

RESEARCH ARTICLE

The effect of sustainable business practices on profitability. Accounting for strategic disclosure

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Abstract

This work tackles from an empirical perspective the widely debated relationship between sustainability in business practices and profitability, focusing on a sample of listed European firms. To measure the extent of sustainable practices at the firm level, the Comprehensive Environmental, Social, and Governance (ESG) score is proposed. The indicator, computed using the Mazziotta-Pareto method, combines qualitative ratings on adherence to ESG standards with quantitative observations on the extent of data disclosure. Firms failing to pursue full disclosure are penalized. Focusing on the constituents of the Euro Stoxx 300 index, a dynamic panel model is implemented, where profitability is explained by the indicator. The results show that sustainability in business practices reduces profitability. These findings are in line with a strand of literature that highlights the role of strategic disclosure of ESG information on part of firms. Strategic disclosure occurs as a combination of greenwashing and social washing, with firms overstating the extent of their positive behaviors. The integration of sustainable practices within successful business models thus remains a relevant societal problem. The current EU policy framework is discussed in line with our findings.

KEYWORDS

dynamic panel estimation, environmental policy, ESG practices, sustainable business practices, sustainable development

1 | INTRODUCTION

In the early 1990s, societal concerns over environmental and social sustainability, arising from the demand side of the market, sparked a shift in business paradigms across developed countries (Kotsantonis et al., 2016). Issues like greenhouse gas emissions, energy consumption, worker rights, workforce diversity and gender equity gradually gained momentum in both the academic debate and the management discourse. Corporate policies tackling these dimensions were collectively labeled Environmental, Social and Governance (ESG) practices.

Some pioneering large firms were the first to try to incorporate ESG practices into their business models, devising various forms of self-regulation schemes (Vitell & Hidalgo, 2006). Over the course of the following 20 years, ESG practices have caught off extensively across industries and countries (Agudelo et al., 2019). Favorable reception on part of both the civil society and institutional actors has fueled their diffusion further. Despite the generalized praise enjoyed by ESG practices worldwide, significant cross-firm heterogeneity is still reported in adherence to ESG practices, and a significant share of laggards exists (Gerard, 2019).

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The presence of firms that fail to comply to ESG standards is *per se* an element that casts doubt on the economic effects of ESG practices. From an economic perspective indeed, it is unclear whether and how ESG practices should affect profitability. Scholars largely disagree on the existence of an *ESG premium* (Avramov et al., 2021; Gillan et al., 2021; Pollard et al., 2018). One key problem in this debate pertains to the all-but-straightforward measurement of ESG performance, which leaves room for several alternative approaches and yields contrasting results (Friede et al., 2015; Gillan et al., 2021; Orlitzky et al., 2003). The empirical literature vastly resorts to ESG ratings, provided by institutional agencies and generally considered as good proxies. Ratings alone however may be misleading, since they are at least in part based on information disclosed by the firms themselves, which may face an incentive to strategically avoid full disclosure and provide only information on some areas where they perform best (McBrayer, 2018; Tamimi & Sebastianelli, 2017). Information on the environmental dimension of ESG practices in particular is less often available in comparative terms, which raises concerns on the drivers of disclosure.

Based on the above, this work attempts to address a long-standing question on the relationship between ESG practices and profitability (Wanger et al., 2002; Horváthová, 2010). To do so, we propose a novel composite indicator that combines ESG ratings with disclosure scores. Strategic disclosure on part of firms, aiming to overstate the actual extent of ESG practices, is thus penalized, consistent with the idea that providing full ESG information is *per se* a positive signal (Minutolo et al., 2019). Ultimately, we aim to capture the real extent of ESG practices and to assess their impact on profitability. The originality of this study is twofold. First, to the best of our knowledge, this is the first time that a metric takes into account information on both the quality and quantity of information on ESG practices is proposed. Using the Mazziotta-Pareto method, our comprehensive ESG score combines Refinitiv data on ESG ratings with Bloomberg data on ESG disclosure. The indicator introduces a nonlinear penalty for firms that fail to disclose full information, consistent with the idea that those that tell less have more to hide. Second, while much of the literature uses either US data or wide international samples, we focus on the constituents of Euro Stoxx 300, meaning we focus on the Eurozone alone. Our results show that the actual effect of ESG practices on economic performance is negative. Nonetheless, we argue that the long-run impact of ESG practices is not only crucial in terms of well-being, but also potentially beneficial for economic performance in a future world that is bound to be structurally different from the present.

The rest of this work is organized as follows. Section 2 provides a review of the current debate in the economic literature and outlines the fundamental research questions of this work. Section 3 describes the empirical strategy adopted, with a focus on the novel indicator proposed. Section 4 introduces the dataset available, providing a rationale for choice of covariates. Section 5 shows and comments the results of the analysis. Section 6 discusses the results obtained in light of the previous literature. Section 7 provides some final considerations and concluding remarks.

2 | LITERATURE REVIEW

The publication of the report entitled “Who Cares Wins” by the UN Global Compact laid the foundations of ESG dimensions of economic activities, emphasizing the importance of ethical finance (Busch et al., 2021; Eccles et al., 2020). The environmental pillar refers to issues such as climate change, biodiversity, air, and water quality. Thus, it measures firm commitment to energy efficiency, emission reduction, and effective use of natural resources. The social pillar instead covers firm commitment to social rights, equal opportunities, and gender equity, aiming for equitable working conditions and social inclusion, with a focus on the community in which the firm operates. Finally, the governance pillar relates to the firm's commitment to transparency in accounting and remuneration, to a balanced distribution of responsibilities among shareholders (including minority shareholders) and to avoidance of illegal practices.

