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Common factors behind companies' Environmental ratings

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ABSTRACT

The increasing interest in sustainability within economics and finance has led to the widespread adoption of Environmental, Social, and Governance (ESG) metrics, expressed as ratings or indices, to assess the sustainable performance of companies. However, inconsistencies among data providers stem not only from definitional differences but also from disagreements on how to measure ESG factors. This paper proposes a novel approach by conversely focusing on ESG factors common to data providers. Through three empirical approaches – correlation analysis, principal component analysis, and panel data regressions – we aim to understand the shared components shaping common ESG metrics, particularly in the Environmental Pillar. Our findings emphasize a limited number of indicators that act as common factors across three providers, primarily concerning managing natural resources. This commonality emerges despite the different perspectives adopted by the rating agencies — such as risk management, corporate impact management, and integration into corporate strategy. This analysis offers valuable insights for companies, financial institutions, practitioners, scholars, and policymakers, enabling more concise information for analyses and decision-making in their respective fields.

1. Introduction

Environmental, Social, and Governance (ESG) criteria have become increasingly important in the global financial landscape, reflecting a growing awareness of sustainability issues among investors, companies, and policymakers. This phenomenon takes on many different forms, including ESG commercial product offerings (Amel-Zadeh & Serafeim, 2018), policy discourse (Lei & Yu, 2024), and investment strategies (e.g., Giese, Lee, Melas, Nagy, & Nishikawa, 2019; Halbritter & Dorfleitner, 2015). In this context, the past decade experienced a remarkable surge in sustainable investments. According to the Global Sustainable Investment Alliance's (GSIA) 2022 report, global ESG assets under management (AuM) significantly increased from $22.8 trillion to $30.3 trillion between 2016 and 2022. Moreover, Bloomberg, based on GSIA's analysis, predicts up to $40 trillion AuM by 2030[1], underlining the ongoing transformative shift in investment preferences towards more socially and environmentally responsible practices. Remarkably, this growth trajectory has proven resilient even in the face of the challenges posed by the global COVID-19 pandemic, as evidenced by the migration of investment flows towards ESG portfolios (Singh, 2020), albeit without relevant improvements in stock returns (Demers, Hendrikse, Joos, & Lev, 2021). Looking at recent sustainable fund flows, some divergence in behavior across countries also emerges, with Europe showing growth in net flows, while the US exhibited negative net flows between Q2 2022 and Q4 2023, according to Morningstar.[2]

These insights underscore the complex and somewhat heterogeneous growth trajectory of sustainable investments, which may be affected by the uncertainties related to the lack of a single definition of ESG, as well as the different attempts of policymakers across countries to promote ESG investments with the European Union (EU) serving as the primary actor of this shift (Matos, 2020). The multifaceted nature of the ESG concept underscores the crucial role of rating agencies in mitigating information asymmetries between investors and companies regarding corporate sustainability (Cui, Jo, & Na, 2018; Kim & Park, 2023). These agencies assess the ESG performance, in the aggregate or by the 'E', S', or 'G' pillars, by producing ratings or indices based on a specific methodology. Despite their crucial role, the production of ESG ratings is subject to challenges, including disagreements and inconsistencies across ESG rating agencies highlighted in the existing literature

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[1] https://www.bloomberg.com/professional/insights/trading/esg-aum-set-to-top-40-trillion-by-2030-anchor-capital-markets/

[2] https://www.morningstar.com/business/insights/blog/funds/global-sustainable-fund-flows-monthly-data?con=14721

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(see, among others, Berg, Koelbel, & Rigobon, 2022; Billio, Costola, Hristova, Latino, & Pelizzon, 2021; Bissoondoyal-Bheenick, Bennett, Lehnherr, & Zhong, 2024; Chatterji, Durand, Levine, & Touboul, 2016; Christensen, Serafeim, & Sikochi, 2022).

Inconsistencies across ESG rating agencies are not only an issue of definitions. At least two other reasons can lead rating providers to score the same company differently. First, rating providers may disagree on how to measure the same ESG factor, as there is no universally accepted approach to measuring non-financial indicators. Rating agencies employ hundreds of ESG-related variables. Some come from company reports and regulatory filings and should be consistent across agencies. Yet many others come through interviews, questionnaires, and third-party independent reports with potentially conflicting approaches. Second, even if agencies agree on measuring different ESG-related factors, each ESG agency has developed its own methodology to decide what ESG-related indicators to consider and how to aggregate them into an overall score.

In response to these challenges, policymakers have launched various initiatives, particularly in the EU. These initiatives have culminated in establishing policy frameworks such as the 2020 'EU Taxonomy for Sustainable Activities'.[3] This classification system establishes criteria for economic activities that are consistent with achieving net zero emissions by 2050, thereby serving as an essential market transparency tool that should direct investments towards the most critical economic activities for the transition, in line with the objectives of the European Green Deal. Additionally, with the same broad purpose of increasing transparency and reducing greenwashing and information asymmetries between investors, financial institutions, and companies, the EU has recently launched a regulatory framework for ESG ratings,[4] the 'ESG Rating Provider Regulation', which aims to enhance the reliability and comparability of ESG ratings, while also guaranteeing those rating providers integrate the appropriate ESG risks into the credit ratings. All these regulatory measures, ongoing policy objectives, and collective wisdom appear to have a tangible influence on ESG-related activities, as evidenced by the EU's continued dominance in ESG investment relative to the US and the rest of the world.

However, the road to ESG convergence remains complex and lengthy. The regulatory framework on ESG ratings adopted so far by the EU takes a *'laissez-faire'* approach, allowing providers to construct ratings as long as they adhere to transparent communication standards regarding their methodologies. Moreover, other countries are not following a similar path by avoiding the introduction of specific frameworks that ESG rating providers must adhere to continue their operations. In such a heterogeneous context, it is clear that to optimize the performance of their ESG ratings, firms need to align themselves with common elements across different rating providers. In other words, companies may be interested in tactically targeting the elements common to the ratings produced by various agencies to score higher on a larger number of ESG rankings. Thus, there is an urgent need to understand the common factors underlying different rating methodologies.

In light of these considerations, this paper takes a novel position compared to previous works that focused on assessing to what extent sustainability ratings providers disagree with their companies' assessments. Rather than highlighting divergences, we explore commonalities within ESG metrics, with a particular focus on the Environmental pillar. This pillar is most directly aligned with broad and widely recognized international policy objectives, such as the Paris Agreement and subsequent initiatives like the EU Taxonomy for Sustainable Activities and the Fit for 55 package. This level of policy focus is not as evident for the Social and Governance pillars. For instance, while the EU taxonomy strongly emphasizes climate change mitigation and adaptation, technical criteria for the Social and Governance pillars are still being established. Moreover, empirical evidence suggests that the development of financial instruments and investors' attention is more overwhelmingly related to environmental and green factors. For example, the issuance of green bonds accounts for about 60 percent of total Green, Social and Sustainable Bonds, while Social Bonds less than 20 percent (Mishra, Kumar, & Rout, 2023; World Bank, 2024).

While recognizing the importance of studying divergence, our approach seeks to complement this by uncovering shared factors that preserve the utility of ESG ratings. This focus addresses a key gap in the literature: understanding how rating agencies interpret environmental factors and identifying patterns that could enhance the transparency and comparability of ESG assessments. By bridging the gap between disagreement-focused studies and practical applications, we provide a framework for more consistent evaluations of environmental risks.

Empirically, our approach examines whether Environmental metrics can be modeled using a small set of reference variables, referred to as *'common factor candidates'*. We further investigate whether these variables are comparable across different data providers, and refer to them as *'actual common factors'*. These common factors represent shared criteria that emerge from the data and offer insights into the environmental elements consistently considered by rating agencies. Unlike structural models or forecasting techniques, our methodology directly identifies commonalities in the data, aiming to improve transparency and comparability in ESG ratings while revealing the environmental factors consistently emphasized by agencies, despite their different methodologies.

While the common factors we identify may not fully capture the true measure of environmental risk and may reflect some shared biases among the raters, they still represent what the agencies consider relevant. This is important because, although these ratings may not perfectly measure environmental sustainability, they are relied upon by investors, financial institutions, and firms to make decisions and assess risk related to sustainable practices and investments, even in the presence of potential biases. Moreover, by identifying these commonalities, the study enhances the transparency and comparability of Environmental ratings, which is a key challenge in the current heterogeneous ESG rating landscape, helping stakeholders manage the complexity of ratings and improving the integration of environmental risks into investment decisions. Ultimately, the findings contribute to the ongoing development of more consistent and reliable ESG ratings, benefiting both academic research and practical applications in sustainable finance.

To conduct this analysis, we employ a three-step approach. Firstly, we construct a unique dataset by merging information from three relevant data providers (MSCI, Moody's, and FactSet). Our database includes details about the Environmental ratings and their corresponding sub-scores from these providers for over 5,000 publicly traded companies observed globally between 2012 and 2022. Next, we examine the relationship between the Environmental sub-scores from different providers to identify a pool of variables that could represent common environmental factors. To achieve this, we perform three distinct types of alternative analyses – pairwise correlation analysis, Principal Component Analysis (PCA), and a set of OLS panel fixed effect regressions – allowing us to identify the 'common factor candidates' through a set of significant relationships (of statistical or econometric nature) among the Environmental sub-scores. Finally, we focus our analysis on these candidate factors common among the providers, and we perform additional OLS panel fixed effects regressions, using them alternatively as dependent and independent variables in a wide range of regressions. In this way, we can select the 'actual common factors' among the E sub-scores that act as common factors within the 'common factor candidates'.

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020R0852

[4] https://data.consilium.europa.eu/doc/document/ST-6255-2024-INIT/en/pdf

Our empirical analysis reveals that, despite a certain level of divergence in E scores among different providers consistent with previous works, there is a (limited) number of indicators that contribute to forming a common factor across three ESG providers. This factor seems to be primarily related to the management of natural resources. Although the indicators share a common thematic focus, they are interpreted through diverse lenses, including perspectives on risk management, corporate impact management, and integration into corporate strategy, based on the diverse goals and scopes of the three ESG agencies.

Since ESG raters may use different approaches to assess companies in distinct geographies and industries, we test the validity of our baseline findings by testing whether they are robust to the exclusion of a single country or sector at a time in more than 700 different experiments. We find that more than 99% of the time, the emerging candidate common factors are the same as the baseline ones. Last, we also explore the potential differential commonalities across ESG raters when focusing on companies operating in 'environmentally friendly' industries, those more engaged in the adaptation to or mitigation of environmental risks and opportunities, which may share characteristics inherently different from those of the generality of companies. We find that, while the number of common factors remains more or less the same when we focus only on environmentally sustainable sectors, the number of cases in which this relationship is stably positive and significant increases when we focus only on more quantitative variables (e.g., involving natural resources or environmental impacts). This finding could be motivated by the fact that ESG agencies use less questionable indicators when assessing the E of green companies since environmental sustainability is a primary area of interest evaluated by financial institutions, banks, and investors precisely for companies operating in such 'environmentally sustainable' sectors.

Our findings offer valuable insights for companies, financial institutions, banks, practitioners, scholars, and policymakers since they present a more streamlined set of information that can enhance analyses and decision-making within their specific domains. In particular, rated companies may strategically enhance their market position and attract sustainable investment by aligning themselves with common environmental factors across rating agencies, with a specific focus on quantitative factors that are less susceptible to greenwashing concerns; financial institutions can optimize their ESG integration processes and direct investments more effectively to 'consistently sustainable' companies that perform well on common E factors; and policymakers should continue to play their crucial role in promoting transparency and standardization of ESG ratings to advance sustainable finance globally.

Overall, this paper tackles the challenge of inconsistencies in ESG ratings by identifying commonalities within the Environmental pillar across major providers. By focusing on shared criteria aligned with global policies like the Paris Agreement, it offers a novel framework to improve the comprehension and usability of sustainability ratings. This approach supports global sustainability efforts by enhancing the transparency and comparability of ESG evaluations, which is crucial for attracting private capital and complementing public resources to achieve the Sustainable Development Goals (SDGs) within the 2030 Agenda for Sustainable Development.

The remainder of this paper is organized as follows. Section 2 reviews the literature on ESG ratings and their role in sustainable finance. Section 3 describes the data involved in the empirical strategy presented in Section 4. Section 5 shows the results of the empirical analysis to define the 'common factor candidates' and the identification of 'actual common factors'. Section 6 provides the robustness tests, while Section 7 explores the heterogeneous behavior of ESG agencies in assessing companies operating in 'environmentally sustainable' sectors. Finally, Section 8 concludes and proposes some policy implications.

2. Literature review

The current discourse surrounding Corporate Social Responsibility (CSR) and ESG topics has garnered significant attention within the economic and financial literature. This discourse encompasses a range of research avenues that are relevant to our investigation. In broader terms, scholarly inquiry aims to elucidate the influence of adopting CSR and ESG practices on a company's value (Flammer, Hong, & Minor, 2019; Zhou, Liu, & Luo, 2022), risk profile (Giese et al., 2019), corporate debt (Asimakopoulos, Asimakopoulos, & Li, 2023), cost of equity (Ng & Rezaee, 2015), and the attraction of sustainable investments (Botsari & Lang, 2020) among others.

The historical evolution of the CSR concept finds its roots in the mid-20th century, with seminal contributions by Carroll (1999, 2008) chronicling its progression. A pivotal turning point occurred in 2015 with the United Nations' unveiling of the 2030 Agenda, comprising 17 SDGs. These SDGs have substantially shaped the trajectory of ESG considerations in corporate and investor strategies. Notably, the notion of circular economy finance has gained traction, driven by heightened demand for sustainable finance solutions. Schröder and Raes (2021) note the escalating prevalence of ESG investment, attributed in part to the contributions of major asset management and investment banking entities. However, this trend is paralleled by the observation that SDGs aligned with the circular economy domain remain underfunded, with financial support primarily directed towards waste management and recycling initiatives in high-income settings. Manifesting this trend further, Lioui and Tarelli (2022) reveals a discernible surge in ESG-related investments on a global scale, evidenced by substantial annual increments. This trajectory culminated in a remarkable escalation, surpassing projected levels by a significant margin in 2020.

A distinct but related strand of research by Loew, Erichsen, Liang, and Postulka (2021) looks at the disclosure of CSR within European banks during 2017–2019, analyzing the efficacy of regulatory mechanisms like the Non-Financial Reporting Directive and the EU Taxonomy Regulation. This examination culminates in a comprehensive assessment of the quality and development of CSR disclosure, underscoring the multidimensional nature of data collection in this context. For instance, Brühl (2021) report examines the prevailing European green finance framework, highlighting the pivotal role of financial industry regulations in facilitating sustainable investment under the EU Green Deal. Similarly, Campiglio, Dafermos, and Monnin (2018) indicate that having a clear methodology for assessing environmental risk could support central banks in their sustainability disclosure. Noteworthy, regulatory initiatives such as the EU Taxonomy regulation and disclosure frameworks for corporate and financial institutions have noticeably enhanced the overarching regulatory landscape for sustainable finance.

