversity scores on the financial performance of firms measured by ROA. This result suggests that financial performance of US firms is less impacted by biodiversity scores than firms in other countries. This result is confirmed by the negative coefficients related to the US dummy variable. The results regarding the moderating effect of being in the US remain the same when it comes to the ROE.

Table 15a: Robustness check 2 - Effects of biodiversity scores on ROA with dummy for US firms.

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	3.1023	-12.8579	1.6551	-21.5847
	(6.2474)	(44.3473)	(6.0196)	(46.5304)
Biodiversity Score (1)	-0.1202	-	-	-
	(0.1860)			
Biodiversity Exposure Score (2)	-	0.9402***	-	-
		(0.3988)		
Biodiversity Management Score (3)	-	-	0.2446	-
			(0.2891)	
Biodiversity Weight (4)	-	-	-	0.4358***
				(0.1142)
Bio.Score* US DUMMY	-0.4294*	-	-	-
	(0.3243)			
Biodiv.Exp. Score* US DUMMY	-	-0.2399	-	-
		(0.7083)		
Bio. Manag. Score*US DUMMY	-	-	-0.6030*	-
			(0.4123)	
Bio. Weight* US DUMMY	-	-	-	-0.4791***
				(0.1191)
Ln Total Assets	-0.2308	7.4660	-0.1755	8.4553
	(2.9099)	(8.6166)	(2.9435)	(8.7274)
Ln Total Liabilities	-3.9014**	-10.5000**	-3.8969**	-10.7207**
	(1.9890)	(6.1602)	(2.0136)	(6.1752)
Price to Book Ratio	-0.0001***	-0.0000	-0.0001***	-0.0000
	(0.0000)	(0.0001)	(0.0000)	(0.0001)
Ln Market Capitalization	4.5381***	4.9281***	4.5505***	4.9721***
	(0.9784)	(1.3029)	(0.9845)	(1.2887)
US DUMMY	-2.7459**	-17.6670*	-2.1701*	-10.0761
	(1.2929)	(11.2910)	(1.5893)	(11.1063)
Observations	4865	4865	4865	4865
Joint test on regressors	57.1611***	11.1232***	56.6543***	12.8924***
Robust test for different intercepts	140.024***	3.86546***	140.207***	3.8658***
Wald joint test on time dummies	73.1412***	72.429***	76.5131***	62.6283***
Hausmann test	11.9994	16.2805**	11.9635	23.8305***
Estimation	RE	FE	RE	FE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 15b: Robustness check 2 - Effects of biodiversity scores on ROE with dummy for US firms

Dependent Variable	ROE			
	(1)	(2)	(3)	(4)
Constant	6.2253	1.4664	73.6383	2.0675
	(18.8320)	(17.5235)	(119.0869)	(19.5364)
Biodiversity Score	0.1465	-	-	-
	(0.5263)			
Biodiversity Exposure Score	-	0.8654	-	-
		(0.7247)		
Biodiversity Management Score	-	-	1.2366*	-
			(0.7955)	
Biodiversity Weight	-	-	-	0.2341
				(0.2122)
Bio.Score* US DUMMY	-1.6539**	-	-	-
	(0.9808)			
Biodiv.Exp. Score* US DUMMY	-	0.0545	-	-
		(1.3583)		
Bio. Manag. Score*US DUMMY	-	-	-2.9025**	-
			(1.3022)	
Bio. Weight* US DUMMY	-	-	-	-0.5110**
				(0.3043)
Ln Total Assets	-6.8184	-7.0736	-9.4965	-6.5821
	(6.8903)	(6.8099)	(19.7706)	(6.9330)
Ln Total Liabilities	-5.7367*	-5.5744*	-15.8853*	-5.7806*
	(4.3655)	(4.3251)	(10.1289)	(4.3869)
Price to Book Ratio	-0.0002***	-0.0002***	-0.0004**	-0.0002***
	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Ln Market Capitalization	13.8151***	13.8662***	16.0353***	13.8105***
	(2.3807)	(2.3634)	(3.0508)	(2.4086)
US DUMMY	-0.9582	-7.2476	25.9831**	0.9720
	(4.0061)	(11.0107)	(11.4283)	(4.9213)
Observations	4865	4865	4865	4865
Joint test on regressors	54.6807***	58.5309***	6.68408***	68.0476***
Robust test for different intercepts	317.86***	317.534***	15.9076***	319.285***
Wald joint test on time dummies	66.3766***	71.591***	52.2282***	59.4795***
Hausmann test	10.9624	7.96	14.5359**	10.8896
Estimation	RE	RE	FE	RE