While the earliest studies on the ESG dimensions of corporate activities date back to the 1970 (Friede et al., 2015), in recent years ESG practices have received much more attention from managers, investors and policymakers (Li et al., 2021), since they provide additional information with respect to financial indicators, thus constituting a valuable asset in the decision-making process (Busch et al., 2016). From the consumer's point of view, the products supplied by firms featuring a strong ESG drive are more attractive due to their higher sustainability content. For investors, the stocks of firms focusing on ESG practices are less risky *ceteris paribus* (Minutolo et al., 2019). In the policymaker's perspective, ESG information sheds light on the extent to which economic development is paired with environmental conservation and social cohesion. For these reasons, firms have become more and more prone to sharing data on ESG practices (Slager et al., 2012). Focusing on Standard & Poor 500 constituents for instance, the listed companies that published ESG reports went from 20% in 2011 to 85% in 2017 (Coppola, 2018). As of 2016, more than 100 rating agencies provided ESG data, including Morgan Stanley Capital International (MSCI), Thomson Reuters/Refinitiv, and Bloomberg. In comparison to US investors, European investors have been shown to be more responsive to ESG data when making portfolio choices (Amel-Zadeh & Serafeim, 2018).

Within the growing body of literature on ESG practices, several studies have tackled the relation between ESG practices and firm performance (Brooks & Oikonomou, 2018; Friede et al., 2015). In particular, scholars have wondered whether ESG practices constitute a source of competitive advantage or mainly a cost burden. Over the last four decades, contradictory results have emerged and the nature of the relationship remains overall ambiguous (Friede et al., 2015; Gillan et al., 2021; Margolis & Walsh, 2003). Many authors find a positive association between the adoption of sustainable practices and profitability. An early meta-analysis covering 52 pioneering studies over a period of 30 years by Orlitzky et al. (2003) shows a strong and positive association between firm commitment to social issues and financial performance. Another meta-analysis by Wu (2006) finds that firms benefit from being socially responsible in terms of profits. Eccles et al. (2014), analysing a sample period of 180 US firms between



1993 and 2009, argue that sustainable firms outperform non-sustainable firms in terms of stock market and accounting performance. More recently, a meta-analysis by Friede et al. (2015), aggregating 3700 studies, suggests that the majority of firm-level works find a positive relation between ESG commitment and corporate financial performance. De Lucia et al. (2020), using sample of 1038 public companies in Europe, find evidence in support of a positive relationship between ESG practices and return on equity (ROE). Alareeni and Hamdan (2020), focusing on S&P 500 listed companies during from 2009 to 2018, report that ESG disclosure has a positive effect on ROE and ROA. While this strand of literature is vast, the lack of specific, standardized, and comparable data on ESG performance casts doubt on its findings. A more recent set of studies has looked at ESG indicators, focusing on banks and financial institutions. Buallay (2019a), using a sample of 235 banks during the 2007–2016 time-span, finds that ESG practices have an overall positive effect on ROA and ROE, but the Social and Environmental pillars taken individually produce negative effects. Cornett et al. (2016), focusing on US commercial banks from 2003 to 2013, find that ROE is positively impacted by ESG practices. Wu and Shen (2013) obtain the same result looking at 162 financial companies during the period 2003–2009. These contributions argue that ESG practices improve performance by reducing financial risks, especially during crises (Broadstock et al., 2021; Lins et al., 2017).

Several theories in the current literature try to explain the positive association between ESG practices and firm performance. Resource-based view (RBV) states that a firm's resources, such as human capital, corporate governance, and sustainable business processes, represent the key to competitive advantage. In this view, ESG practices constitute strategic resources (Bird et al., 2007; Barney, 1991; Hull & Rothenberg, 2008; Russo & Fouts, 1997) that boost firm reputation (Aguilera et al., 2007; Kim et al., 2018; Li et al., 2019; Orlitzky et al., 2003) and enhance loyalty and trust among consumers (Greening & Turban, 2000; Roberts & Dowling, 2002). ESG practices are thus described as a key driver of superior long-run performances (Ruf et al., 2001). Stakeholder theory proposes an alternative interpretation. In this view, the firm faces a moral duty to maximize the value of all subjects that gravitate around it, including customers, employees, and regulators (Azmi et al., 2021). The firm should thus meet the demands of multiple stakeholders, in view of profit-maximization (Freeman, 2010; Jones, 1995; Steurer et al., 2005; Ali et al., 2017). Satisfying the interests of different actors related to the firm, helps create value for all stakeholders (and not only for shareholders), enhancing the success of the firm in the long run (Freeman, 2010). To this regard, Makni et al. (2009) show that leaving stakeholders unsatisfied may lead to negative consequences for firm performance. Overall, stakeholder theory emphasizes the firm's ability to convert social responsibilities into profits. Porter and Kramer (2006) argue that ESG activities should be seen as an opportunity for competitive advantage, rather than a source of costs. Firms thus undertake sustainable initiatives both for positive firm image (Franceschelli et al., 2018; Santoro et al., 2019) and due to the pressure exerted by stakeholders (Sharma & Henriques, 2005).