To foster the growth of a robust and liquid green financial market, one of the pivotal risks demanding attention is that of Greenwashing. This practice is the concern that underpins regulation, while the financial literature deals extensively with the complex and multidisciplinary nature of this phenomenon. Falcão, Bezerra, da Luz, et al. (2020) and Yang, Nguyen, Nguyen, Nguyen, and Cao (2020) conduct systematic analyses and comprehensive reviews of the core concepts and typologies characterizing greenwashing over the past decade.

The surge in sustainable investment demand and the risk of greenwashing has triggered a proliferation of ESG rating agencies, which play a crucial role in assessing companies' commitment to ESG policies and their impact. These ratings offer investors credible insights into their chosen institutions. A key concern explored in the literature pertains to variations in rating values, potentially affecting stock prices and creating uncertainty among financial practitioners, thereby influencing investment decisions. Empirical studies have consistently highlighted that these divergences arise due to methodological differences, significantly impacting the performance of ESG factors. Hartzmark and

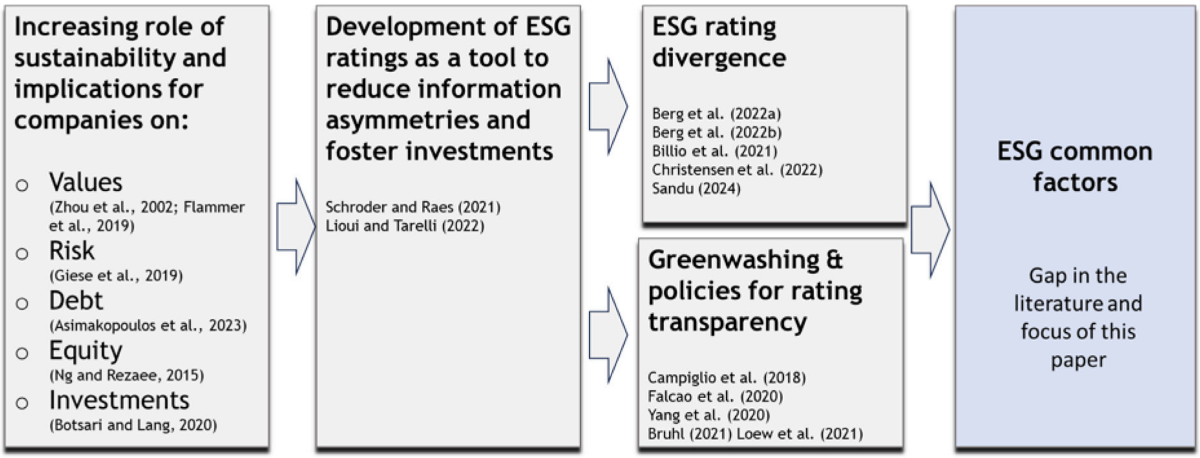

Fig. 1. This figure summarizes the literature and research gap motivating this research.

Sussman (2019) identify a positive correlation between fund allocations and highly rated ESG funds, which reverses for poorly rated ones. Gibson Brandon, Krueger, and Schmidt (2021) scrutinize ESG ratings for S&P 500 firms, noting positive correlations between stock returns and ESG rating discrepancies, particularly in environmental aspects. Yoon and Serafeim (2020) demonstrate the predictive power of consensus ESG ratings for future news and market reactions. Lioui and Tarelli (2022) compare ESG factor construction methodologies, underlining the need for methodological and dataset considerations. Christensen et al. (2022) find that greater ESG disclosure intensifies rating discrepancies, particularly for outcome metrics. Li, Zhang, & Li, 2024 highlight that the disagreement over ESG ratings reduces business innovation by reinforcing firms' financing constraints and reducing their human capital. Moreover, implications of disagreement on stock returns (Gibson Brandon et al., 2021) and ESG portfolio performance (Billio et al., 2021; Sandu, 2024) are also found relevant.

Rating agencies typically assess ESG engagement through methodologies that aggregate indicators into a performance score or a rating. However, disagreements in ESG ratings for the same companies across providers are prevalent. Tang, Yan, and Yao (2022) show that MSCI assigns higher scores to firms connected through institutional ownership. Despite concerns about reliability, many investment professionals use ESG data. Berg, Koelbel, Pavlova, and Rigobon (2022) uncover repeated historical ESG score changes by Refinitiv ESG. Bissoondoyal-Bheenick et al., 2024 highlight a systematic divergence between ESG scores across raters, although the degree of divergence depends on the databases being compared. Chatterji et al. (2016) highlight the absence of a common CSR theorization and commensurability as sources of disagreement. Berg, Koelbel, and Rigobon (2022) examine the reasons behind divergence, attributing it to measurement, scope, and weight disparities, with measurement emerging as the most influential driver. Christensen et al. (2022) connect disclosure to rating divergence, finding that more disclosure heightens discrepancies.

The rise of ESG rating agencies and ensuing divergence in ratings have profound implications for investment decision-making, with methodological disparities being a primary catalyst. At the same time, understanding the drivers of the ESG converging and common factors – the scope of this work – is vital for informed investment choices and improved rating reliability. A graphical representation of the literature underlying and motivating our research is displayed in Fig. 1.

3. Data

In this Section, we introduce the data used in our analysis. First, we provide an overview of the sources of the ESG scores. Then, we focus on the Environmental scores data involved and describe the scopes of the environmental ratings by data providers.

3.1. Sources

The evolution of ESG ratings has seen significant progress across academics, professionals, and more. Initially designed for investor insight into sustainability, these ratings are now pivotal across different subjects, including scholars, practitioners, and policymakers. Academics leverage them to connect company behavior with financial results. In professional spheres, ESG guides investment choices, aiding ethical portfolio integration. Corporations adopt these ratings as benchmarks, fostering transparency and responsibility. Governments and regulators recognize their role in promoting ethical business. As ESG awareness expands, these ratings will further diversify applications, fostering a sustainable global corporate environment.

Although the ESG theme wields extensive influence across various fields, a single coherent definition of this concept remains elusive, primarily due to a few interrelated yet non-exclusive reasons: (i) the potential for divergent interpretations of the underlying ESG concepts, (ii) the ability to associate diverse indicators with the foundational ESG concepts when appraising business performance, and (iii) its multifaceted nature, primarily anchored in the three pillars of environmental, social, and governance considerations. This lack of precise definitions underscores the importance of comprehending how raw data are processed (i.e., normalized) to facilitate aggregation, determining the most suitable weighting system (e.g., deciding whether some indicators should take precedence over others), and deliberating on whether to adopt compensatory or non-compensatory forms of aggregation. As a result, the diverse providers of ESG ratings might yield heterogeneous final outputs due to the varying structures of ratings, underlying indicators, and the distinct methodologies employed in constructing the ratings.

Constructing an extensive dataset gathered from various sources is essential for inquiring and recognizing common factors in ESG rating systems. With this perspective, our consideration has gravitated towards three commercial databases, among the most widely used and adopted: MSCI, Moody's, and FactSet.[5] MSCI offers its 'MSCI-ESG Scores' service, which provides ESG rating information for a global cohort of approximately 14,000 issuers since 2007. Moody's provides a dedicated service called 'DataLab' offering ESG rating information for more than 5,000 globally listed companies since 2005. Lastly, FactSet's 'TruValue' service emerges as a conduit that provides ESG ratings on a

[5] MSCI and Moody's are included in the latest investor surveys, 'Rate the Raters', conducted by the SustainAbility Institute, spanning the years 2019, 2020, and 2023. FactSet's Truvalue has been utilized in studies examining the convergence of ESG ratings (e.g., Capizzi, Gioia, Giudici, & Tenca, 2021 and Berg, Koelbel, & Rigobon, 2022).

Table 1
ESG rating tree data structure of Factset, Moody's, and MSCI. For each data provider, the table reports the number of levels of the structure of the ESG dataset. The table also shows if the root node (level 1) and the parent nodes (level 2) are available. The total number of ESG indicators across the levels and their scale of measurement are reported.

Data provider	Nr. of Levels	ESG score (level 1)	E, S, G pillars (level 2)	Nr. of ESG Indicators	Scale
FactSet (FS)	3	Yes	No	37	0–100
Moody's (MO)	5	Yes	Yes	64	0–100
MSCI (MS)	4	Yes	Yes	47	0–10

comprehensive sample of around 230,000 worldwide enterprises since 2007. For each provider, we have access to the overall ESG ratings, the scores for the three pillars (E, S, and G), all underlying sub-scores down to the lowest and most granular level of analysis, and documentation detailing the process for combining the ratings and the measurement methodologies for the underlying factors.

As will become more evident in Section 3.3, we have chosen these databases precisely because they have *ex-ante* different scopes, characteristics, and philosophies in assessing ESG factors.

3.2. E-scores data

The joint dataset used in this study results from merging information provided by the three providers mentioned above. Since they organize their databases independently and distinctly, we follow the procedure in Christensen et al. (2022).[6]

Although they serve a similar purpose, the three databases provide ESG ratings using notably distinct frameworks. Table 1 synthetically presents these differences. A primary one lies in the 'depth' of the database, which refers to the granularity of raw data underlying the ESG ratings provided by each provider, as well as the abundance of indicators at each level.

In this context, MSCI employs four levels of detail: (i) the ESG Intangible Value Assessment (IVA) indicator, which synthesizes the three ESG pillars into a single composite indicator; (ii) the three pillars — encompassing Environmental, Social, and Governance; (iii) the ten underlying theme scores for each pillar (e.g., Climate Change for E, Product Liability for S, Corporate Behavior for G); (iv) the 33 key issues underlying each theme score (e.g., Carbon Emissions for Climate Change, Labor Management for Product Liability, Tax Transparency for Corporate Behavior). In total, MSCI offers 47 indicators.

On the other hand, Moody's comprises five levels of detail: (i) the Global Score indicator, providing a single value for the ESG concept; (ii) the three indicators for the pillars — Environmental, Social, and Governance; (iii) the six domains underlying the three pillars (e.g., Community Involvement Domain for S); (iv) the 17 criteria underlying the six domains (e.g., Management of the societal impact of companies for Community Involvement); (v) the 37 sub-criteria underlying the 17 criteria (e.g., Philanthropy for Management of the societal impact of companies). Overall, Moody's presents a total of 64 indicators.

Lastly, FactSet consists of three levels of detail: (i) the overall ESG indicator; (ii) 10 macro-categories addressing various ESG issues not explicitly categorized into E, S, and G (e.g., Social Capital); (iii) 26 categories related to the ten macro-categories (e.g., Customer Privacy in Social Capital). In sum, FactSet offers 37 distinct ESG indicators. Notably, the sub-scores exhibit heterogeneity across the databases, starting from the second level of detail. FactSet lacks an aggregate level for the environmental, social, and governance pillars. However, this level of information can be obtained as a weighted average of the underlying scores based on their scope.

The most relevant implication of the heterogeneous structure of ESG data across agencies is that the level of granularity shared by the three agencies is the third level of a hierarchy beginning with the definition of ESG, as reported in Column 2 of Table 1. Thus, Our analysis, therefore, focuses on the environmental factors shared at this level, rather than those at deeper levels, to avoid inconsistencies in the comparison.

A second – though minor – distinction pertains to the range of indicators. In the case of MSCI, the range spans from 0 (worst) to 10 (best), whereas for Moody's and FactSet, it ranges from 0 (worst) to 100 (best).

Table 2 presents the summary statistics for our merged dataset up to the first level of analysis, that is, the ESG score (level 1) and the E pillar (level 2). We observe that different agencies' mean aggregated ESG ratings are dissimilar. Specifically, when considering the different scales, Moody's has the lowest average score and lower standard deviation, while MSCI and FactSet show higher and closer average and standard deviation values. Similar considerations apply when comparing the medians. These differences provide the first motivation for investigating common factors across ratings and providers.[7]

As our information is organized in panel form, we also provide evidence of the evolution of each E-score's mean and standard deviation by year. We synthesize the distribution of observations by country and year (see Table A.2 in the Appendix), which also highlights the consistency of the percentage distribution of firms across countries over time. When we analyze the distribution of these values across years (see Table A.3 in Appendix), we find that these series are – broadly speaking – quite consistent over time, i.e., time variance should not emerge as a relevant factor to be taken into account in our empirical analyses.

3.3. Scope of the environmental ratings

Besides the structural and measurement differences in strategies, divergences between the ratings may also arise from the providers' varying measurement objectives in evaluating companies. In this regard, we observe distinct focuses among the three providers in measuring the level of environmental sustainability for assessed companies, encompassing both selected indicators and the overall focus of the analysis.

During the selection of underlying indicators, certain themes appear nominally common across all providers (e.g., the use of natural resources). In contrast, others are covered by only two databases (e.g., biodiversity is not explicitly addressed by FactSet) or a single database (e.g., access to finance managed solely by MSCI). Nevertheless, indicators present uniquely in one database may still be encompassed within the assessments of more general indicators from other databases that do not explicitly include the term in the name or description of the variable.

Regarding the broader scope of the assessment, MSCI focuses more on the implications for firms' ability to respond to risks and opportunities arising from environmental challenges. MSCI's Environmental score is based on three sub-indicators examining the response to risks related to climate change (e.g., an increase in CO2 emissions or product carbon footprint), the exploitation of natural resources (e.g., water shortages potentially impacting operations), and pollution and waste generation

[6] In Appendix A, we provide a detailed description of the construction of the merged dataset.

[7] Table A.1 in the Appendix includes a detailed description of each E sub-score from the three rating providers analyzed in this work.

Table 2
Summary Statistics. The table reports descriptive statistics of the ESG, E-scores, and E sub-scores for the three datasets involved in the analysis, i.e., Factset (FS), MSCI (MS), and Moody's (MO), calculated on the sub-sample of companies having joint non-missing information at the E score level.