Notes: The total number of observations is 4,856. There can be missing values for some variables in some periods. Therefore, it is an unbalanced panel data sample. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

VI.3. Robustness check 3: With additional control variables

In this section, we check the robustness of our results when including additional control variables in the baseline regression. For that, we consider three different groups of control variables and estimate three different regressions. These three groups of control variables are CSR variables (Tables 16a and 16b), corporate reputation variables (Tables 17a and 17b), corporate governance variables (Tables 18a and 18b).

Table 16a: Robustness check 3 – With additional control variables – CSR variables (ROA)

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	-8.7832	-14.2359	-10.1134	-18.7792
	(45.9471)	(45.9838)	(45.9238)	(46.7106)
Biodiversity Score (1)	-0.2684	-	-	-
	(0.2130)			
Biodiversity Exposure Score (2)	-	0.8323**	-	-
		(0.3650)		
Biodiversity Manag. Score (3)	-	-	-0.2968	-
			(0.3221)	
Biodiversity Weight (4)	-	-	-	0.2122**
				(0.096)
Ln Total Assets	18.5858**	18.6878***	18.7654***	19.8814***
	(8.0071)	(8.016)	(7.954)	(8.044)
Ln Total Liabilities	-23.3512***	-23.4185***	-23.4253***	-23.9436***
	(6.265)	(6.269)	(6.223)	(6.234)
Price to Book Ratio	-0.0441	-0.0406	-0.0414	-0.0285
	(0.0446)	(0.0418)	(0.0441)	(0.0407)
Ln Market Capitalization	4.8507***	4.6997***	4.8987***	4.7745***
	(1.625)	(1.614)	(1.627)	(1.626)
CSR_Training	-1.8834	-2.1104*	-1.8465	-2.1589*
	(1.5277)	(1.5340)	(1.5254)	(1.5671)
CSR_Committee	0.6681	0.6823	0.5974	0.6735
	(1.5207)	(1.5227)	(1.5263)	(1.5287)
Observations	4865	4865	4865	4865
Joint test on regressors	4.9120***	5.5544***	4.6181***	5.6038***
Robust test for different intercepts	3.2506***	3.4591***	3.8798***	3.8709***
Wald joint test on time dummies	59.7681***	65.5094***	64.7112***	56.4099***
Hausmann test	18.7537***	20.3597***	18.7491***	27.342***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 16b: Robustness check 3 – With additional control variables – CSR variables (ROE)

Dependent Variable	ROE			
	(1)	(2)	(3)	(4)
Constant	-26.3746*	-34.0656*	-29.2943*	33.1468
	(18.3578)	(20.7435)	(19.1119)	(177.1548)
Biodiversity Score (1)	-0.7554*			
	(0.5500)			
Biodiversity Exposure Score (2)		0.8131		
		(0.7140)		
Biodiversity Manag. Score (3)			-0.1627	
			(0.6603)	
Biodiversity Weight (4)				-0.0559
				(0.3048)
Ln Total Assets	2.4294	2.4084	2.7879	21.3734
	(8.4867)	(8.4461)	(8.5425)	(21.3129)
Ln Total Liabilities	-11.4027**	-11.4369**	-11.6439**	-41.5863***
	(6.7943)	(6.7697)	(6.8308)	(15.75)
Price to Book Ratio	-0.5613*	-0.5462*	-0.5476*	-0.7306**
	(0.3631)	(0.3665)	(0.3640)	(0.3360)
Ln Market Capitalization	12.9909***	13.0552***	13.0501***	15.1829***
	(2.374)	(2.356)	(2.387)	(3.710)
CSR_Training	0.6298	0.2472	0.6724	-6.9121**
	(3.1469)	(3.3005)	(3.1148)	(3.4478)
CSR_Committee	-1.2698	-1.6403	-1.2800	4.2368
	(3.3813)	(3.3054)	(3.3645)	(4.1230)
Observations	4865	4865	4865	4865
Joint test on regressors	52.3733***	52.8825***	50.891***	5.9121***
Robust test for different intercepts	157.042***	157.232***	157.871***	5.4255***
Wald joint test on time dummies	59.1737***	63.9721***	61.506***	43.7649***
Hausmann test	10.7094	11.1712	12.0376*	14.7369***
Estimation	RE	RE	RE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 17a: Robustness check 3 – With additional control variables – reputation variables (ROA)