Another strand of the economic literature maintains that ESG practices produce a negative impact on firm performance (Brammer et al., 2006; Branco & Rodrigues, 2008; Duque-Grisales & Aguilera-Caracuel, 2021; Smith et al., 2007). An early contribution by Aupperle et al. (1985) highlights an inverse relation between the emphasis put on the ethical components of economic activities and profitability. Lee et al. (2009) finds a decline in equity value for firms with high-ESG scores, arguing that ESG activities penalize financial performance. Reinhardt and Stavins (2010) find that involvement in sustainable initiatives leads to competitive disadvantage. Along the same line, Devinney (2009) points out that ESG practices entail significant costs that outweigh the additional flows of revenues they generate. Preston and O'Bannon (1997) find that the costs of sustainable projects reduce shareholder value and firm profitability. Buallay (2019b), focusing on 342 financial institutions between 2007 and 2016, find that ESG practices decrease profitability. Mohamed Buallay et al. (2021) find a negative relationship between sustainability reporting and financial performance in different areas of the globe over the 2008–2017 period. DasGupta (2021), using data from 27 countries from 2010 to 2019, concludes that ESG practices hinder financial performance. Similarly, Qureshi et al. (2021) suggests that spending on environmental and social activities decreases the profitability. Finally, Buallay et al. (2020), examining 882 financial firms from developed and developing countries in the 11 years after the 2008 financial crisis, find a negative impact of ESG practices on ROA, ROE, and Tobin's Q. This strand of the literature points out that ESG activities are costly, and firms engaged in ethical initiatives are bound to underperform in the long run (Bauer et al., 2006; Cardebat & Sirven, 2010; Di Giuli & Kostovetsky, 2014).

Several theoretical explanations have been proposed to justify these results. Contrary to the stakeholder view, Brown and Caylor (2006) for instance claim that attempting to satisfy all stakeholders is not beneficial, but even negative for firm performance. The trade-off view considers ESG activities as a supplementary cost, eroding shareholders value through an inefficient use of resources which impacts firm performance (Friedman, 1970). In general, the traditional neoclassical approach, sees ESG practices mostly as a source of additional costs (Derwall et al., 2005; Hassel et al., 2005; Palmer et al., 1995). According to Schuler and Cording (2006), managers who implement ESG activities are giving up alternative initiatives that may prove more profitable. In this view, apart from the explicit costs implied by ESG activities, they also come with a relevant opportunity cost. Sprinkle and Maines (2010) widen the cost argument, identifying three types of costs associated with ESG activities: opportunity costs, sunk costs and recurrent costs, all which contribute to worsening economic performance. According to agency theory instead, managerial incentives to pursue personal interests represent a cost for shareholders (Brown et al., 2006; Krüger, 2015). ESG practices constitute one of the channels through which the managerial agency problem occurs (Bénabou & Tirole, 2010; Buchanan et al., 2018; Masulis & Reza, 2015; Seifert et al., 2004). Barnea and Rubin (2010) state that agency costs arise when managers tend to engage in ESG activities to develop and strengthen individual benefits, such as personal

reputation, decreasing the focus on core managerial duties and responsibilities (Jensen, 2002). Other studies confirm that managers may fail maximize profits while pursuing ESG targets for their own interest (Jensen & Meckling, 1976; Jiraporn & Chintrakarn, 2013).

While some studies find positive effects of ESG practices on firm performance and other find negative effects, another strand of the empirical literature finds no significant relationship between the two variables. Garcia and Orsato (2020) for instance obtain mixed outcomes. Observing samples from developing countries such as Brazil and South Africa, they report a negative relationship between ESG scores financial performance. The direction of the relationship changes when using a sample of firms operating in developed countries. Buallay (2019b) illustrates that ESG practices positively affects firm performance positively in the manufacturing sector, but negatively in the banking sector. Shakil et al. (2019), examining 93 banks in emerging countries during the period 2015–2018, find that the Environmental and Social pillars produce a positive impact on ROE, while the Governance pillar has no effect. Nirino et al. (2021) fail to confirm the mitigating effect of ESG practice on the association between corporate controversies and financial performance. La Torre et al. (2021), using a panel of European banks listed in STOXX Europe 600 from 2008 to 2019, find no relationship between ESG practices and account-based performance. Several other studies indeed find nonsignificant relationships, adding complexity to the puzzle (Chih et al., 2010; Gilley et al., 2000; Hsu et al., 2018; Humphrey et al., 2012; Surroca et al., 2010). The vast and growing literature tackling the relationship between sustainable practices and profitability has taken advantage of a substantial increase in the availability of ESG data (Kotsantonis et al., 2016).

The economic literature however raises some concerns with respect to the quality of ESG information. The lack of an internationally recognized ESG auditing authority and the presence of behavioral issues at the firm level may hinder the accuracy of ESG measures (Friede, 2019; Kotsantonis & Serafeim, 2019; Yu et al., 2020). In particular, the fact that not all firms pursue full disclosure of ESG information casts doubt on the actual incentives that drive disclosure decisions. The general consensus holds that increases in the amount of information disclosed do not necessarily imply a stronger commitment to ESG practices (Plumlee et al., 2015). According to Hopwood (2009), strategic disclosure may smoothen the reputation building process. In particular, narrative disclosure may shape public opinion by catering self-servingly biased information (Merkl-Davies & Brennan, 2011). In this view, managerial boards may misrepresent the extend of actual ESG practices, disclosing favorable information that improves reputation for both the firm and managers themselves (Brennan & Guillamon-Saorin, 2009; Melloni et al., 2017). Given the voluntary nature of ESG disclosure, managers strategically select the data to disclose, consistent with their preferences, influencing the market environment in which they compete (Clarkson et al., 2008). This literature refers to the “management obfuscation hypothesis,” first introduced by Li (2008), according to which managers have an incentive to lie and cloud the quality of information when ESG performance is poor, while they are willing to disclose and divulgate full information when the ESG performance is strong.