	Observations	Mean	Std.Dev.	Min	Median	Max
FS ESG score	5,575	53.412	20.977	5.203	56.393	95.553
MO ESG score	5,575	40.331	11.282	8.000	39.000	77.000
MS ESG score	5,575	5.833	2.325	0.000	5.900	10.000
FS E-score	5,575	51.52 2	11.525	13.465	51.546	87.004
MO E-score	5,575	40.107	16.237	0.000	40.000	93.000
MS E-score	5,575	5.721	2.181	0.000	5.600	10.000
FS GHG Emissions	5,575	52.478	24.962	3.708	50.507	99.132
FS Air Quality	5,575	48.518	24.733	0.000	50.000	99.829
FS Energy Management	5,575	50.614	25.056	0.014	50.000	98.628
FS Water Waste	5,575	50.851	27.445	0.913	50.000	100.000
FS Hazardous Waste	5,575	54.376	26.616	0.477	50.000	100.000
FS Ecological Impact	5,575	52.296	27.634	1.194	50.000	100.000
MO Corporate Env. Strategy	5,575	48.372	19.620	0.000	48.000	100.000
MO Nat. Resources in production	5,562	36.436	16.905	0.000	36.000	94.000
MO Env. impacts of product use	2,829	33.641	21.465	0.000	32.000	100.000
MS Climate Change	5,539	7.349	2.675	0.000	8.000	10.000
MS Natural Resources	5,027	6.306	2.603	0.000	6.200	10.000
MS Waste Management	3,401	5,338	2.551	0.000	5.300	10.000
MS Environmental Opportunities	2,261	5.102	1.531	0.000	5.100	9.700

(e.g., potential liabilities associated with contamination and the emission of toxic and carcinogenic substances). It also includes one indicator related to business opportunities arising from areas like clean tech, green building, and the use of renewable energy. Moody's provides more details on how evaluated companies integrate environmental issues into their operations. It uses three indicators that, from a circular economy perspective, describe three different phases of business activity: the definition of strategy, the manufacturing and distribution of products, and the use and disposal of products and services. The domains observed in the environmental area, such as pollution prevention and control, attention to biodiversity, and the development of a line of green products and services, are somewhat considered throughout the company's entire decision-making and production chain. Lastly, FactSet appears to focus on how evaluated companies manage the impact of their operations on some of the most relevant environmental issues. Specifically, it employs six scores covering numerical indicators such as GHG emissions, air pollutants (e.g., oxides of nitrogen and sulfur), energy prices, the use of natural resources in production, waste production, hazardous materials, and impacts on ecosystems and biodiversity. Compared to the previous criteria, FactSet seems to provide more comprehensive information about the company's environmental impact on the business front and its management by the company's leadership.

Overall, divergences in database structure, summary statistics, underlying selected indicators, and the broader scope of the analysis offer valuable insights to motivate an investigation into common environmental factors across Environmental ratings and providers. The varying degrees of granularity, even at the second level of detail, necessitates a higher level of detail in any similar analysis. Similarly, as the number of levels is not uniform across sources, identifying the appropriate level of granularity becomes crucial for accurate comparison. Moreover, the use of differing scales for indicators among the databases underscores the necessity of data normalization onto a common scale before analysis. Lastly, the presence of indicators addressing diverse topics underscores the motivation behind our work and the need for statistical analysis to discern the underlying common components of the Environmental rating concept.

4. Empirical strategy

Our empirical strategy is divided into two main phases: the selection of common factor candidates within the pool of E sub-scores and the identification of actual common factors. We initially employ three complementary empirical approaches to identify potential common factors among Environmental scores from different providers.

First, we descriptively investigate the pairwise correlation among different providers' Environmental (sub-)ratings. This analysis aims to establish descriptive links across scores to (i) test whether sub-scores of the same provider are more correlated with each other than with sub-scores of different providers and (ii) identify correlations across Environmental sub-scores of different providers that can be included within the list of potential candidates for common Environmental factors.

Second, we employ the PCA to reduce data dimensionality and identify common components. PCA has been frequently employed in management literature for dimensional reduction of databases and identifying a limited number of common components that include the most relevant variables for representing a phenomenon or corporate behavior (see Allee, Do, & Raymundo, 2022, for a review). More recently, this approach has also been used to integrate and combine multiple ESG indicators into a single score (Lindsey, Pruitt, & Schiller, 2023) or to select the main factors that best synthesize the original set of ESG indicators (Bonacorsi, Cerasi, Paola, & Manera, 2022). In our framework, this analysis investigates whether the most relevant components align with the E sub-scores from the same data provider or are influenced by factors common across two or three providers. Unlike the correlation analysis, this approach potentially allows the identification of more than two relevant E sub-scores in one component, significantly expanding the pool of potential common factors.

Third, leveraging the panel structure, we conduct OLS fixed effect regressions: we use E scores as dependent variables and test the significance of E sub-scores from the same and other data providers. Looking at the significance and magnitude of the estimated coefficients, we can identify those E sub-scores significantly and positively correlated with E scores and sub-scores of other providers, thus being eligible to act as common factors. More specifically, we estimate the following set of models:

$$E_{it}^{P} = \alpha + \beta_1 subE_{it}^{MS} + \beta_2 subE_{it}^{MO} + \beta_3 subE_{it}^{FS} + \phi_i + \varepsilon_{it}, \quad (1)$$

where i denotes companies, t years, P one of the providers (MSCI or MS; Moody's or MO; FactSet or FS). E is the Environmental rating, and $subE$ denotes the sub-scores of the Environmental ratings for each provider. We control for unobservable heterogeneity by introducing company fixed effects, i.e., ϕ_i. The error terms ϵ_{it} are clustered at the company

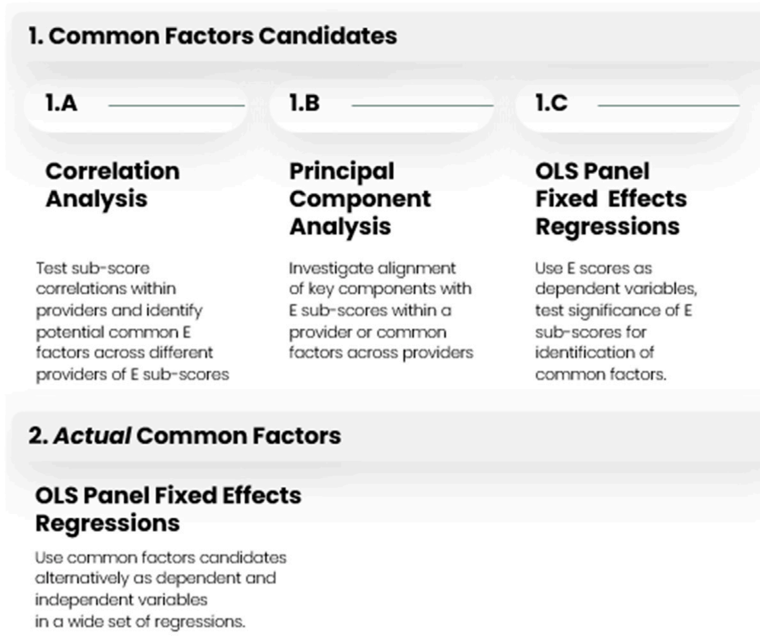

Fig. 2. This figure summarizes the empirical strategy adopted in the paper to identify Environmental common factors across ESG rating providers.

level.[8] We conduct 15 experiments based on various combinations of E and E sub-ratings, structured as follows. First, we consider the E score for MSCI as the dependent variable and select as regressors the E sub-scores of (i) MSCI, (ii) Moody's, (iii) FactSet, (iv) MSCI and Moody's, (v) MSCI and FactSet, and (vi) MSCI, Moody's, and FactSet, in six different specifications. Second, we change our dependent variable to the E score of Moody's and use the E sub-scores of (i) Moody's, (ii) MSCI, (iii) FactSet, (iv) MSCI and Moody's, (v) Moody's and FactSet, and (vi) MSCI, Moody's, and FactSet as regressors in six separate specifications. Last, we employ the E-scores derived from FactSet and regress them against the E sub-scores of (i) MSCI, (ii) Moody's, and (iii) MSCI and Moody's, for a total of three new specifications.[9] The E sub-indicators from providers other than those of the E score, whose coefficients are positive and statistically significant, become good candidates for acting as factors common to different raters.

As the second step in our investigation, we focus on the 'common factor candidates' that emerged from the previous analyses. We then conduct new OLS panel fixed effects regressions, using them alternatively as dependent and independent variables in a comprehensive set of regressions as described in Section 5.2 to identify the actual E common factors.

The empirical strategy described above is summarized in Fig. 2.

5. Environmental common factors

5.1. Identification of the pool of common candidates

We provide the results of the empirical strategy described in Section 4 to identify the pool of potential candidates for common Environmental factors within all the E sub-scores included in our dataset based on the merger of data from the three rating agencies.

Table 3 provides the Pearson's correlation coefficients among the E sub-scores of each data provider. Focusing on the relationship between the E sub-scores of each data provider, a positively statistically significant mild correlation (i.e., > 0.5) emerges among Moody's E sub-scores. A positive but less statistically significant relationship exists between the MSCI E-scores. Instead, the coefficient correlations among FactSet variables are positive (< 0.1) but not statistically significantly different from zero. Studying the correlation among the E sub-scores of the different data providers, the correlation coefficient is approximately zero or negative in most of the other cases (i.e., < 0.25 in 85% of occurrences). Considering a potential pool of common factors, we document only a small number of cases (15% of the total) for which there emerges a modest correlation (between 0.25 and 0.50) across providers, limitedly to MSCI and Moody's.

Tables 4 and 5 show the results from the PCA over four merging datasets: (1) dataset including all the E sub-scores; (2) dataset based on MSCI and Moody's E sub-scores; (3) dataset including MSCI and FactSet E sub-scores; and finally, (4) dataset based on Moody's and FactSet E sub-scores. We apply PCA methodology to each dataset, and we assess the sufficient number of components to be considered by applying the criteria proposed in Kaiser (1960) and Jolliffe (1973), i.e., we select the number of components with eigenvalues greater than 1 and that approximately explain 70% of the total variance. As shown in Table 4, all the PCAs based on the different samples highlight a relatively high number of selected components due to a relatively low level of correlation of scores across providers. For each merging dataset, we select the first seven, three, six, and five principal components, respectively. To interpret each principal component, Table 5 reports the magnitude and direction of the coefficients for the original variables. The larger the absolute value of the coefficient, the more important the corresponding variable is in calculating the component. Across all the merging datasets, the first principal component has large positive associations with 'Climate Change'. 'Natural Resources', and 'Natural Resources in production'. Considering also the second principal component, we can conclude that 'Natural Resources in production' from Moody's seems to emerge as a potential common E factor across data providers, linking indicators from MSCI ('Natural Resources') and FactSet ('Ecological Impact'). Focusing also on the next components, which explain only a marginal percentage of the variance of the data, we observe that

[8] We also study different model specifications, adopting alternative ways of clustering standard errors. Results, in line with the baseline estimations, are available upon request.

[9] In this case, we do not include the E sub-scores of FactSet in the estimations. The E score for FactSet is computed as an equally weighted average of the six FactSet E sub-scores since FactSet did not provide it.

Table 3

Correlation matrix across the Environmental sub-ratings. The table reports Pearson's correlation coefficients between all pairs of variables. In the upper triangular part of the matrix, the *p*-values (in italics) for the test of zero correlation for each pair of variables are also reported.

	Variables	FactSet						Moody's			MSCI			
		GHG Emissions	Air Quality	Energy Manag.	Water Waste	Hazardous Waste	Ecological Impact	Corporate Env. strategy	Nat. Resources in production	Env. impacts of product use	Climate Change	Natural Resources	Waste Manag.	Env. Opport.
FactSet	GHG Emissions	1	*0.072*	*0.000*	*0.002*	*0.000*	*0.029*	*0.005*	*0.000*	*0.026*	*0.210*	*0.578*	*0.004*	*0.354*
	Air Quality	0.016	1	*0.318*	*0.000*	*0.001*	*0.243*	*0.435*	*0.173*	*0.122*	*0.493*	*0.079*	*0.012*	*0.963*
	Energy Management	0.029	0.009	1	*0.157*	*0.000*	*0.209*	*0.032*	*0.006*	*0.518*	*0.004*	*0.034*	*0.145*	*0.096*
	Water Waste	0.024	0.038	0.011	1	*0.000*	*0.000*	*0.068*	*0.022*	*0.309*	*0.963*	*0.080*	*0.740*	*0.114*
	Hazardous Waste	0.036	0.031	0.069	0.055	1	*0.000*	*0.030*	*0.010*	*0.408*	*0.003*	*0.001*	*0.022*	*0.627*
	Ecological Impact	0.016	0.011	0.009	0.060	0.039	1	*0.004*	*0.011*	*0.011*	*0.059*	*0.133*	*0.256*	*0.549*
Moody's	Corporate Env. Strategy	0.022	0.008	-0.017	0.017	0.021	0.026	1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Nat. Resources in production	0.032	0.015	-0.022	0.022	0.025	0.023	0.761	1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Env. impacts of product use	0.025	0.024	-0.007	0.013	0.011	0.033	0.618	0.638	1	*0.000*	*0.000*	*0.000*	*0.000*
MSCI	Climate Change	0.008	0.006	-0.018	0.000	0.024	0.014	0.358	0.375	0.204	1	*0.000*	*0.000*	*0.000*
	Natural Resources	0.004	0.017	-0.015	0.015	0.028	0.012	0.343	0.418	0.268	0.445	1	*0.000*	*0.000*
	Waste Management	-0.024	-0.028	-0.013	-0.003	-0.024	-0.011	0.098	0.167	0.148	0.332	0.455	1	*0.000*
	Environmental Opportunities	0.009	0.001	-0.017	0.019	-0.006	0.007	0.350	0.406	0.377	0.242	0.247	0.241	1

Table 4
Principal Component Analysis: eigenvalues. The table reports the eigenvalues extracted from the four combinations of the three datasets: (1) all E sub-indicators, (2) MSCI & Moody's, (3) MSCI & FactSet, (4) Moody's & FactSet. In correspondence with each eigenvalue and each combination of data, the explained variance is also reported. Finally, the number of observations included in each sample is reported.

	All sub-E ind.	MS & MO	MS & FS	MO & FS
Eigenvalues	(1)	(2)	(3)	(4)
C1	2.932	3.146	2.256	2.155
C2	1.279	**1.160**	1.197	1.159
C3	1.188	0.769	**1.098**	**1.040**
C4	1.086	0.662	0.998	0.983
C5	**1.009**	0.532	0.957	0.970
C6	0.973	0.425	0.928	0.946
C7	0.901	0.306	0.827	0.898
C8	0.847		0.784	0.527
C9	0.832		0.513	0.321
C10	0.644		0.443	
C11	0.532			
C12	0.430			
C13	0.348			
Explained Var	(1)	(2)	(3)	(4)
C1	0.226	0.449	0.226	0.240
C2	0.098	0.166	0.120	0.129
C3	0.091	**0.110**	0.110	0.116
C4	0.084	0.095	0.100	0.109
C5	0.078	0.076	0.096	**0.108**
C6	0.075	0.061	**0.093**	0.105
C7	**0.069**	0.044	0.083	0.100
C8	0.065		0.078	0.059
C9	0.064		0.051	0.036
C10	0.050		0.044	
C11	0.041			
C12	0.033			
C13	0.027			
Nr. of Obs.	911	2,253	2,173	2,983

the third component, across all four experiments, shows a positive association mainly with environmental variables related to 'Air Quality' and 'Water Waste'. Finally, we also observe that the fourth and fifth components have a large positive association with 'GHG emissions'. However, we do not observe the emergence of common factors across different ESG rating providers in all the cases.