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	51.6925	47.6563	52.5315	45.7793
	(71.5028)	(72.4470)	(72.0964)	(72.8268)
Biodiversity Score (1)	-0.1261			
	(0.2876)			
Biodiversity Exposure Score (2)		0.8899**		
		(0.4326)		
Biodiversity Manag. Score (3)			-0.3852	
			(0.4271)	
Biodiversity Weight (4)				0.1513
				(0.1327)
Ln Total Assets	41.8787***	42.2933***	41.4375***	42.7021***
	(11.75)	(11.58)	(11.4)	(11.72)
Ln Total Liabilities	-54.5660***	-54.8169***	-54.2116***	-54.7535***
	(15.41)	(15.24)	(15.14)	(15.26)
Price to Book Ratio	-0.0424	-0.0334	-0.0459	-0.0367
	(0.0627)	(0.0642)	(0.0616)	(0.0673)
Ln Market Capitalization	4.8078**	4.2328*	4.9021**	4.4427*
	(2.9020)	(2.9055)	(2.9190)	(2.9542)
News heat	3.9549*	3.6001*	4.1345*	3.7594*
	(2.7985)	(2.7900)	(2.8361)	(2.7691)
Analyst recommendations	-1.9600*	-1.6480	-2.0247*	-1.8694
	(1.5226)	(1.5158)	(1.5137)	(1.5293)
ESG_News_Positive	-1.4296**	-1.3613**	-1.4265**	-1.5303**
	(0.7142)	(0.7609)	(0.6956)	(0.7416)
ESG_News_Negative	-1.4799***	-1.4787***	-1.4861***	-1.5117***
	(0.578)	(0.574)	(0.572)	(0.58)
Observations	4865	4865	4865	4865
Joint test on regressors	2.9939***	3.3571***	2.9430***	2.8874***
Robust test for different intercepts	9.9285***	7.6861***	14.3154***	7.9476***
Wald joint test on time dummies	27.0492***	29.569***	27.1094***	21.4972***
Hausmann test	23.8103***	24.6057***	24.97***	24.767***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 17b: Robustness check 3 – With additional control variables – reputation variables (ROE)

Dependent Variable	ROE			
	(1)	(2)	(3)	(4)
Constant	345.5815	338.0946	347.0917	346.1802
	(287.6809)	(291.2565)	(290.2967)	(292.1797)
Biodiversity Score (1)	-0.6185			
	(0.9900)			
Biodiversity Exposure Score (2)		0.7469		
		(1.3699)		
Biodiversity Manag. Score (3)			-1.3482	
			(1.3179)	
Biodiversity Weight (4)				-0.1714
				(0.4946)
Ln Total Assets	69.1216**	70.6409***	67.9823**	69.9280***
	(30.140)	(29.44)	(29.8)	(29.96)
Ln Total Liabilities	-125.676***	-126.798***	-124.750***	-126.816***
	(47.98)	(47.21)	(47.31)	(47.21)
Price to Book Ratio	-1.1145***	-1.1038***	-1.1255***	-1.1165***
	(0.324)	(0.327)	(0.318)	(0.318)
Ln Market Capitalization	10.1965	9.8001	10.5565	10.7382
	(9.8018)	(9.7968)	(9.8353)	(9.9545)
News heat	9.5713	9.1334	10.1515	9.5847
	(8.5196)	(8.5630)	(8.5679)	(8.4798)
Analyst recommendations	1.2680	1.4534	1.0152	1.0519
	(3.7820)	(3.7959)	(3.7071)	(3.7862)
ESG_News_Positive	-1.9463	-2.0000	-1.9737	-1.9971
	(2.4086)	(2.4046)	(2.3256)	(2.4260)
ESG_News_Negative	-3.5626**	-3.5805**	-3.5910**	-3.5547**
	(1.7011)	(1.7120)	(1.6765)	(1.7281)
Observations	4865	4865	4865	4865
Joint test on regressors	6.2217***	5.4319***	6.2822***	6.3329***
Robust test for different intercepts	26.6781***	245.548***	21.6072***	74.069***
Wald joint test on time dummies	17.6706***	17.7604***	17.4929***	12.0281**
Hausmann test	18.8023**	18.7758**	17.7722**	20.6118**
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 18a: Robustness check 3 – With additional control variables – governance variables (ROA)