TABLE 1 Sectoral breakdown

Industry	Number	Share
Banking services	18	9.0%
Chemicals	14	7.0%
Automobiles & auto parts	11	5.5%
Electric utilities & IPPs	11	5.5%
Insurance	10	5.0%
Machinery, tools, heavy vehicles, trains	10	5.0%
Telecommunications services	10	5.0%
Construction & engineering	7	3.5%
Pharmaceuticals	7	3.5%
Food & drug retailing	6	3.0%
Oil & gas	6	3.0%
Professional & commercial services	6	3.0%
Software & IT services	6	3.0%
Aerospace & defense	5	2.5%
Multiline utilities	5	2.5%
Residential & commercial REITs	5	2.5%
Textiles & apparel	5	2.5%
Beverages	4	2.0%
Investment banking & investment services	4	2.0%
Media & publishing	4	2.0%
Oil & gas related equipment and services	4	2.0%
Construction materials	3	1.5%
Healthcare equipment & supplies	3	1.5%
Hotels & entertainment services	3	1.5%
Metals & mining	3	1.5%
Personal & household products & services	3	1.5%
Semiconductors & semiconductor equipment	3	1.5%
Transport infrastructure	3	1.5%
Consumer goods conglomerates	2	1.0%
Healthcare providers & services	2	1.0%
Homebuilding & construction supplies	2	1.0%
Paper & forest products	2	1.0%
Passenger transportation services	2	1.0%
Specialty retailers	2	1.0%
Biotechnology & medical research	1	0.5%
Communications & networking	1	0.5%
Food & tobacco	1	0.5%
Freight & logistics services	1	0.5%
Household goods	1	0.5%
Investment holding companies	1	0.5%
Natural gas utilities	1	0.5%
Renewable energy	1	0.5%
Water & related utilities	1	0.5%

In spite of the problems related to strategic disclosure, the vast majority of the empirical studies on the effect of ESG practices use ESG scores provided by rating agencies (Escrig-Olmedo et al., 2019;

TABLE 2 Descriptive statistics

	Observations	Mean	Std. dev.	Min	Max
ROE	2000	11.782	12.849	−66.870	264.360
Com ESG score	2000	68.363	20.483	0	100.000
Debt on equity	2000	126.600	341.124	0	5785.000
Firm size	2000	6.581	0.990	0	7.574
Revenues	2000	9.159	1.342	4.263	12.440
Market value	1984	2.351	2.624	0.170	79.850

Abbreviations: ESG, environmental, social, and governance; ROE, return on equity.

Howard-Grenville, 2021; Tarmuji et al., 2016). Friede et al. (2015), running a meta-analysis on over 2000 scientific articles, find significant differences with respect to the measures employed in assessing ESG practices. Pagano et al. (2018) discuss the current state of ESG indicators, identifying the pros and cons of nine different ESG data providers. Multidimensional or original measures have also been used: Rodríguez-Fernández et al. (2019) for instance integrate Thompson Reuters's ESG score, with the controversy indicator (C), a proxy for firm exposure to ESG risks reflected in global media, obtaining the so-called ESGC index. Fiaschi et al. (2020) instead propose an original index of corporate wrongdoing, measured as the number of controversies in which firm is involved. In the face of this plethora of options, Muñoz-Torres et al. (2019), as well as Li and Polychronopoulos (2020) claim that investors and academics should choose the data providers whose ratings align more closely with their personal views on ESG practices. Summing up, in the presence of all these alternatives in the measurement of ESG practices, it should not be surprising that no broad consensus exists on how ESG practices affect profitability.

3 | DATA

The dataset used in this work refers to the constituents of Euro Stoxx 300, which is a share index of Eurozone stocks designed by STOXX, an index provider owned by the Deutsche Börse Group. It contains constituents belonging to 11 Eurozone countries. In total, Euro Stoxx 300 contains over 290 firms. For the purpose of this work, 200 firms were considered due to data availability. In particular, some firms lacked either an *ESG Score* or an *ESG Disclosure Score*, or even both. Overall, our dataset contains yearly observations for 200 firms, spanning from 2010 to 2019. The firms considered operate in several different industries. The sectoral breakdown of the firms in the sample is shown in Table 1.

The main statistical features of the firms considered are summed up in Table 2.

The definitions of the variables used is provided below:

- *Return on Equity (ROE)* is a defined as the ratio between net income and shareholder equity. This measure financial performance allows to assess relative profitability (Al-Qudah, 2017; Hou et al., 2015). It captures financial health, and it is commonly used as the

dependent variable in the ESG literature (Buallay, 2019c; Cornett et al., 2016; Esteban-Sanchez et al., 2017; Nizam et al., 2019; Shakil et al., 2019; Waddock & Graves, 1997).