Tables 6–8 provide the regression results for the Eq. (1). When we only study the relationship between the E score of one provider and the E sub-scores of the others, we still find a positive and significant relationship when considering MSCI and Moody's. As explained in Section 4, we cannot perform the same analysis on the FactSet E score since it does not directly provide a built-in E score. When we also introduce the E sub-scores of the same provider, the coefficients of the other E sub-scores are not statistically significant in most cases, thus providing mild evidence of the presence of common factors. A few exceptions emerge, namely MSCI 'Environmental Opportunities', MSCI 'Climate Change', Moody's 'Natural Resources in production', and FactSet 'Water Waste', with all these indicators sharing the fact that they are mostly related to quantitative measures for environmental performance. When we focus on the relationships among these relevant variables, we find that these indicators are positively and significantly related only in the case of MSCI 'Environmental Opportunities' with Moody's 'Corporate Environmental Strategy' and with Moody's 'Natural Resources in Production', providing evidence on the limited role of common environmental factors in our setting.

Overall, the results from the three analyses highlight a divergence of Environmental scores since most of the E sub-scores correlate with other indicators of the same data providers. However, one common factor seems to be emerging around the most 'quantitative' characteristics of companies' performance, such as their emissions and use of natural resources (in production).

5.2. Identification of the actual common factors

We now provide panel regression analysis by focusing only on the subset of the environmental common factors candidates selected through the analysis performed in Section 5.1. In particular, we build twenty-two regression linear models where the dependent variables correspond with the environmental common factors explained by the E sub-scores of the different data providers. Table 9 provides an overview of the list of the model studies. We estimate each model using a robust OLS panel fixed-effects approach, with errors clustered at the company level. The results for each model are reported in Table B.1 in the Appendix. This analysis allows us to identify the *actual* common factors across the data providers.

Table 10 provides the number of statistically significant pair combinations of dependent and independent variables involved in the regression analysis. From this synthesis of results, it emerges that the most relevant indicators across the common factors candidates involve the variables (i) 'Natural Resources' (both for Moody's and MSCI), (ii) 'Corporate Environmental Strategy'. (iii) 'Climate Change'. (iv) 'Waste Management'. (v) 'Environmental Opportunities'. and (vi) 'Ecological Impact'. Deepening in the results, from Table 9, 'Natural Resources' provided by MSCI explained most of the candidates' common factors. In particular, we observe that its corresponding coefficient is positive and strongly statistically significant for the 'Corporate Environmental Strategy' and 'Natural Resources in Production' provided by Moody's and for the 'Ecological Impact' by FactSet. All these variables capture 'quantitative' characteristics of companies' performance, such as the so-called 'natural resources management' (NRM). NRM refers to the sustainable utilization of primary natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna. Together, these resources provide the ecosystem services that provide better

Table 5
Principal Component Analysis: scoring coefficients. The table reports the estimated factor loadings corresponding to the eigenvalues extracted from the four combinations of the three datasets: (1) all E sub-indicators, (2) MSCI & Moody's, (3) MSCI & FactSet, (4) Moody's & FactSet.

	Factor Loading	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7
	Panel A: All sub-E indicators							
	GHG Emissions	0.069	−0.009	0.061	0.145	**0.692**	**0.690**	0.083
	Air Quality	0.007	**0.369**	**0.375**	−0.297	−0.120	0.074	**0.748**
	Energy Management	−0.022	0.226	0.196	**0.596**	0.210	−0.440	0.184
FactSet	Water Waste	0.016	0.070	**0.545**	−0.159	−0.373	**0.341**	−0.389
	Hazardous Waste	0.058	0.172	**0.528**	**0.413**	0.010	−0.027	−0.281
	Ecological Impact	−0.005	0.149	0.232	−0.532	**0.502**	−0.379	−0.216
	Corporate Env. strategy	**0.456**	0.183	−0.096	−0.049	−0.008	−0.057	−0.130
Moody's	Natural Resources in prod.	**0.434**	**0.304**	−0.134	−0.028	0.029	−0.009	−0.172
	Env. impacts of product use	0.287	**0.561**	−0.286	−0.014	−0.059	0.088	−0.056
	Climate Change	**0.370**	−0.258	0.206	−0.038	−0.024	−0.040	0.182
	Natural Resources	**0.386**	−0.344	0.164	−0.071	0.106	−0.156	0.046
MSCI	Waste Management	**0.385**	−0.357	0.063	0.000	0.019	−0.070	0.078
	Environmental Opportunities	0.280	−0.063	−0.071	0.217	−0.233	0.155	0.176
	Panel B: MS & MO							
	Corporate Env. strategy	**0.449**	−0.232	−0.212				
Moody's	Natural Resources in prod.	**0.461**	−0.273	−0.065				
	Env. impacts of product use	**0.366**	−0.532	−0.018				
	Climate Change	**0.358**	**0.355**	−0.284				
	Natural Resources	**0.381**	**0.367**	−0.272				
MSCI	Waste Management	0.271	**0.573**	0.206				
	Environmental Opportunities	**0.324**	0.008	**0.868**				
	Panel C: MS & FS							
	GHG Emissions	0.004	0.237	−0.324	**0.632**	**0.625**	0.220	
	Air Quality	−0.022	**0.373**	**0.391**	−0.436	0.289	**0.612**	
	Energy Management	−0.057	**0.420**	−0.575	−0.117	−0.320	−0.030	
FactSet	Water Waste	0.025	**0.387**	**0.473**	0.098	0.243	−0.686	
	Hazardous Waste	0.027	**0.662**	−0.137	−0.135	−0.162	−0.095	
	Ecological Impact	−0.024	0.187	**0.403**	**0.606**	−0.581	0.299	
	Climate Change	**0.546**	0.019	0.019	−0.033	−0.002	0.062	
	Natural Resources	**0.512**	0.049	0.021	0.007	−0.019	0.046	
MSCI	Waste Management	**0.535**	−0.026	−0.023	0.023	−0.009	−0.013	
	Environmental Opportunities	**0.385**	−0.036	−0.078	−0.003	−0.037	−0.033	
	Panel D: MO & FS							
	GHG Emissions	0.041	0.220	−0.365	**0.879**	0.187		
	Air Quality	0.047	**0.337**	**0.374**	−0.127	**0.790**		
	Energy Management	−0.010	**0.484**	−0.444	−0.246	−0.005		
FactSet	Water Waste	−0.004	**0.349**	**0.555**	0.229	−0.087		
	Hazardous Waste	0.005	**0.552**	−0.314	−0.290	−0.064		
	Ecological Impact	0.032	**0.421**	**0.352**	0.114	−0.572		
	Corporate Env. strategy	**0.585**	−0.023	−0.014	−0.023	−0.032		
Moody's	Natural Resources in prod.	**0.601**	−0.021	−0.007	−0.022	−0.022		
	Env. impacts of product use	**0.540**	−0.017	−0.004	−0.013	0.011		

quality of human life.

Similar conclusions arise from examining the graphical representation of the findings reported in Table 10, depicted as a network in Fig. 3. In this graph, the size of each node reflects the frequency with which each environmental E sub-score appears as either a dependent or independent variable in the estimations from Table 10, while the width of the links represents the proportion of statistically significant relationships.

It emerges that not all environmental factors find common ground among the rating providers, particularly in the case of FactSet (e.g., Air Quality or Energy Management). On the other hand, the core set of common factors is confirmed to primarily relate to natural resource themes, with MSCI's 'Natural Resources' and Moody's 'Natural Resources in Production' emerging as particularly significant. These factors are highly interconnected and serve as a bridge to other quantitative factors such as 'Climate Change' and 'Waste Management' (MSCI).

Overall, the selected actual common factors share a common thematic focus around quantitative measures (and natural resources in particular), but include in their definition a different perspective on risk management, corporate impact management, and integration into corporate strategy due to the diverse goals and scopes of the ESG agencies, as described in Section 3.

6. Robustness tests

We conduct a battery of robustness tests to confirm the validity of the previous findings. In particular, we test whether the results obtained on the whole sample are driven by behaviors at the sector and country levels.

6.1. Exclusion of single sectors

Although ESG ratings are constructed to take into account the specific characteristics and attributes of heterogeneous business activities,

Table 6
Linear regression analysis on MSCI E Score. The table reports estimation results of regressions Eq. (1) of MSCI E score on MSCI E sub-scores (column 1), Moody's E sub-scores (column 2), and FactSet E sub-scores (column 3). Regression results in columns 4–6 include as regressors E sub-scores from MSCI and Moodys, MSCI and Factset, and all the E sub-scores, respectively. Standard errors clustered at the company level are reported in parentheses. ***, **, and * indicate that the parameter estimate significantly differs from zero at the 1%, 5%, and 10% levels, respectively.

Dependendent variable		MSCI E Score					
		(1)	(2)	(3)	(4)	(5)	(6)
MSCI	Climate Change	0.199***			0.170***	0.250***	0.233***
		(0.012)			(0.021)	(0.021)	(0.038)
	Natural Resources	0.078***			0.080***	0.112***	0.130***
		(0.010)			(0.018)	(0.019)	(0.033)
	Waste Management	0.121***			0.152***	0.159***	0.166***
		(0.013)			(0.022)	(0.027)	(0.043)
	Environmental Opportunities	0.526***			0.592***	0.488***	0.544***
		(0.018)			(0.027)	(0.033)	(0.046)
Moody's	Corporate Env. Strategy		0.046**		0.002		0.018
			(0.018)		(0.024)		(0.037)
	Nat. Resources in production		0.083***		−0.008		−0.023
			(0.019)		(0.026)		(0.036)
	Env. impacts of product use		0.047***		0.019		0.012
			(0.015)		(0.020)		(0.026)
FactSet	GHG Emissions			0.008*		−0.007	−0.006
				(0.004)		(0.005)	(0.008)
	Air Quality			0.002		0.004	0.006
				(0.005)		(0.004)	(0.007)
	Energy Management			−0.008*		−0.004	−0.002
				(0.004)		(0.004)	(0.007)
	Water Waste			0.001		−0.006	−0.009
				(0.004)		(0.004)	(0.007)
	Hazardous Waste			0.011**		−0.001	0.001
				(0.004)		(0.004)	(0.007)
	Ecological Impact			0.004		0.003	0.007
				(0.004)		(0.004)	(0.006)
Observations		6,365	9,852	8,520	2,253	2,173	911
Company FE		Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared		0.566	0.024	0.001	0.584	0.598	0.613

different industries may be perceived and evaluated differently by the rating agencies. This can lead to potential heterogeneous results based on the sector in identifying common environmental factors among different providers.

To test whether the common factors identified in the main analysis are not driven by a single sector, we follow the following procedure. First, using the information on firms' sectors in our database according to the NACE classification, we attribute each company to one of the identified sectors (2-digit level). Specifically, the firms in our database are associated with 82 out of 88 possible sectors, depending on the analyzed sample. Second, we identify common-factor candidates by replicating each of the analyses (correlation analysis, principal component analysis, and panel fixed effects regressions) 82 times by dropping one sector at a time. Since we need to impose a direction in the relationship for the panel fixed regressions, the experiments are conducted 82 times for the E rating of each of the providers. We thus conduct 410 experiments (82 from the correlation analysis, 82 from the PCA, and 246 from the regressions) from which potential common factor environmental candidates can emerge. Third, we compare the outcomes of these 410 experiments with the results of our baseline analysis. Regarding correlation analysis, we consider as aligned the results that do not show new correlation coefficients above the identified threshold (> 0.250) compared with the baseline case. Regarding PCA, we consider as aligned the results that do not show in the same component new loadings above the threshold (> 0.300) belonging to different providers. Finally, regarding the fixed effect panel regressions, we consider as aligned the results that do not show statistically significant new coefficients at 10% belonging to different providers. In all other cases, we are in the presence of misalignments from the baseline, suggesting potential new environmental common factors candidates.

Table 11 shows a summary of the results obtained from the experiments, where we indicate for each of the three empirical methodologies the number of experiments whose outcomes are aligned ('A') or misaligned ('M') with respect to the baseline. The results show that excluding one sector at a time from the analyses impacts the results only in four experiments, while in all other cases, we do not observe impacts. In terms of relevance, this implies a ratio of aligned over total experiments of approximately 99%. These results prove our findings' robustness to the exclusions of single sectors.

6.2. Exclusion of single countries

We then use the same approach to test whether the results of the baseline analysis are instead driven by a single country. Different countries may be subject to heterogeneous assessments based on the ESG risks that raters might attribute. Our sample contains joint information for the three data providers covering 70 countries. This leads to a total number of experiments conducted in the common factor identification step equal to 350. Similar to the case of sectors, we compare the outcomes of these experiments with our baseline analysis. Results presented in Table 12 show a substantial alignment of the empirical results for most of the estimations. Few exceptions emerge for the exclusions of three countries, Sweden, Taiwan, and the United States, for which panel fixed effects regression models show misalignments limited to the emergence of potential common factors when using Moody's E score as the dependent variable for a total of three experiments. These results indicate a ratio of aligned over total experiments of 99%.

Overall, the robustness analysis shows that the procedure to select common factors presented in the baseline is not driven by specific

Table 7
Linear regression analysis on Moody's E Score. The table reports estimation results of regressions Eq. (1) of Moody's E score on Moody's E sub-scores (column 1), MSCI E sub-scores (column 2), and FactSet E sub-scores (column 3). Regression results in columns 4–6 include as regressors E sub-scores from MSCI and Moodys, Moodys and Factset, and all the E sub-scores, respectively. Standard errors clustered at the company level are reported in parentheses. ***, **, and * indicate that the parameter estimate significantly differs from zero at the 1%, 5%, and 10% levels, respectively.

Dependendent variable		Moody's E Score					
		(1)	(2)	(3)	(4)	(5)	(6)
MSCI	Climate Change		0.106***		−0.001		−0.004
			(0.014)		(0.004)		(0.006)
	Natural Resources		0.078***		0.005		0.014**
			(0.013)		(0.004)		(0.006)
	Waste Management		0.049***		−0.007		−0.014*
			(0.016)		(0.004)		(0.007)
	Environmental Opportunities		0.031		0.001		0.008
			(0.022)		(0.006)		(0.009)
Moody's	Corporate Env. Strategy	0.325***			0.332***	0.344***	0.359***
		(0.005)			(0.014)	(0.011)	(0.025)
	Nat. Resources in production	0.446***			0.405***	0.436***	0.389***
		(0.006)			(0.011)	(0.012)	(0.018)
	Env. impacts of product use	0.183***			0.182***	0.165***	0.167***
		(0.003)			(0.006)	(0.005)	(0.009)
FactSet	GHG Emissions			0.020***		0.000	0.004
				(0.004)		(0.001)	(0.003)
	Air Quality			0.011**		0.001	−0.002
				(0.004)		(0.001)	(0.002)
	Energy Management			−0.008**		−0.000	−0.001
				(0.004)		(0.001)	(0.002)
	Water Waste			0.003		0.001	0.002
				(0.004)		(0.001)	(0.002)
	Hazardous Waste			0.017***		0.001	0.001
				(0.004)		(0.001)	(0.002)
	Ecological Impact			0.012***		−0.002*	−0.004**
				(0.004)		(0.001)	(0.002)
Observations		10,724	3,374	5,895	2,253	2,983	911
Company FE		Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared		0.966	0.102	0.014	0.943	0.953	0.935

Table 8
Linear regression analysis on FactSet E Score. The table reports estimation results of regressions Eq. (1) of FactSet E score on MSCI E sub-scores (column 1), Moody's E sub-scores (column 2), and MSCI and Moody's E sub-scores (column 3). Standard errors clustered at the company level are reported in parentheses. ***, **, and * indicate that the parameter estimate significantly differs from zero at the 1%, 5%, and 10% levels, respectively.