Dependent Variable	ROA			
	(1)	(2)	(3)	(4)
Constant	-37.4302	-39.7405	-32.0344	-56.3949*
	(41.4227)	(43.8486)	(41.6455)	(42.3618)
Biodiversity Score (1)	0.4466	-	-	-
	(0.3736)			
Biodiversity Exposure Score (2)	-	2.0288***	-	-
		(0.773)		
Biodiversity Manag. Score (3)	-	-	0.8817***	-
			(0.345)	
Biodiversity Weight (4)	-	-	-	0.4542***
				(0.185)
Ln Total Assets	17.4556*	18.7028*	17.5574*	19.6210*
	(11.9106)	(12.8722)	(11.8705)	(12.3721)
Ln Total Liabilities	-21.7962**	-23.6291**	-22.2287**	-22.3059**
	(10.58)	(11.647)	(10.53)	(10.811)
Price to Book Ratio	0.0050	-0.0332	0.0041	0.0003
	(0.0502)	(0.0422)	(0.0506)	(0.0503)
Ln Market Capitalization	4.4913**	3.9998*	4.4217**	4.1570*
	(2.6468)	(2.4998)	(2.6038)	(2.6148)
Women_Board	0.0361	0.0797	0.0256	0.0673
	(0.0902)	(0.0846)	(0.0891)	(0.0832)
Women_Management	0.1840*	0.1981*	0.1779	0.1874*
	(0.1370)	(0.1342)	(0.1409)	(0.1414)
Women_Employees	-0.4022**	-0.3189**	-0.4463***	-0.5155***
	(0.1793)	(0.1664)	(0.183)	(0.215)
Duality_Chair_CEO	0.3148	0.9096	0.4719	-0.4805
	(1.8261)	(1.9334)	(1.9924)	(1.9105)
Board_Age	0.5415	0.4674	0.5022	0.6072*
	(0.4225)	(0.4103)	(0.4248)	(0.4161)
Insider_Holdings	-0.1497**	-0.1559**	-0.1473**	-0.1471**
	(0.0712)	(0.0703)	(0.0718)	(0.0780)
Institional_Holdings	0.0001	0.0001	0.0001	-0.0000
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Observations	4865	4865	4865	4865
Joint test on regressors	4.7988***	4.9970***	5.2640***	4.4553***
Robust test for different intercepts	3.7230***	4.4964***	3.7228***	3.7788***
Wald joint test on time dummies	9.3853**	10.6181***	9.7283***	10.8311***
Hausmann test	39.2507***	29.8234***	36.7163***	36.5405***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Assets (ROA)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Table 18b: Robustness check 3 – With additional control variables – governance variables (ROE)

Dependent Variable	ROE			
	(1)	(2)	(3)	(4)
Constant	-124.3574	-124.5091	-114.7674	-143.4046*
	(105.5274)	(111.5461)	(107.5103)	(107.682)
Biodiversity Score (1)	0.8470	-	-	-
	(0.8768)			
Biodiversity Exposure Score (2)	-	2.4575	-	-
		(2.0170)		
Biodiversity Manag. Score (3)	-	-	1.3426*	-
			(0.8775)	
Biodiversity Weight (4)	-	-	-	0.5320
				(0.4187)
Ln Total Assets	10.1476	11.5808	10.2570	12.6230
	(27.6467)	(28.9056)	(27.7026)	(28.7956)
Ln Total Liabilities	-26.7876	-28.9918	-27.4475	-27.3044
	(23.5142)	(24.9004)	(23.6345)	(24.0143)
Price to Book Ratio	-1.4147***	-1.4701***	-1.4211***	-1.4294***
	(0.114)	(0.101)	(0.11)	(0.107)
Ln Market Capitalization	19.5988***	18.9052***	19.4466***	19.0572***
	(4.99)	(4.891)	(4.975)	(5.052)
Women_Board	0.1905	0.2603	0.1830	0.2499
	(0.2317)	(0.2229)	(0.2262)	(0.2174)
Women_Management	0.1491	0.1623	0.1385	0.1437
	(0.4882)	(0.4688)	(0.4901)	(0.4830)
Women_Employees	-1.2612***	-1.1253***	-1.3089***	-1.3597***
	(0.459)	(0.418)	(0.462)	(0.505)
Duality_Chair_CEO	-3.0279	-2.5044	-2.8646	-4.3651
	(3.4968)	(3.7514)	(3.6734)	(3.9704)
Board_Age	2.0514**	1.9439**	1.9836**	2.0989**
	(1.0683)	(1.0737)	(1.0814)	(1.0593)
Insider_Holdings	-0.4350**	-0.4353**	-0.4290**	-0.4144*
	(0.2468)	(0.2375)	(0.2479)	(0.2573)
Institional_Holdings	0.0003	0.0003	0.0003	0.0002
	(0.0007)	(0.0007)	(0.0007)	(0.0006)
Observations	4865	4865	4865	4865
Joint test on regressors	41.6533***	37.0928***	39.9775***	43.9137***
Robust test for different intercepts	4.1730***	4.3443***	3.8964***	3.985***
Wald joint test on time dummies	11.3592***	11.7892***	11.5896***	11.3702***
Hausmann test	47.8212***	43.7961***	42.1526***	43.4727***
Estimation	FE	FE	FE	FE