- The *Debt on Equity* ratio is calculated as total liabilities over shareholder equity. It proxies the firm's capital structure and represents its ability to finance growth through debt. This metric is widely employed in the financial literature to denote leverage (Hovakimian et al., 2001). A high Debt on Equity ratio implies that the firm may have a hard time servicing its debt through cash flow. As such, it is a monitoring tool for financial risk. From a theoretical perspective, the relation between Debt on Equity and profitability is ambiguous. By taking on debt, firms face higher costs, which decreases profitability. Obtaining credit however allows assets to grow. Moreover, increases in the value of the debt decrease the value of the equity, which in turn improves ROE (equity appears at the denominator). The empirical evidence is also mixed. Some authors support a negative relationship between the two variables (Abor, 2005; Cassar & Holmes, 2003; Graham, 2000; Hall et al., 2004; Muscettola & Naccarato, 2016; Petersen & Rajan, 1994; Titman & Wessels, 1988). Others find a weak positive relationship (Champion, 1999; Gill et al., 2011; Margaritis & Psillaki, 2010; Taub, 1975), while still others unfold no significant relationship (Muscettola, 2014, 2015; Muscettola & Naccarato, 2016; Tailab, 2014).
- *Firm size* is computed as the natural logarithm of total assets. It represents the total volume of all business operations, or alternatively, the scale of the business activities turned out (Desai & Dharmapala, 2009). In most empirical studies, size is considered as a fundamental factor for profitability, since it represents a dimensional control (Dang et al., 2018; Vijn & Yang, 2013). The relationship between firm size and firm profitability is highly debated (İsık et al., 2017; Kuncová et al., 2016; Liargovas & Skandalis, 2010; Nunes & Serrasquero, 2008; Wu, 2006). Conflicting and ambiguous results have been reported. Some support a direct link between size and profitability (Nunes & Serrasquero, 2008; Papadogonas, 2007). Others find evidence in favor of an inversely relation (Becker-Blease et al., 2010; Goddard et al., 2005; Lee, 2009). Still others find no significant effect (Amato & Burson, 2007; Nireesh & Thirunavukkarasu, 2014; Kartikasari & Merianti, 2016).
- *Revenues* are often seen as a proxy of firm growth (Delmar et al., 2003; Fuertes-Callén & Cuellar-Fernández, 2019) and for

long-run survival probability (Fuertes-Callén & Cuellar-Fernández, 2019; Gupta et al., 2013). The state of the art about the relationship between revenues and profitability is complex (Wright & Stigliani, 2013; Love & Roper, 2015; Davidsson et al., 2006). Many studies find a positive association (Coad, 2007; Davidsson et al., 2009; Federico & Capelleras, 2015; Goddard et al., 2004; Mendelson, 2000). The theoretical justifications for this result range from economies of scale (Davidsson et al., 2009), to first mover-advantage (Lechner & Gudmundsson, 2014; Lieberman & Montgomery, 1988; Suarez & Lanzolla, 2007), to experience curve effects (Katz & Shapiro, 1985; Ritala, 2012). Conversely, other works find a negative relationship (Reid, 1995; Jang and Park, 2011). Still others, like Markman and Gartner (2002) do not find any significant effect.

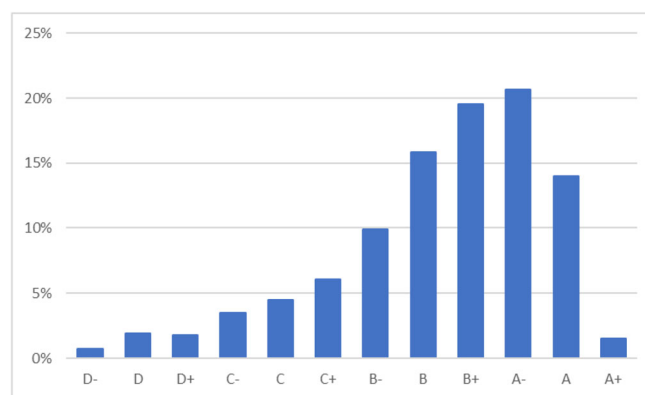
- **Market value** represents the worth of a company on the market in terms of its book value (Ceccagnoli, 2009; Lee & Makhija, 2009). It is computed by the market to book ratio (M/B), that compares the market value, determined share price and number of outstanding shares, and book value, which equals net assets. This measure helps investors and market participants understand whether the stock price of a firm is in line with its book value. In other words, it is a measure of the valuation of a company's stock relating to its net assets. The relationship between market value and profitability is positive. Market value may be seen as an overall picture of investment decision, assets management and growth opportunities (Fajaria & Isnalita, 2018). Several researchers have examined how market to book ratio may be related to profitability. For example, Beaver and Ryan (2000) have explored the ability of book-to-market ratios (the inverse of market to book ratio) to predict profitability, finding a negative and significant effect. Further research has shown that the book-to-market ratio is inversely related to ROE (Penman, 1991, 1992, 1996). This result is in line with Zhang (2005) who claims that firms with high market-to-book ratios are more profitable. The seminal contribution by Fama and French (1995) confirms that “high book-to-market stocks are less profitable than low-ones for four years before and at least five years after ranking dates” (Fama & French, 1995).

4 | METHODS

This section illustrates the novel indicator proposed in this work in order to provide a comprehensive measure of ESG practices. Moreover, it outlines the empirical strategy devised, aiming to assess the relationship between the indicator and firm profitability.