Dependendent variable		FactSet E Score		
		(1)	(2)	(3)
MSCI	Climate Change	0.002		0.047
		(0.026)		(0.041)
	Natural Resources	0.067***		0.035
		(0.023)		(0.041)
	Waste Management	−0.044		−0.072
		(0.030)		(0.045)
	Environmental Opportunities	0.011		−0.034
		(0.038)		(0.064)
Moody's	Corporate Env. Strategy		0.018	0.004
			(0.036)	(0.071)
	Nat. Resources in production		0.090**	0.165***
			(0.036)	(0.059)
	Env. impacts of product use		0.005	−0.011
			(0.026)	(0.046)
Observations		2,173	2,983	911
Company FE		Yes	Yes	Yes
Adj. R-squared		0.004	0.004	0.011

Table 9

Linear model specifications for the environmental common factors. The table summarizes the models of the selected environmental common factors on the E sub-scores from the different data providers, listed in Table A.1 in the Appendix. The gray cells identify the selected environmental common factors from the same data provider of the dependent variable, used as regressors in the linear analysis. The table reports the dependent and independent variables involved in the estimation in columns. Then, the number of observations and the adjusted *R*-squared are also reported in the last two columns. The shades of green, i.e., dark green, green, and light green, indicate that the corresponding parameter of the regressor is significantly different from zero at 1%, 5%, and 10%, respectively.

#	Dependent	Independent 1	Independent 2	Independent 3	Independent 4	Independent 5	Independent 6	Independent 7	Independent 8	Independent 9	Independent 10	Independent 11	Independent 12	Obs.	Adj R2
1	Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)								3,505	0.888
2	Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Waste Management (MSCI)	Nat. Resources in production (Moody's)									8,879	0.867
3	Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)								3,505	0.888
4	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Env. impacts of product use (Moody's)								3,505	0.834
5	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Waste Management (MSCI)	Corporate Env. Strategy (Moody's)									8,879	0.843
6	Nat. Resources in production (Moody's)	Air Quality (FactSet)	Corporate Env. Strategy (Moody's)											4,247	0.805
7	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Env. impacts of product use (Moody's)								3,505	0.834
8	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Env. impacts of product use (Moody's)							2,253	0.838
9	Env. impacts of product use (Moody's)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)									3,515	0.822
10	Env. impacts of product use (Moody's)	Air Quality (FactSet)	Nat. Resources in production (Moody's)											4,247	0.802
11	Env. impacts of product use (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)								3,505	0.823
12	Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Natural Resources (MSCI)	Waste Management (MSCI)									8,879	0.827
13	Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Natural Resources (MSCI)	Waste Management (MSCI)									8,879	0.827
14	Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product (Moody's)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)								3,505	0.725
15	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product (Moody's)	Climate Change (MSCI)	Waste Management (MSCI)								4,379	0.742
16	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Waste Management (MSCI)									8,879	0.744
17	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product (Moody's)	Climate Change (MSCI)	Environmental Opportunities (MSCI)								3,505	0.724
18	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product (Moody's)	GHG Emissions (FactSet)	Air Quality (FactSet)	Energy Management (FactSet)	Water Waste (FactSet)	Hazardous Waste (FactSet)	Ecological Impact (FactSet)	Climate Change (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)	911	0.748
19	Waste Management (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)									8,879	0.778
20	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)										5,377	0.753
21	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)								3,505	0.743
22	Air Quality (FactSet)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)											4,247	0.159

Table 10
Identification of the actual common factors. By sorting pairs of the dependent and independent variables of the linear models listed in Table 9, the table reports 'Ratio Significant', i.e., the ratio between the number of statistically significant pairwise combinations over the number of possible pair combinations of the two variables in the linear models.

Dependent	Independent	Ratio significant
Nat. Resources in production (Moody's)	Climate Change (MSCI)	4/4
Nat. Resources in production (Moody's)	Natural Resources (MSCI)	4/4
Natural Resources (MSCI)	Nat. Resources in production (Moody's)	4/4
Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	3/3
Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	3/3
Climate Change (MSCI)	Nat. Resources in production (Moody's)	3/3
Nat. Resources in production (Moody's)	Waste Management (MSCI)	2/2
Env. impacts of product use (Moody's)	Environmental Opportunities (MSCI)	2/2
Environmental Opportunities (MSCI)	Env. impacts of product use (Moody's)	2/2
Natural Resources (MSCI)	Ecological Impact (FactSet)	1/1
Waste Management (MSCI)	Nat. Resources in production (Moody's)	1/1
Waste Management (MSCI)	Corporate Env. Strategy (Moody's)	1/1
Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	2/4
Corporate Env. Strategy (Moody's)	Natural Resources (MSCI)	1/3
Nat. Resources in production (Moody's)	Environmental Opportunities (MSCI)	1/3
Corporate Env. Strategy (Moody's)	Waste Management (MSCI)	0/1
Corporate Env. Strategy (Moody's)	Environmental Opportunities (MSCI)	0/1
Nat. Resources in production (Moody's)	Air Quality (FactSet)	0/1
Env. impacts of product use (Moody's)	Climate Change (MSCI)	0/1
Env. impacts of product use (Moody's)	Natural Resources (MSCI)	0/2
Env. impacts of product use (Moody's)	Air Quality (FactSet)	0/1
Climate Change (MSCI)	Env. impacts of product use (Moody's)	0/1
Natural Resources (MSCI)	Env. impacts of product use (Moody's)	0/3
Natural Resources (MSCI)	GHG Emissions	0/1
Natural Resources (MSCI)	Air Quality	0/1
Natural Resources (MSCI)	Energy Management	0/1
Natural Resources (MSCI)	Water Waste	0/1
Natural Resources (MSCI)	Hazardous Waste	0/1
Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	0/2
Environmental Opportunities (MSCI)	Nat. Resources in production (Moody's)	0/2
Air Quality (FactSet)	Nat. Resources in production (Moody's)	0/1
Air Quality (FactSet)	Env. impacts of product use (Moody's)	0/1

sectors or countries, as out of a total of 760 experiments for the identification of common factor candidates according to the different settings seven (0.9%) lead to results that differ from the baseline.[10]

7. Common factors in environmentally sustainable sectors

We now investigate whether the presence of common factors across rating agencies changes according to the degree to which companies' business activities are aligned with environmental sustainability. Rating agencies may place a stronger focus on those business activities engaged in adapting to or mitigating environmental risks and opportunities. This is because this pool of companies is the one that is most likely regarded by investors willing to invest in environmentally sustainable – or 'green' – activities. This focus may imply that ESG raters are more likely to consider more objective and less disputable variables in assessing green activities, thereby leading to common factors more linked to quantitative measures for green vs. the other companies across rating agencies. A second aspect to consider is that companies in environmentally sustainable sectors may also be the most responsive to the E factor of ESG ratings. As a result, we can also expect greater convergence in the number of common factors among rating agencies when focusing on the environmental pillar of 'greener companies'.[11]

We test these hypotheses by conducting our empirical analysis on the sample of companies in more environmentally sustainable sectors to identify common E factors among ESG rating providers. To select these sectors, we rely on the EU Taxonomy, which provides a tool for assessing environmentally sustainable economic activities and has the advantage of (i) being adopted in one of the most developed policy contexts in the field of sustainability, where sustainable investments are growing and resilient to crises, and (ii) being directly applicable to the NACE industrial sector classification.

For this purpose, we leverage the definition of sectoral taxonomy based on Alessi and Battiston (2022), who assigns each sector within the EU Taxonomy a Taxonomy Alignment Coefficient (TAC) representing its contribution to environmental sustainability. Therefore, we focus on a subsample of our database consisting of companies operating in aligned sectors, i.e., companies with a NACE having a

[10] For the sake of completeness, we have tested whether the potential common factors resulting from these cases also emerge as *actual* common factors. The results show that this happens (i) when Sweden and Taiwan are excluded and that a significant relationship emerges between 'GHG Emissions' (FactSet), 'Natural Resources in Production' (Moody's) and 'Environmental Impact of Product Use' (Moody's), and (ii) when sector 28 (Manufacture of machinery and equipment n.e.c.) is excluded, and that a significant relationship emerges between 'Environmental Impact of Product Use' (Moody's) and 'Climate Change' (MSCI). Including these *actual* common factors in the list displayed in Table 10 would not affect the overall findings derived from the baseline. The results of all 760 experiments and tests of *actual* common factors on candidate common factors are available upon request.

[11] The alternative hypothesis suggests that rating providers may be more attentive in analyzing companies operating in less environmentally sustainable sectors. These companies may have more room for improvement in environmental sustainability, which would lead raters to focus on analyzing quantitative variables. This may result in a greater likelihood of common factors among providers.

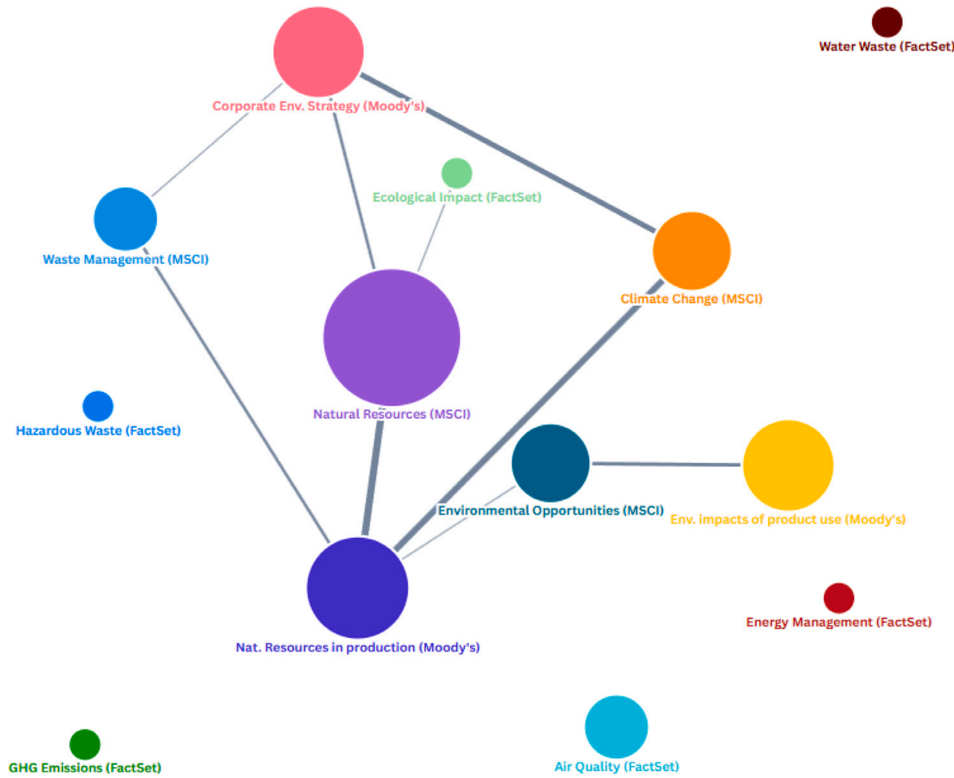

Fig. 3. This figure illustrates the relationships between environmental factors in a network format. The size of each node indicates the frequency with which each environmental factor appears as either a dependent or independent variable in the estimations reported in Table 10. The width of the links represents the proportion of times the corresponding relationships are statistically significant.

positive alignment-to-the-taxonomy coefficient.[12] We perform the empirical strategy described in Section 4 to identify potential common factors among the rating providers, and we test whether they are actual common factors via regression analyses. Last, we compare these results with our baseline ones to check for possible heterogeneous behaviors of ESG agencies in rating 'greener companies'.

If we were to find more E sub-scores candidates for common factors in the subset of taxonomy-aligned companies, we could argue that ESG rating agencies, in this case, are more likely to converge in their assessment because these indicators are more relevant – and directly comparable – when they play an important role in the company's activities. In other words, ESG raters can make a genuine distinction on environmental indicators when companies' behavior can be objectively assessed, i.e., when they operate in more environmentally sustainable sectors. On the other hand, the disagreement would be more likely for companies rated on the environmental pillar but do not operate in taxonomy-aligned sectors.

Tables 13, 14, and 15 show the results of the correlation analysis, PCA, and fixed-effect panel regressions on the taxonomy-aligned sectors, respectively. The correlation analysis (Table 13) provides results consistent with the baseline analysis, confirming all the emerging common factors with only one difference, which concerns a new salient relationship between 'Climate Change' (MSCI) and 'Environmental Impact of Product Use' (Moody's). Overall, one more common factor candidate emerges vs. the baseline, and all others are confirmed.

On the other hand, the PCA leads to greater differences compared to the baseline (see Table 14). Focusing on the setting that analyses the three ESG rating providers at the same time, we observe six new coefficients above the threshold of 0.3 emerge among the providers for components 1, 2, 3, and 7: (i) MSCI's 'Environmental Opportunities' together with Moody's 'Corporate Environmental Strategy' and 'Natural Resources in Production, and MSCI's 'Climate Change', 'Natural Resources', and 'Waste Management'; (ii/iii) FactSet's 'Energy Management' and 'Hazardous Waste' jointly with FactSet's 'Air Quality' and Moody's 'Environmental Impact of Product Use', (iv/v) FactSet's 'Ecological Impact' and Moody's 'Environmental Impact of Product Use' with FactSet's 'Air Quality', and (vi) MSCI's 'Natural Resources' with FactSet's 'Air Quality'. In addition, one common candidate factor does not emerge with respect to the baseline, namely Moody's 'Natural resources in production' with FactSet's 'Air quality' and Moody's 'Environmental impact of product use'. Overall, seven more candidate common factors emerge compared to the baseline, and all others are confirmed with this last exception.

The regression analysis shown in Table 15 indicates that there are no differences vs. the baseline analysis when the dependent variable is MSCI's E. If Moody's E is the dependent variable, a candidate common factor emerging from the baseline analysis (MSCI's 'Natural Resources' jointly with Moody's 'Corporate Environmental Strategy', 'Natural Resources in Production', and 'Environmental Impacts of Product Use') does not emerge when focusing on companies in the taxonomy-aligned sectors. Moreover, when FactSet's E is the dependent variable, both MSCI's 'Natural Resources' and Moody's 'Natural Resources in Production' emerge as candidate common factors, with the former not being so in the baseline analysis but still emerging from the regression with Moody's E as the dependent variable. Thus, overall, no new common factor candidates arise. A common baseline factor derived from the relationship between E Moody's and all sub-scores (i.e., MSCI 'Natural Resources') does not emerge in this setting. Still, it does emerge from the relationship between E FactSet and all sub-scores. However, given

[12] The complete list of the environmentally sustainable (aligned) sectors is displayed in Table A.4 of the Appendix.