Notes: Panel regression. We choose the best model according to the Hausmann test results. If the Hausman test rejects the null hypothesis it means that the best model is the standard Fixed-Effects model, on the contrary, if the Hausmann test does not reject the null hypothesis, the best model is the Random-Effects. The joint test on regressors tests the relevance of the regressors employed (F test) considering a null hypothesis that all the regressors are zero. The robust test for different intercepts tests the poolability of the model and the Wald test on time dummies investigates if there is a time effect on the panel. The dependent variable is the *Return On Equity (ROE)* while the main variables of interest are linked to the biodiversity score. *, **, *** mean p-value lower than 1%, 5%, 10% respectively.

Overall, the results in Tables 16, 17, and 18, show that the biodiversity score has a negative effect while the biodiversity risk exposure score has a positive effect on firm financial performance. Therefore, we conclude that our main finding is robust when including additional control variable in the baseline model.

VII. Conclusion

This research has investigated the effect of biodiversity management and risk exposure of firms on its financial and ESG performance. Our data sample covers 973 firms in different countries over the 2018-2022 period. The biodiversity management and risk exposure of firms are measured by MSCI biodiversity scores. Using panel data regressions, our results show that the biodiversity score has a negative effect on firm financial performance. However, the biodiversity risk exposure score has a positive effect on firm financial performance. In addition, the effect of biodiversity scores is different on the E, S, and G components of the ESG scores, especially there is no effect on the G pillar. Therefore, there is a disconnection between biodiversity scores and governance scores. Furthermore, the effect of biodiversity scores on the Bloomberg ESG disclosure scores is totally different from those with MSCI ESG scores. Corporate leverage and reputation have a moderating effect on the relationship between biodiversity scores and financial performance. In addition, there is no lagged effect from biodiversity scores to firms' financial performance. Finally, being a firm in the US has a reducing moderating effect on the impact of biodiversity scores on financial performance.

These research results imply that firms' engagement in biodiversity protection and risk management is costly and reduce its financial performance. However, this engagement helps firm improve its ESG performance measured by MSCI. In the meanwhile, we learn from this research that firms' exposure to biodiversity risks may also mean firms' dependance on biodiversity in its activities. In turn, this dependance on biodiversity helps firm improve its financial performance. This result makes us recommend that firms with a higher dependance on biodiversity should make higher efforts in its protection as this in turn helps them improve their financial performance. Another important result from our research is that there is a disconnection between governance score and biodiversity score. We therefore recommend including new governance metrics about the consideration of biodiversity protection and risk management by the governance body of firms. Finally, US firms and investors may less consider biodiversity issue than those in other countries as being in the US has a negative moderating effect on the relationship between biodiversity and financial performance. Our results also show that firms' reputation and leverage can have a moderating effect on the

relationship between biodiversity scores and financial performance. Therefore, we recommend that firms should care about its reputation in newspapers. We also recommend that firms should consider biodiversity issues when making capital structure decisions as they can influence the relationship between biodiversity scores and financial performance.

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