4.1 | A novel measure of ESG practices

This work proposes the comprehensive ESG score, a composite indicator combining the ESG score provided by Refinitiv with the ESG Disclosure Score provided by Bloomberg. It is computed using the Mazziotta-Pareto method (Mazziotta and Pareto, 2011; see the



Source: original elaborations based on data provided by Refinitiv (2021)

FIGURE 1 Refinitiv ESG ratings. ESG, environmental, social, and governance. ESG, environmental, social, and governance. Source: Original elaborations based on data provided by Refinitiv (2021) [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/csr.2389)]

Appendix A for more details). This method features the peculiar characteristic of not allowing for perfect substitutability across pillars: very high scores in a certain pillar cannot compensate very low scores in another, so units featuring a good degree of balance across dimensions receive relatively higher scores, while units characterized by unbalanced values across dimensions are penalized. The ESG Score measures ESG performance at the firm level based on verifiable reported data in the public domain (Refinitiv, 2021). This score is based on three main pillars (ESG). Firm scores span from A+ to D–, where A+ indicates an excellent ESG performance (identifying ESG Leaders) and D– indicates a very poor ESG performance (identifying ESG Laggards). We convert these qualitative ratings into numerical scores, ranging from 0 to 100 according to the percentiles of the distribution. Figure 1 shows the distribution of the qualitative ESG Score.

The ESG Disclosure Score measures the extent of ESG disclosure on part of firms (McBrayer, 2018). The score ranges from 0 to 100, where firms that disclose no information at all obtain 0 and firms that disclose full information obtain 100. This score is computed differently according to economic sectors. It is important to stress that the ESG Disclosure Score captures the amount of ESG information publicly disclosed, but it means nothing in terms of ESG practices. Once the wESG Score is obtained, it is finally rescaled, using a monotonic transformation¹ so as to make sure that it lies in the 0–100 interval.

4.2 | GMM-SYS

In order to evaluate the impact of the Comprehensive ESG Score on firm profitability, we use the GMM-SYS version of the Arellano-Bond estimator. This empirical approach is especially useful in the presence of inertia in the dependent variable. Failing to include the past values

¹In particular, wESG is multiplied by a constant factor, that guarantees all values lie within the 0–100 range.

TABLE 3 Estimation results

	ROE
Lagged ROE ^a	0.485 (0.028)***
Combined ESG score	−0.018 (0.009)**
Debt on equity	0.000 (0.000)
Revenues ^a	0.381 (0.206)*
Firm size ^a	−0.472 (0.182)***
Market value ^a	1.140 (0.184)***
Time dummies	Yes
Country dummies	Yes
_cons	4.869 (1.719)***
F-test on time dummies	19.48 (0.000)***
F-test on country dummies	17.22 (0.069)*
Sargan test	52.22 (0.214)
Hansen test	57.08 (0.117)
AR (1)	−2.84 (0.004)***
AR (2)	0.76 (0.449)
AR (3)	−1.37 (0.171)
N	1785

Note: Standard errors are shown below coefficient estimates. *p*-values are shown below test statistics.

Abbreviation: ESG, environmental, social, and governance.

^aEndogenous variable, suitably instrumented.

p* < 0.1; *p* < 0.05; ****p* < 0.01.

of profits would likely cause biased results if persistency characterizes the profit dynamics. In formal terms, the model may be outlined as follows:

$$Y_t = \rho Y_{t-1} + X_t \beta + \varepsilon_t, \quad (1)$$

where Y_t is an $N \times 1$ vector representing firm profitability, X_t is an $N \times K$ matrix of contemporaneous covariates that includes a first column of ones and ε_t is a well-behaved conformable vector of error terms. The parameter ρ represents the effect of the autoregressive component that captures time persistency in the dependent variable,

while β is a $K \times 1$ vector of marginal effects. The presence of Y_{t-1} on the right-hand side of the equation generates a problem of endogeneity, which may be sorted out by instrumenting Y_{t-1} with its further lags. The estimator obtained using this procedure is called GMM-SYS, since it resorts to a system of equations, both in levels and in first differences, from which the instrumental variables are drawn. To avoid losing time periods when deeper lags are introduced, we replace the missing values with zeros (Agovino et al., 2019; Arellano & Bond, 1991; Baltagi, 2013; Ferraro et al., 2019; Holtz-Eakin et al., 1988).

Endogeneity may arise also from the columns of the X matrix. In the presence of endogenous regressors (other than the lagged dependent variable), the deeper lags of the regressors themselves may be used as instruments (again, both in levels and in first differences) to address the problem. In order to corroborate the choice of the instrument set, the Sargan test is implemented. Failure to reject the null indicates that instrument validity is questionable (Bowsher, 2002).

5 | RESULTS

The results of the dynamic panel model are shown in Table 3. Besides the lagged dependent variable—that is by definition endogenous—some control covariates are likely to be in a simultaneous relationship with ROE. As a result, they are suitably instrumented. It is important to stress that both the Sargan and the Hansen test for overidentification fail to reject the null, corroborating the choice of the instrument set, which contains the deep lags of the dependent variable and of the endogenous covariates. The AR tests confirm the validity of the model specification selected. In particular, the residual features a first-order autoregressive process, as should be expected, while higher order autocorrelation is ruled out by non-significant test statistics.

The coefficient associated with the lagged dependent variable is positive and significant, revealing the presence of a relevant degree of inertia in profits. This result is not surprising, since persistency in profits is largely documented in the empirical literature (see e.g., Hirsch & Gschwandtner, 2013; Lawrence et al., 2018). The most relevant result of this analysis concerns the negative and significant coefficient associated with the comprehensive ESG score. This result indicates that increases in the commitment to ESG practices worsen firm performance overall. The channels through which this effect occurs are either increases in costs (trade-off theory) or diversion of managerial focus from core activities (agency view).