Table 11
Robustness — Sector Excluded. The Table summarizes the results of the 410 experiments based on the procedure described in Section 6.1, excluding one macro-sector at a time for each statistical technique (Correlation, PCA, and Regression). Results that are Aligned (A) and Misaligned (M) vis-a-vis the respective baseline analysis are reported in Columns A and M, respectively. The 'Ratio Aligned' column displays the ratio between the number of experiments aligned with the respective baseline over the total number of experiments.

Country	Experiment						Ratio Aligned
	Corr.		PCA		Regr.		
	A	M	A	M	A	M	
01	1		1		3		100
02	1		1		3		100
03	1		1		3		100
05	1		1		3		100
06	1		1		3		100
07	1		1		3		100
08	1		1		3		100
09	1		1		3		100
10	1		1		3		100
11	1		1		3		100
12	1		1		3		100
13	1		1		3		100
14	1		1		3		100
15	1		1		3		100
16	1		1		3		100
17	1		1		3		100
18	1		1		3		100
19	1			1	3		80
20	1		1		3		100
21	1			1	3		80
22	1		1		3		100
23	1		1		3		100
24	1		1		3		100
25	1		1		3		100
26	1		1		3		100
27	1		1		3		100
28	1			1	2	1	60
29	1		1		3		100
30	1		1		3		100
31	1		1		3		100
32	1		1		3		100
33	1		1		3		100
35	1		1		3		100
36	1		1		3		100
37	1		1		3		100
38	1		1		3		100
39	1		1		3		100
41	1		1		3		100
42	1		1		3		100
43	1		1		3		100
45	1		1		3		100
46	1		1		3		100
47	1		1		3		100
49	1		1		3		100
50	1		1		3		100
51	1		1		3		100
52	1		1		3		100
53	1		1		3		100
55	1		1		3		100
56	1		1		3		100
58	1		1		3		100
59	1		1		3		100
60	1		1		3		100
61	1		1		3		100
62	1		1		3		100
63	1		1		3		100
64	1		1		3		100
65	1		1		3		100
66	1		1		3		100
68	1		1		3		100
69	1		1		3		100
70	1		1		3		100
71	1		1		3		100
72	1		1		3		100
73	1		1		3		100
74	1		1		3		100
75	1		1		3		100
77	1		1		3		100
78	1		1		3		100
79	1		1		3		100
80	1		1		3		100
81	1		1		3		100
82	1		1		3		100
84	1		1		3		100
85	1		1		3		100
86	1		1		3		100
87	1		1		3		100
88	1		1		3		100
92	1		1		3		100
93	1		1		3		100
94	1		1		3		100
96	1		1		3		100

(*continued on next page*)

Table 11 (*continued*).

that the latter estimate cannot include by construction FactSet's E sub-scores as regressors when looking for the actual common factors, to test whether these are confirmed as actual common factors, we cannot run the same estimation (line 18 of Table 9), but should estimate a new regression that is the same but excludes all FactSet's E sub-scores.

Moving on to the second step of the analysis, we identify the *actual* common factors estimating several regressions, including the candidates that emerged in the first step as dependent or independent variables, based on the procedure described in Section 5.2. Table 16 displays all the estimated models and their results, while Table 17 focuses on the number of statistically significant pair combinations of dependent and independent variables involved in the regression analyses (similarly to Tables 9 and 10, respectively, for the baseline analysis).

The results of the second step analysis provide several indications. If, as we have seen, the number of candidate factors common to the three providers increases when we focus exclusively on the taxonomy-aligned sectors compared to the whole sample, when we move on to the second step of analysis to verify the *actual* common factors we do not find any noticeable differences either in the number of regressions we have to run (23 as shown in Table 16 vs. 21 of the baseline in Table 9), or in the number of pairwise relationships to be tested (33 as shown in Table 17 vs. 32 of the baseline in Table 10).

However, if we focus on the significance levels of these relationships, we obtain results that are not always consistent with the baseline analysis. The number of pairwise relationships that are never significant is close for the taxonomy-aligned sectors (18 out of 33) compared to the total sample (17 out of 32). In particular, in both cases, the number of relationships for which at least one of the estimated models has a positive and statistically significant coefficient is 15. However, two main differences emerge: the number of more consistently positive and statistically significant relationships and the characteristics of these relationships. While in the baseline analysis, the number of relationships with a value in the 'Ratio Significant' column of 100%, i.e., the most stable positive ones, was 12, when we look only at the sub-sample of companies in the taxonomy-aligned sectors, this

Table 12
Robustness — Country Excluded. The Table summarizes the results of the 350 experiments based on the procedure described in Section 6.1, excluding one country at a time for each statistical technique (Correlation, PCA, and Regression). Results that are Aligned (A) and Misaligned (M) vis-a-vis the respective baseline analysis are reported in Columns A and M, respectively. The 'Ratio Aligned' column displays the ratio between the number of experiments aligned with the respective baseline over the total number of experiments.

Country	Experiment						Ratio Aligned
	Corr.		PCA		Regr.		
	A	M	A	M	A	M	
AE	1		1		3		100
AR	1		1		3		100
AT	1		1		3		100
AU	1		1		3		100
BE	1		1		3		100
BM	1		1		3		100
BR	1		1		3		100
CA	1		1		3		100
CH	1		1		3		100
CL	1		1		3		100
CN	1		1		3		100
CO	1		1		3		100
CY	1		1		3		100
CZ	1		1		3		100
DE	1		1		3		100
DK	1		1		3		100
EG	1		1		3		100
ES	1		1		3		100
FI	1		1		3		100
FO	1		1		3		100
FR	1		1		3		100
GA	1		1		3		100
GB	1		1		3		100
GE	1		1		3		100
GG	1		1		3		100
GI	1		1		3		100
GR	1		1		3		100
HK	1		1		3		100
HU	1		1		3		100
ID	1		1		3		100
IE	1		1		3		100
IL	1		1		3		100
IM	1		1		3		100
IN	1		1		3		100
IT	1		1		3		100
JE	1		1		3		100
JP	1		1		3		100
KR	1		1		3		100
KY	1		1		3		100
KZ	1		1		3		100
LU	1		1		3		100
MA	1		1		3		100
MO	1		1		3		100
MT	1		1		3		100
MU	1		1		3		100
MX	1		1		3		100
MY	1		1		3		100
NL	1		1		3		100
NO	1		1		3		100
NZ	1		1		3		100
PE	1		1		3		100
PG	1		1		3		100
PH	1		1		3		100
PL	1		1		3		100
PR	1		1		3		100
PT	1		1		3		100
QA	1		1		3		100
RO	1		1		3		100
RU	1		1		3		100
SA	1		1		3		100
SE	1		1		2	1	80
SG	1		1		3		100
TH	1		1		3		100
TR	1		1		3		100
TW	1		1		2	1	80
UA	1		1		3		100
US	1		1		2	1	80
UY	1		1		3		100
VG	1		1		3		100
ZA	1		1		3		100

(*continued on next page*)

Table 12 (*continued*).

number reduces to 6. Looking at the characteristics of these six pairs of indicators and comparing them with the 12 in the baseline, we see that the former are all strongly linked to variables more directly related to quantitative measures, and in particular to natural resources (e.g. Moody's Natural Resources in Production and MSCI's Natural Resource) and environmental impact (e.g. Moody's Environmental Impact of Product Use, FactSet's Air Quality, MSCI's Climate Change) and less on more qualitative aspects such as corporate environmental strategy or environmental opportunities (e.g. Moody's Corporate Environmental Strategy and MSCI's Environmental Opportunities) which, instead, played a comparably important role in the baseline results.

Overall, our findings suggest that while the commonality of E ratings for companies operating in environmentally sustainable sectors is not drastically different from the generality of companies, it appears to be even more focused on quantitative indicators. This result could be motivated by the need for ESG agencies to adhere to less controversial indicators when rating the environmental sustainability of companies in taxonomy-aligned sectors. This is crucial as environmental sustainability is a key focus area for financial institutions and investors when assessing such sectors and business activities.

8. Conclusions and policy implications

The rising interest in sustainability within economics and finance has driven the adoption of ESG metrics, as a useful tool to reduce information asymmetries between financial institutions and companies in the sphere of environmental, social, and governance risks. This paper contributes to the literature investigating the presence of common factors across ESG data providers. Based on a unique dataset merging data from three agencies, we model ESG metrics as a combination of a structural nonrandom part and random interference, seeking commonality among them. Through three empirical approaches – correlation analysis, principal component analysis, and panel data regressions – we investigate potential shared structures in Environmental scores across MSCI, Moody's, and FactSet. In broader terms, we confirm the presence of disparities in line with the literature (e.g., Berg, Koelbel, & Rigobon, 2022; Billio et al., 2021; Gibson Brandon et al., 2021). At the same time, we highlight the emergence of a common factor within the Environmental scores, mainly linked to quantitative performance measures, such as the use of natural resources.

When we focus on more environmentally sustainable sectors, i.e., those that are more aligned with achieving environmental sustainability based on the EU taxonomy, we find that the commonality of E-ratings across providers appears to be even more focused on quantitative indicators. This suggests that ESG agencies tend to stick to less controversial indicators when rating the environmental sustainability of more sustainable sectors.

Table 13
Correlation matrix across the Environmental sub-ratings of companies in environmentally sustainable sectors. The table reports Pearson's correlation coefficients between all pairs of variables for companies in the environmentally sustainable sectors based on the alignment to the EU Taxonomy definition. In the upper triangular part of the matrix, the *p*-values (in italics) for the test of zero correlation for each pair of variables are also reported. New common factors candidates vs. the baseline analysis are underlined.

		FactSet						Moody's			MSCI			
Variables		GHG Emissions	Air Quality	Energy Manag.	Water Waste	Hazardous Waste	Ecological Impact	Corporate Env. strategy	Nat. Resources in production	Env. impacts of product use	Climate Change	Natural Resources	Waste Manag.	Env. Opport.
FactSet	GHG Emissions	1	*0.116*	*0.011*	*0.021*	*0.005*	*0.113*	*0.108*	*0.002*	*0.559*	*0.006*	*0.098*	*0.018*	*0.234*
	Air Quality	0.020	1	*0.917*	*0.187*	*0.628*	*0.664*	*0.662*	*0.441*	*0.121*	*0.718*	*0.039*	*0.179*	*0.400*
	Energy Management	0.024	0.001	1	*0.570*	*0.000*	*0.886*	*0.202*	*0.047*	*0.707*	*0.375*	*0.364*	*0.749*	*0.092*
	Water Waste	0.026	0.019	0.006	1	*0.000*	*0.004*	*0.087*	*0.015*	*0.501*	*0.632*	*0.004*	*0.376*	*0.133*
	Hazardous Waste	0.033	0.007	0.071	0.046	1	*0.256*	*0.071*	*0.030*	*0.289*	*0.002*	*0.020*	*0.291*	*0.631*
	Ecological Impact	0.017	0.006	0.002	0.035	0.014	1	*0.106*	*0.214*	*0.102*	*0.224*	*0.027*	*0.406*	*0.443*
Moody's	Corporate Env. Strategy	0.018	0.007	-0.014	0.024	0.026	0.021	1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Nat. Resources in production	0.035	0.012	-0.022	0.034	0.031	0.016	0.768	1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	Env. impacts of product use	0.011	0.042	0.007	0.015	0.026	0.036	0.634	0.624	1	*0.000*	*0.000*	*0.037*	*0.000*
MSCI	Climate Change	0.025	-0.005	-0.008	0.005	0.037	0.013	0.354	0.377	<u>0.283</u>	1	*0.000*	*0.000*	*0.000*
	Natural Resources	0.017	0.030	-0.009	0.036	0.031	0.026	0.363	0.427	0.259	0.298	1	*0.000*	*0.000*
	Waste Management	-0.032	-0.024	-0.004	-0.014	-0.018	-0.013	0.093	0.134	0.053	0.352	0.504	1	*0.000*
	Environmental Opportunities	0.017	0.017	-0.024	0.026	-0.009	0.013	0.423	0.444	0.385	0.281	0.257	0.245	1

Table 14
Principal Component Analysis: scoring coefficients of companies in environmentally sustainable sectors. The table reports the estimated factor loadings corresponding to the eigenvalues extracted from all E sub-indicators for environmentally sustainable sectors based on the alignment to the EU Taxonomy definition. New common factors candidates vs. the baseline analysis are underlined.

	Factor Loading	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7
FactSet	GHG Emissions	0.116	0.183	−0.057	0.213	0.284	−0.892	−0.077
	Air Quality	−0.002	**0.322**	**0.485**	0.239	−0.083	0.028	**0.748**
	Energy Management	0.000	**0.501**	−0.331	−0.383	0.184	0.094	0.161
	Water Waste	0.000	0.278	−0.016	**0.706**	−0.229	0.197	−0.324
	Hazardous Waste	0.059	**0.540**	−0.428	0.128	0.166	0.196	−0.003
	Ecological Impact	0.001	−0.027	**0.360**	0.169	**0.760**	0.292	−0.246
Moody's	Corporate Env. strategy	**0.456**	0.021	0.065	−0.125	−0.028	0.076	−0.089
	Natural Resources in prod.	**0.434**	0.047	0.102	−0.172	0.157	0.103	−0.021
	Env. impacts of product use	0.241	**0.351**	**0.502**	−0.301	−0.154	−0.089	−0.294
MSCI	Climate Change	**0.348**	0.055	0.032	0.141	−0.195	−0.043	−0.066
	Natural Resources	**0.393**	−0.211	−0.179	0.136	0.196	0.032	**0.324**
	Waste Management	**0.420**	−0.261	−0.176	0.180	0.062	0.053	0.156
	Environmental Opportunities	**0.311**	0.024	−0.088	−0.031	−0.302	0.055	−0.124

Table 15
Linear regression analysis for companies in environmentally sustainable sectors. The table reports estimation results of regressions Eq. (1) of the MSCI (column 1), Moody's (column 2), and FactSet (column 3) E scores on all the subscores in the sub-sample of companies in the environmentally sustainable sectors based on the alignment to the EU Taxonomy definition. New common factors candidates vs. the baseline analysis are underlined. Standard errors clustered at the company level are reported in parentheses. ***, **, and * indicate that the parameter estimate significantly differs from zero at the 1%, 5%, and 10% levels, respectively.

Dependendent variable		MSCI	Moody's	FactSet
		(1)	(2)	(3)
MSCI	Climate Change	0.344***	−0.007	0.042
		(0.038)	(0.006)	(0.045)
	Natural Resources	0.223***	0.016	0.093*
		(0.034)	(0.011)	(0.055)
	Waste Management	0.028	0.007	−0.093
		(0.054)	(0.008)	(0.081)
	Environmental Opportunities	0.373***	0.006	−0.076
		(0.056)	(0.010)	(0.091)
Moody's	Corporate Env. Strategy	0.031	0.448***	−0.091
		(0.045)	(0.055)	(0.101)
	Nat. Resources in production	0.004	0.317***	0.155**
		(0.045)	(0.023)	(0.074)
	Env. impacts of product use	0.031	0.144***	0.029
		(0.022)	(0.010)	(0.062)
FactSet	GHG Emissions	−0.004	0.000	
		(0.010)	(0.003)	
	Air Quality	−0.003	−0.001	
		(0.010)	(0.003)	
	Energy Management	−0.012	0.001	
		(0.011)	(0.003)	
	Water Waste	−0.010	0.001	
		(0.010)	(0.003)	
	Hazardous Waste	−0.004	−0.001	
		(0.010)	(0.003)	
	Ecological Impact	0.000	−0.003	
		(0.009)	(0.002)	
Observations		439	439	439
Environmentally Sustainable Sectors		Yes	Yes	Yes
Company FE		Yes	Yes	Yes
Adj. R-squared		0.727	0.959	0.016

This research contributes to the broad advancement of societal well-being and environmental protection by fostering more informed sustainable investment decisions and aligning practices with global sustainability goals. Specifically, it enhances the transparency and comparability of ESG ratings, providing practical implications for companies, financial institutions, banks, and policymakers. Rated companies can strengthen their market position and attract sustainable investment flows by strategically aligning their own sustainable strategies with the common elements arising from the different rating agencies. This proactive approach – as well as a focus on more quantitative factors – may improve their scores in multiple ESG rankings and enhance their reputation with investors and stakeholders. Similarly, financial institutions may gain invaluable insights by identifying common factors across different ESG rating providers. This knowledge enables them to streamline their ESG integration processes and focus resources on critical areas materially impacting ESG ratings. As a result, financial

Table 16

Linear model specifications for the environmental common factors in the environmentally sustainable sectors. The table summarizes the models of the selected environmental common factors on the E sub-scores from the different data providers for the sub-set of companies operating in environmentally sustainable sectors based on the alignment to the EU Taxonomy definition. The gray cells identify the selected environmental common factors from the same data provider of the dependent variable, used as regressors in the linear analysis. The table reports the dependent and independent variables involved in the estimation in columns. Then, the number of observations and the adjusted R-squared are also reported in the last two columns. The shades of green, i.e., dark green, green, and light green, indicate that the corresponding parameter of the regressor is significantly different from zero at 1%, 5%, and 10%, respectively.

#	Dependent	Independent 1	Independent 2	Independent 3	Independent 4	Independent 5	Independent 6	Obs.	Adj R2
1	Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)		1,640	0.371
2	Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Waste Management (MSCI)	Nat. Resources in production (Moody's)		1,533	0.240
3	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Env. impacts of product use (Moody's)		1,640	0.341
4	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Waste Management (MSCI)	Corporate Env. Strategy (Moody's)		1,533	0.294
5	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Env. impacts of product use (Moody's)	1,030	0.326
6	Env. impacts of product use (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)		1,640	0.304
7	Env. impacts of product use (Moody's)	Air Quality (FactSet)	Energy Management (FactSet)	Hazardous Waste (FactSet)				1,043	0.001
8	Env. impacts of product use (Moody's)	Air Quality (FactSet)	Ecological Impact (FactSet)					1,207	0.002
9	Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Waste Management (MSCI)	1,030	0.113
10	Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)	Waste Management (MSCI)		1,533	0.103
11	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)	Climate Change (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)	1,030	0.354
12	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)		1,533	0.270
13	Natural Resources (MSCI)	Air Quality (FactSet)						4,869	0.002
14	Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)	Climate Change (MSCI)	Waste Management (MSCI)	Environmental Opportunities (MSCI)	1,030	0.354
15	Waste Management (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Environmental Opportunities (MSCI)		1,533	0.249
16	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Env. impacts of product use (Moody's)	Natural Resources (MSCI)			1,643	0.024
17	Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	Nat. Resources in production (Moody's)	Climate Change (MSCI)	Natural Resources (MSCI)	Waste Management (MSCI)		1,533	0.034
18	Air Quality (FactSet)	Env. impacts of product use (Moody's)	Energy Management (FactSet)	Hazardous Waste (FactSet)				1,043	0.002
19	Air Quality (FactSet)	Env. impacts of product use (Moody's)	Ecological Impact (FactSet)					1,207	0.001
20	Air Quality (FactSet)	Natural Resources (MSCI)						4,869	0.002
21	Energy Management (FactSet)	Env. impacts of product use (Moody's)	Air Quality (FactSet)	Hazardous Waste (FactSet)				1,043	0.022
22	Waste Hazardous (FactSet)	Env. impacts of product use (Moody's)	Air Quality (FactSet)	Energy Management (FactSet)				1,043	0.020
23	Ecological Impact (FactSet)	Env. impacts of product use (Moody's)	Air Quality (FactSet)					1,207	0.001

Table 17
Identification of the actual common factors for companies in environmentally sustainable sectors. By sorting pairs of the dependent and independent variables of the linear models listed in Table 16, the table reports 'Ratio Significant'. i.e., the ratio between the number of statistically significant pairwise combinations over the number of possible pair combinations of the two variables in the linear models.

Dependent	Independent	Ratio significant
Nat. Resources in production (Moody's)	Natural Resources (MSCI)	3/3
Natural Resources (MSCI)	Nat. Resources in production (Moody's)	3/3
Environmental Opportunities (MSCI)	Env. impacts of product use (Moody's)	2/2
Env. impacts of product use (Moody's)	Climate Change (MSCI)	1/1
Natural Resources (MSCI)	Air Quality (FactSet)	1/1
Air Quality (FactSet)	Natural Resources (MSCI)	1/1
Nat. Resources in production (Moody's)	Environmental Opportunities (MSCI)	2/3
Corporate Env. Strategy (Moody's)	Climate Change (MSCI)	1/2
Corporate Env. Strategy (Moody's)	Natural Resources (MSCI)	1/2
Corporate Env. Strategy (Moody's)	Environmental Opportunities (MSCI)	1/2
Nat. Resources in production (Moody's)	Waste Management (MSCI)	1/2
Climate Change (MSCI)	Corporate Env. Strategy (Moody's)	1/2
Waste Management (MSCI)	Corporate Env. Strategy (Moody's)	1/2
Waste Management (MSCI)	Nat. Resources in production (Moody's)	1/2
Nat. Resources in production (Moody's)	Climate Change (MSCI)	1/3
Natural Resources (MSCI)	Corporate Env. Strategy (Moody's)	0/3
Env. impacts of product use (Moody's)	Air Quality (FactSet)	0/2
Climate Change (MSCI)	Nat. Resources in production (Moody's)	0/2
Natural Resources (MSCI)	Env. impacts of product use (Moody's)	0/2
Environmental Opportunities (MSCI)	Corporate Env. Strategy (Moody's)	0/2
Environmental Opportunities (MSCI)	Nat. Resources in production (Moody's)	0/2
Air Quality (FactSet)	Env. impacts of product use (Moody's)	0/2
Corporate Env. Strategy (Moody's)	Waste Management (MSCI)	0/1
Env. impacts of product use (Moody's)	Natural Resources (MSCI)	0/1
Env. impacts of product use (Moody's)	Environmental Opportunities (MSCI)	0/1
Env. impacts of product use (Moody's)	Energy Management (FactSet)	0/1
Env. impacts of product use (Moody's)	Hazardous Waste (FactSet)	0/1
Env. impacts of product use (Moody's)	Ecological Impact (FactSet)	0/1
Climate Change (MSCI)	Env. impacts of product use (Moody's)	0/1
Waste Management (MSCI)	Env. impacts of product use (Moody's)	0/1
Energy Management (FactSet)	Env. impacts of product use (Moody's)	0/1
Waste Hazardous (FactSet)	Env. impacts of product use (Moody's)	0/1
Ecological Impact (FactSet)	Env. impacts of product use (Moody's)	0/1

institutions can allocate resources more efficiently, prioritize initiatives in line with market expectations, and direct investments to companies that demonstrate consistent sustainability performance across different raters.

These findings are subject to potential limitations. Regarding data sources, our study compares three well-known ESG rating agencies, specifically chosen for their distinct approaches to assessing ESG risks. While these agencies provide a meaningful representation of the market, the results could vary if other ESG raters with different methodologies were included in the analysis. With respect to the scope, our analysis indicates that quantitative factors are more commonly aligned across different rating providers within the environmental pillar, likely due to its stronger connection to underlying quantitative metrics. Further investigation is needed to determine whether these findings are consistent when considering ESG ratings as an aggregate or focusing on the Social (S) and Governance (G) pillars. Concerning the interpretation of the results, while the identification of common quantitative factors, particularly in Environmental ratings, suggests that ratings based on precise data tend to show less divergence, this alone is not sufficient to mitigate greenwashing. Common factors may still reflect shared misperceptions among different raters.

In this context, policymakers are pivotal in fostering an enabling environment for sustainable finance by addressing information asymmetries and promoting transparency in ESG ratings. Regulatory frameworks, such as the EU Taxonomy for Sustainable Activities, are important tools for improving the reliability, comparability, and transparency of ESG ratings. By setting clear criteria and standards, policymakers are building confidence in sustainable investment and aligning it with the broader environmental and social objectives of international agreements. This joint effort not only benefits individual stakeholders but also contributes to the collective advancement of sustainable finance on a global scale. In particular, the recent adoption by the EU of the Regulation on the Transparency and Integrity of ESG Rating Activities[13] introduced measures to improve the reliability and comparability of ESG ratings by requiring ESG rating providers within the EU to be authorized and supervised by the European Security and Markets Authority (ESMA), to comply with transparency standards regarding methodologies and information sources, and to ensure separation of activities to avoid conflicts of interest. Future research should examine the impact of this regulation on the convergence of ESG ratings across agencies and assess its effectiveness in promoting consistency and alignment of ESG ratings.

CRediT authorship contribution statement

Gianluca Gucciardi: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – reviewing & editing. **Elisa Ossola:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – reviewing & editing. **Lucia**

[13] https://data.consilium.europa.eu/doc/document/PE-43-2024-INIT/en/pdf.

Parisio: Conceptualization, Methodology, Writing – original draft, Writing – reviewing & editing. **Matteo Pelagatti:** Conceptualization, Methodology, Writing – original draft, Writing – reviewing & editing.

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Appendix A. Dataset construction

In this Section, we describe the construction of the merged dataset. Similarly to Christensen et al., 2022, we proceed as follows: (i) we identify a key present in all three databases that could uniquely identify our unit of observation, i.e., the company; (ii) we retry the Environmental score profile data of the companies provided by the three raters[14]; (iii) we use the identified unique key to complete the merger of the three databases and obtain ESG profile information from all three providers for each ID.

Although all databases contain information about company names, these are subject to differences related to abbreviations, translations, presence (absence) of punctuation marks, and inclusion (exclusion) of details about the company type (e.g., limited company vs partnership). Therefore, we chose the International Securities Identification Number (ISIN) as the unique key for merging. The ISIN is a 12-character alphanumeric code that serves as a standardized identifier for securities and is widely used in financial markets and systems worldwide. However, a company might have more than one ISIN code, and thus, the three ESG providers could use different ISIN codes to identify the same company, potentially reducing the number of observed merged companies. To address this issue, we initially enhanced the databases for every available company with their corresponding ISINs for the MSCI and Moody databases, as they permit bulk downloading of all accessible data. We achieved this using Orbis, the Bureau van Dijk database containing company identification details, including a comprehensive list of their ISIN codes.

Since we are also interested in investigating the evolution of the Environmental ratings over time, we structured the data in a panel format to encompass the companies identified in the three databases for the broadest possible analysis period. When a rating agency releases multiple ratings for a given firm-year's performance, we retain the last rating issued within 12 months of the firm's fiscal year-end. This practice ensures that all the rating agencies in our sample have had an opportunity to observe any disclosures a firm has made relating to the year t's Environmental performance. The final dataset includes Environmental ratings from three different databases for 5,128 listed companies based in 70 countries, observed over 11 years (2012–2022). The three databases include different structures and levels. Table A.1 describes all the variables we use to analyze the sub-E-level scores. Our dataset is an unbalanced panel as information regarding Environmental ratings is not consistently available for all years (see Table A.2 for the distribution of the observations by country and year and Table A.3 for the evolution of E sub-scores).

[14] It is necessary to mention that the data download system from the three providers is different: while MSCI and Moody's allow bulk download of all available data, FactSet only allows obtaining ESG data for companies following a search via identifier. As a result, from a chronological perspective, we first merged MSCI and Moody's data and then verified which companies present in both databases were also available on FactSet.

Table A.1
Description of sub-E-score variables The table provides a qualitative description of E sub-scores based on the definition of the three ESG rating providers.

Provider	Sub E-Score	Description
FactSet	GHG Emissions	Scope 1 greenhouse gas emissions that a company generates through its operations.
	Air Quality	Air quality impacts resulting from stationary and mobile sources and industrial emissions.
	Energy Management	Environmental impacts associated with energy consumption (energy efficiency/ mix).
	Water Waste	Company's water use, water consumption, and wastewater generation.
	Hazardous Waste	Environmental issues associated with (non)hazardous waste generated by companies.
	Ecological Impacts	Company's impacts on ecosystems and biodiversity (e.g., land use, extraction).
Moody's	Corporate Env. Strategy	Integration of Environmental Issues into the Corporate Strategy (e.g., green product/services)
	Natural Resources in Production	Incorporation of Environmental Considerations into Manufacturing and Distribution of Products
	Env. Impact of Product Use	Environmental Considerations in the Use and Disposal of Products/Services
MSCI	Climate Change	Company's exposure to risks related to Climate Change (e.g., Carbon Emissions, Energy Efficiency).
	Natural Resources	Company's exposure to risks related to Water Stress, Biodiversity and Land Use, and Raw Material Sourcing.
	Waste Management	Company's exposure to risks related to Toxic Emissions and Waste, Packaging Material and Waste, and Electronic Waste.
	Environmental Opportunities	Company's exposure to risks related to Opportunities in Clean Tech, Green Building, and Renewable Energy.

Table A.2
Distribution of companies by country and year The table shows the distribution of observations of companies showing joint non-missing information at the E-score level by country and year.