The effect of the leverage ratio (Debt on Equity) is non-significant. Given the theoretical ambiguity of the effect and the mixed results obtained by the empirical literature, this result is not surprising. Revenues increase profitability, which is intuitive from an economic point of view. The real effect of increases in revenues thus prevails. Firms size exhibits a negative and significant coefficient. Following the interpretation proposed by Fama & French, K. (1992), this effect is related to risk, in that large firms, whose stocks are less risky on average, do not need pay a risk premium to their shareholders. Thus, they can afford to distribute fewer profits and reinvest a larger share of their economic results. Finally, as largely agreed upon in the empirical

literature, market value has a positive and significant effect on profitability.

One interesting question pertaining to the effect of ESG practices on profitability concerns the stability of the negative effect indicated by our results across industrial sectors.² In order to tackle this problem, we estimate again the regression indicated in Equation (1), including this time both industrial dummies and interactions between the combined ESG score and the industrial dummies. In other words, we allow the marginal effect of the combined ESG score to vary across industrial sectors. The estimates produced by this richer version of the model are shown in Table 4.

While the coefficient estimates obtained in this case are very similar to those displayed in Table 3, confirming substantially the findings already discussed, it is interesting to notice that for 10 of the 43 sectors covered by our data, the marginal effect of the Combined ESG score varies significantly with respect to the average value of -0.024 .³ This means that ESG practices generate different effects depending on the industrial sector considered. Table 5 displays the marginal effects for the Combined ESG Score for the sectors featuring a significant coefficient associated to the interaction term.

In all of these sectors, the marginal effect is either negative or non-significant. The most negative effect is observed in the sector of consumer goods conglomerates, followed by the sector of biotechnology and medical research. Due to technological constraints, in both these sectors commitment to ESG is especially expensive. In other sectors, namely electric utilities & IPPs, food & tobacco, freight & logistics services, household goods and investment banking & investment services, the marginal effect is not significantly different from zero. This result may either spur from a lower cost associated to commitment to ESG practices or from a higher sensitivity of revenues to ESG investments.

Overall, our results indicate that—with a few exceptions—the effect of ESG practices on firm performance is negative. This relationship is well documented in the recent literature (Barauskaite & Streimikiene, 2021; Chen et al., 2021). Other recent works, resorting to different data sources, reach the same conclusion. Lin et al. (2019), using a panel of Fortune magazine's 100 most admired companies in 2016 and 2017, claim that commitment to sustainable practices does not necessarily lead to better financial performance. Specifically, they find a negative association between sustainable practices and three accounting financial measures, namely ROE, ROA, and ROI. Lys et al. (2015) argue that if ESG practices are mainly pushed by opportunistic purposes, expenditures related to ESG activities represent a cost rather than an investment. Lastly, Hirigoyen and Poulain-Rehm (2015) confirm the managerial opportunism hypothesis, according to which sustainable practices have a negative impact on financial performance. Less recently, McWilliams and Siegel (2000) assert that firms engaging in sustainable practices may miss out major investments in other aspects, worsening the financial performance. With respect to this

literature, our work adds a relevant element in the relationship, that is, the role of strategic disclosure of ESG data. While previous works focus only on the raw measure of ESG score, we use the comprehensive ESG score, in order to obtain an unbiased estimate of the effect of the ESG practices on profitability.

6 | DISCUSSIONS AND POLICY IMPLICATIONS

The empirical results obtained raise broad questions on the role that ESG practices play in determining firm performance. While a sizeable strand of literature supports the existence of a positive relationship, we find a negative effect. Traditional explanations for this effect include the trade-off perspective and agency theory. A novel argument that may be drawn from this work relates to the strategic behavior adopted by firms in terms of disclosure. High-ESG ratings may be achieved by committing to ESG practices strongly while pursuing full disclosure, or by tackling only some dimensions of ESG practices while strategically disclosing partial information, exactly on the (few) virtuous behaviors that the firm adopts. Failing to take into account the potential bias induced by behavioral issues, much of the previous literature is likely to have obtained inconsistent estimates. This work conversely aims to capture the actual effect of ESG practices by introducing a penalty for the firms that fail to disclose full information. This penalty reduces significantly the score assigned to many of the firms that face high-ROE values, thus yielding a negative coefficient for the comprehensive ESG score.

The *strategic disclosure* argument is corroborated by descriptive evidence in our sample. In particular, Figure 2 shows that the firms that disclose more information (i.e., those in the Top 25% of the disclosure score distribution) obtain on average significantly larger ESG ratings with respect to the firms that disclose less information (i.e., those in the Bottom 25% of the disclosure score distribution, labeled disclosure laggards). So, the firms that disclose less seem to be those that have more to hide. Failing to disclose some information may thus be viewed as a negative signal.

Some firms thus resort to strategic behaviors, disclosing partial and cloudy information without committing at full to ESG practices or changing corporate vision (Yu et al., 2020). In particular, strategic disclosure takes the form of *Greenwashing* and *Social Washing*. Corporate greenwashing occurs when firms falsely claim eco-friendliness (Laufer, 2003). Greenwashing is considered as distortion factor (Seele & Gatti, 2017), since it leads firms to overstate their commitment to the environment through communication channels (De Vries et al., 2015). Firms find greenwashing attractive since it allows to enhance their reputation, which in turn increases profits (Ferrón-Vílchez et al., 2021; Kucharska & Kowalczyk, 2019; Lyon & Montgomery, 2013). In this view, greenwashing leverages on the growing societal concerns over environmental sustainability to extend the firm's customer base (Figge, 2005), capturing ethical and eco-conscious consumers, an emerging market segment characterized by the willing to pay a significant price premium for sustainable products

²We thank our anonymous referee for raising this point.