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Avg	Share
USA	109	144	144	168	159	217	234	373	385	220	215	38.6%
Japan	28	13	39	23	51	29	72	114	120	72	56	10.1%
United Kingdom	20	16	29	28	32	36	48	72	87	37	41	7.3%
France	14	20	19	20	21	22	30	43	49	44	28	5.1%
Canada	6	15	8	18	19	28	35	57	51	33	27	4.8%
Germany	10	17	20	17	19	18	27	36	37	18	22	3.9%
India	5	12	13	10	10	15	13	32	24	25	16	2.9%
Australia	6	4	12	5	17	8	20	30	28	19	15	2.7%
Korea	3	10	9	12	8	14	7	28	25	19	14	2.4%
Switzerland	5	7	7	6	8	7	12	20	19	12	10	1.8%
Spain	3	5	6	7	5	7	8	15	19	15	9	1.6%
China	0	1	3	4	3	3	5	22	20	25	9	1.5%
South Africa	5	7	8	4	5	6	8	18	14	11	9	1.5%
Netherlands	3	3	6	3	5	7	9	16	19	12	8	1.5%
Hong Kong	2	2	7	1	8	2	8	16	20	11	8	1.4%
Italy	0	1	1	1	1	3	4	10	15	19	6	1.0%
Sweden	1	3	2	4	3	5	7	11	12	6	5	1.0%
Taiwan	0	1	1	2	2	2	3	9	13	14	5	0.8%
Denmark	2	2	1	5	2	3	6	8	10	7	5	0.8%
Finland	2	4	1	3	2	5	3	11	11	4	5	0.8%
Ireland	2	2	2	4	1	6	4	10	10	4	5	0.8%
Russia	3	2	6	4	3	3	4	8	5	2	4	0.7%
Singapore	1	1	1	3	1	5	2	10	8	7	4	0.7%
Brazil	1	2	1	2	1	3	4	7	8	6	4	0.6%
Malaysia	1	3	3	3	1	3	1	6	6	4	3	0.6%
Thailand	0	0	0	1	1	3	3	7	5	7	3	0.5%
New Zealand	0	0	1	1	1	1	4	9	4	5	3	0.5%
Austria	0	1	1	2	1	2	1	5	5	6	2	0.4%
Norway	1	1	1	2	1	1	2	5	7	3	2	0.4%
Mexico	0	2	2	1	1	1	1	6	5	2	2	0.4%
Israel	0	0	0	0	1	4	1	6	3	4	2	0.3%
Chile	1	1	1	0	1	1	2	4	4	2	2	0.3%
Philippines	0	2	0	1	1	2	1	4	3	3	2	0.3%
Belgium	0	0	0	1	2	1	2	3	5	1	2	0.3%
Turkiye	0	0	0	0	1	0	2	3	3	5	1	0.3%
Luxembourg	0	0	0	0	1	0	1	4	3	4	1	0.2%
Colombia	0	1	1	1	0	1	1	2	2	1	1	0.2%
Poland	0	1	0	1	0	1	0	2	1	3	1	0.2%
Qatar	0	1	0	1	0	1	1	2	2	1	1	0.2%
Indonesia	0	0	0	0	1	0	1	2	1	1	1	0.1%
Bermuda	0	0	0	0	0	0	0	1	3	1	1	0.1%
Macao	0	0	0	0	1	0	1	1	1	1	1	0.1%
Portugal	0	0	0	0	0	0	1	1	2	1	1	0.1%
UAE	0	0	0	1	0	1	0	1	0	1	0	0.1%
Saudi Arabia	0	0	0	0	0	1	0	1	1	1	0	0.1%
Czech Republic	0	0	0	0	0	0	0	1	0	1	0	0.0%
Peru	0	0	0	0	0	0	0	1	0	1	0	0.0%
Greece	0	0	0	1	0	0	0	0	0	0	0	0.0%

Table A.3
Evolution of E sub-scores The table describes the evolution of E sub-scores in times. For each indicator and year, the table presents the sample mean and related standard deviation (in brackets). The columns 'Avg', 'Median', 'Min', 'Max', and 'SD' display the mean, median, minimum, maximum, and standard deviation across years of each E sub-score.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Avg	Median	Min	Max	SD
FS GHG Emissions	48.656	51.354	49.835	49.072	50.661	51.549	48.862	49.290	56.487	60.793	51.656	50.248	48.656	60.793	3.746
	(23.921)	(25.217)	(24.146)	(25.174)	(26.558)	(25.170)	(25.049)	(24.400)	(23.807)	(24.280)					
FS Air Quality	46.811	44.27	47.722	46.412	47.571	49.118	48.794	47.847	49.212	52.305	48.006	47.785	44.270	52.305	2.000
	(25.582)	(24.616)	(26.211)	(24.849)	(24.487)	(23.949)	(24.620)	(24.060)	(25.268)	(24.78)					
FS Energy Management	54.022	50.638	53.657	50.038	51.041	51.24	49.276	50.683	48.169	52.343	51.111	50.862	48.169	54.022	1.734
	(25.910)	(24.550)	(26.782)	(24.984)	(25.357)	(23.776)	(24.751)	(24.577)	(26.169)	(23.696)					
FS Water Waste	45.147	46.082	52.951	51.319	50.529	51.590	50.309	48.580	51.350	56.390	50.425	50.924	45.147	56.390	3.084
	(28.775)	(27.839)	(28.439)	(28.628)	(27.429)	(26.432)	(26.867)	(27.232)	(27.303)	(26.390)					
FS Hazardous Waste	51.182	52.424	49.918	49.627	49.451	48.597	53.824	58.164	56.552	59.278	52.902	51.803	48.597	59.278	3.685
	(26.501)	(26.667)	(26.553)	(26.793)	(24.681)	(24.477)	(25.865)	(27.157)	(27.476)	(25.451)					
FS Ecological Impact	49.524	48.593	49.896	49.125	49.792	51.253	50.546	51.101	56.066	57.376	51.327	50.221	48.593	57.376	2.823
	(29.198)	(27.819)	(28.511)	(28.484)	(26.461)	(27.310)	(27.608)	(27.228)	(27.742)	(26.258)					
MO Corporate Env. Strategy	48.397	45.518	46.688	44.102	45.791	44.462	49.129	48.216	50.964	52.484	47.575	47.452	44.102	52.484	2.628
	(19.105)	(19.472)	(19.352)	(19.616)	(19.819)	(19.856)	(19.345)	(19.597)	(19.131)	(19.401)					
MO Nat. Resources in produc.	34.709	31.797	34.194	32.878	33.948	33.727	36.828	36.434	39.213	40.695	35.442	34.452	31.797	40.695	2.680
	(16.285)	(16.562)	(16.158)	(16.184)	(15.983)	(16.802)	(15.884)	(16.872)	(16.802)	(17.985)					
MO Env. Impacts of prod. use	34.638	32.421	34.503	31.020	32.491	28.343	36.170	32.994	34.945	34.768	33.229	33.749	28.343	36.170	2.181
	(20.099)	(20.196)	(21.360)	(20.941)	(22.712)	(22.08431	(21.721)	(21.230)	(21.356)	(21.321)					
MS Climate Change	77.057	68.034	71.213	70.488	71.883	71.395	73.210	73.244	75.514	77.157	72.920	72.547	68.034	77.157	2.794
	(22.796)	(29.544)	(26.239)	(28.498)	(26.039)	(28.876)	(26.996)	(26.895)	(25.766)	(25.190)					
MS Natural Resources	53.609	55.064	63.378	63.401	61.826	62.223	60.062	64.725	66.454	66.247	61.699	62.801	53.609	66.454	4.130
	(26.172)	(26.509)	(26.425)	(27.110)	(25.284)	(27.327)	(26.849)	(25.695)	(24.553)	(24.470)					
MS Waste Management	52.725	56.187	64.836	65.507	65.516	45.167	46.83	45.381	47.462	46.604	53.622	50.094	45.167	65.516	8.298
	(24.211)	(26.709)	(27.237)	(27.713)	(26.340)	(24.927)	(20.564)	(21.476)	(21.554)	(21.064)					
MS Env. Opportunities	59.929	51.463	52.858	50.641	51.941	48.670	49.037	49.181	51.666	51.363	51.675	51.413	48.670	59.929	3.050
	(17.583)	(16.035)	(14.703)	(15.866)	(16.254)	(14.544)	(16.671)	(14.707)	(14.468)	(15.461)					

Table A.4
List of environmentally sustainable sectors based on the alignment to the EU Taxonomy. The table lists all the NACE sectors included in the EU Taxonomy and with a positive taxonomy alignment coefficient (TAC) according to Alessi and Battiston (2022).

NACE Code	NACE Description	TAC
C.20.13	Manufacture of other inorganic basic chemicals	0.050
C.20.14	Manufacture of other organic basic chemicals	0.050
C.20.15	Manufacture of fertilizers and nitrogen compounds	0.050
C.20.16	Manufacture of plastics in primary forms	0.070
C.23.51	Manufacture of cement	0.050
C.24.1	Manufacture of basic iron and steel and ferro-alloys	0.050
C.24.2	Manufacture of tubes, pipes, hollow profiles, and related fittings of steel	0.050
C.24.31	Cold drawing of bars	0.050
C.24.32	Cold rolling of narrow strip	0.050
C.24.33	Cold forming or folding	0.050
C.24.34	Cold drawing of wire	0.050
C.24.42	Aluminum production	0.050
C.24.51	Casting of iron	0.050
C.24.52	Casting of steel	0.050
C.24.53	Casting of light metals	0.050
C.27.2	Manufacture of batteries and accumulators	1.000
C.29.1	Manufacture of motor vehicles	0.022
C.30.2	Manufacture of railway locomotives and rolling stock	0.562
D.35.11	Production of electricity	0.346
D.35.12	Transmission of electricity	1.000
D.35.13	Distribution of electricity	1.000
D.35.21	Manufacture of gas	0.010
D.35.3	Steam and air conditioning supply	0.315
E.38.11	Collection of non-hazardous waste	0.379
E.38.21	Treatment and disposal of non-hazardous waste	0.022
E.38.32	Recovery of sorted materials	1.000
F.41	Construction of buildings	0.400
F.41.1	Development of building projects	0.400
F.41.2	Construction of residential and non-residential buildings	0.400
F.42.12	Construction of railways and underground railways	0.562
F.42.13	Construction of bridges and tunnels	0.036
F.42.22	Construction of utility projects for electricity and telecommunications	0.256
F.43	Specialized construction activities	0.400
F.43.22	Plumbing, heat and air-conditioning installation	0.120
H.49.10	Passenger rail transport, interurban	0.562
H.49.20	Freight rail transport	0.562
H.49.31	Urban and suburban passenger land transport	0.019
H.49.32	Taxi operation	0.003
H.49.39	Other passenger land transport n.e.c.	0.003
H.49.41	Freight transport by road	0.002

(*continued on next page*)

Table A.4 (*continued*).

NACE Code	NACE Description	TAC
H.52.21	Service activities incidental to land transportation	0.036
H.53.1	Postal activities under universal service obligation	0.002
H.53.2	Other postal and courier activities	0.002
L.68	Real estate activities	0.150
N.77.1	Rental and leasing of motor vehicles	0.020
N.77.11	Rental and leasing of cars and light motor vehicles	0.003
N.77.12	Rental and leasing of trucks	0.002

Table B.1

Linear model specification for the environmental common factors. The table describes the results of the estimations summarized in Table 9. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A - Dependent Variables from Moody's

Dependent variables		Corporate Env. Strategy (Moody's)			Nat. Resources in production (Moody's)					Env. Impacts of Product Use (Moody's)		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Moody's	Corporate Env. Strategy				0.363***	0.408***		0.363***	0.301***	0.429***		0.424***
					(0.035)	(0.017)		(0.035)	(0.039)	(0.046)		(0.046)
	Nat. Resources in production	0.310***	0.492***	0.310***						0.219***	0.442***	0.212***
		(0.026)	(0.019)	(0.026)						(0.038)	(0.034)	(0.039)
	Env. Impacts of Product Use	0.254***		0.254***	0.148***		0.288***	0.148***	0.112***			
		(0.031)		(0.031)	(0.027)		(0.024)	(0.027)	(0.028)			
FactSet	Air Quality						0.009				0.008	
							(0.006)				(0.008)	
MSCI	Climate Change	0.042***	0.060***	0.042***	0.115***	0.049***		0.115***	0.062***			0.030
		(0.016)	(0.010)	(0.016)	(0.019)	(0.009)		(0.019)	(0.020)			(0.024)
	Waste Management		−0.022**			0.027***			0.075***			
			(0.009)			(0.009)			(0.020)			
	Environmental Opportunities	−0.048**		−0.048**	0.028			0.028	0.024	0.052*		0.054*
		(0.022)		(0.022)	(0.025)			(0.025)	(0.025)	(0.030)		(0.029)
	Natural Resources	0.024	0.018*	0.024	0.114***	0.083***		0.114***	0.106***	0.010		0.007
		(0.015)	(0.009)	(0.015)	(0.015)	(0.009)		(0.015)	(0.018)	(0.019)		(0.019)
Observations		3,505	8,879	3,505	3,505	8,879	4,247	3,505	2,253	3,515	4,247	3,505
Adj. R-squared		0.888	0.867	0.888	0.834	0.843	0.805	0.834	0.838	0.822	0.802	0.823
Company FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B - Dependent Variables from MSCI and FactSet

Dependent variables		Climate Change (MS)			Natural Resources (MS)				Waste Manag. (MS)	Env. Opport.(MS)		Air Quality (FS)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Moody's	Corporate Env. Strategy	0.163***	0.163***	0.104**	0.073	0.056*	0.081	0.158*	−0.063**	−0.033	−0.061**	
		(0.026)	(0.026)	(0.040)	(0.046)	(0.029)	(0.050)	(0.093)	(0.028)	(0.023)	(0.027)	
	Nat. Resources in prod.	0.160***	0.160***	0.241***	0.370***	0.306***	0.329***	0.337***	0.094***	0.031	0.031	0.084
		(0.029)	(0.029)	(0.038)	(0.044)	(0.033)	(0.043)	(0.081)	(0.029)	(0.023)	(0.027)	(0.053)
	Env. Impacts of Prod. Use			0.044	0.033		0.013	−0.089		0.060***	0.041*	0.047
				(0.035)	(0.031)		(0.039)	(0.061)		(0.020)	(0.022)	(0.046)
FactSet	GHG Emissions							0.016				
								(0.020)				
	Air Quality							0.010				
								(0.017)				
	Energy Management							−0.049***				
								(0.017)				
	Water Waste							−0.001				
								(0.017)				
	Hazardous Waste							0.021				
								(0.015)				
	Ecological Impact							0.034**				
								(0.015)				
MSCI	Climate Change				0.148***	0.015	0.147***	0.035	0.034**		0.027	
					(0.027)	(0.022)	(0.035)	(0.061)	(0.016)		(0.020)	
	Waste Management	0.032**	0.032**		0.170***	0.232***		0.497***				
		(0.015)	(0.015)		(0.026)	(0.021)		(0.057)				
	Env. Opport.			0.051			−0.022	0.116				
				(0.037)			(0.048)	(0.080)				
	Natural Resources	0.013	0.013	0.106***					0.217***		−0.008	
		(0.020)	(0.020)	(0.025)					(0.016)		(0.018)	
Observations		8,879	8,879	3,505	4,379	8,879	3,505	911	8,879	5,377	3,505	4,247
Adj. R-squared		0.827	0.827	0.725	0.742	0.744	0.724	0.748	0.778	0.753	0.743	0.001
Company FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix B. Actual environmental common factors identification

In this Section of the Appendix, we provide all the results of the estimations synthetically represented in Table 9.

Data availability

The authors do not have permission to share data.

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