³For the sake of readability, Table 4 does not show the coefficients associated to the interactions if they are not significant. Nonetheless, we will be happy to provide readers with this information, should they be interested.

**TABLE 4** Regression results with slopes varying across industries

	ROE
Lagged ROE ^a	0.459
	(0.030)

Combined ESG score	−0.024
	(0.009)**
Debt on equity	0.000
	(0.956)
Revenues ^a	0.333
	(0.208)
Firm size ^a	−0.492
	(0.190)

Market value ^a	1.148
	(0.189)

Time dummies	Yes
Country dummies	Yes
Industry dummies	Yes
ESG × sector: Biotechnology & medical research	−0.105
	(0.016)

ESG × sector: Communications & networking	−0.064
	(0.011)

ESG × sector: Consumer goods conglomerates	−0.403
	(0.045)

ESG × sector: Electric utilities & IPPs	0.036
	(0.019)*
ESG × sector: Food & tobacco	0.011
	(0.004)

ESG × sector: Freight & logistics services	0.031
	(0.005)

ESG × sector: Healthcare equipment & supplies	−0.032
	(0.016)*
ESG × sector: Household goods	0.029
	(0.005)

ESG × sector: Investment banking & investment services	0.047
	(0.021)**
ESG × sector: Water & related utilities	−0.035
	(0.005)

_cons	5.758
	(1.915)

F-test on time dummies	21.19

TABLE 4 (Continued)

	ROE
	(0.002)

F-test on country dummies	18.28
	(0.050)**
F-test on industry dummies	99.02
	(0.000)

Sargan	44.8
	(0.124)
Hansen	42.13
	(0.19)
AR (1)	−2.81
	(0.005)

AR (2)	0.71
	(0.477)
AR (3)	−1.41
	(0.159)
N	1785

Note: Standard errors are shown below coefficient estimates. *p*-values are shown below test statistics.

Abbreviations: ESG, environmental, social, and governance; ROE, return on equity.

^aEndogenous variable, suitably instrumented.

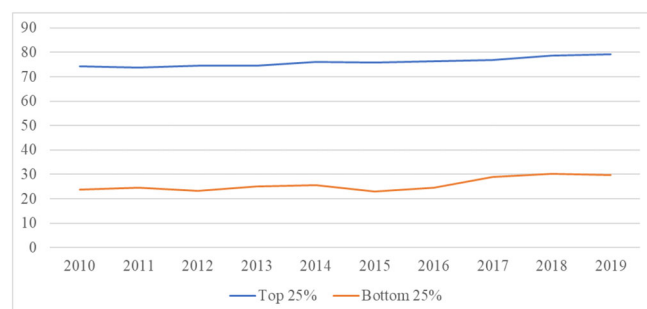
p* < 0.1; *p* < 0.05; ****p* < 0.01.

(Agovino et al., 2018; Yang et al., 2020; Zhang & Xie, 2022). External stakeholders and competitive pressures moreover may induce firms to adopt greenwashing practices in response to a widespread market standard (Testa et al., 2018). Social Washing instead refers to deceptive marketing strategies that firms adopt in order to overstate the social value they create (Rizzi et al., 2020; Troje & Gluch, 2020). As in the case of greenwashing, firms provide misleading information to distort the insights of their stakeholders (Balluchi et al., 2020), leveraging on communication tools that influence consumer perception and brand image (Zhang & Xie, 2022).

Broadly speaking, increasing commitment to ESG practices requires not only attitudinal changes on part of private agents, but also engagement on part of supervisory entities and regulatory authorities. Commitment to ESG practices in this view needs to be actively pursued by governmental bodies. Several policy tools have been proposed. Gatti et al. (2019) maintain that the introduction of sustainability regulations, in the form of either industry self-regulation or public provisions, may lower the divergence between the extent of sustainable practices and corporate communication. According to Qi et al. (2012), credible third-party certification may be the key to enhancing sustainability in business practices (Wang et al., 2018). Mio et al. (2020) highlight the relevance of mandatory regulations, as a way to induce large companies to provide vaster non-financial information, reducing information asymmetry and agency problems. The

TABLE 5 Marginal effect of the combined ESG score on profitability by industrial sector

Sector	Coefficient	Standard error	z score	p-value	Lower bound	Upper bound
Biotechnology & medical research	−0.12838	0.019058	−6.74	0.000	−0.16573	−0.09103
Communications & networking	−0.08725	0.012984	−6.72	0.000	−0.1127	−0.0618
Consumer goods conglomerates	−0.42678	0.047128	−9.06	0.000	−0.51915	−0.33441
Electric utilities & IPPs	0.012558	0.018049	0.7	0.487	−0.02282	0.047934
Food & tobacco	−0.01227	0.008863	−1.38	0.166	−0.02964	0.0051
Freight & logistics services	0.007519	0.009236	0.81	0.416	−0.01058	0.025621
Healthcare equipment & supplies	−0.05575	0.015051	−3.7	0.000	−0.08525	−0.02625
Household goods	0.004899	0.010271	0.48	0.633	−0.01523	0.02503
Investment banking & investment services	0.023069	0.020565	1.12	0.262	−0.01724	0.063375
Water & related utilities	−0.05884	0.010692	−5.5	0.000	−0.07979	−0.03788



Source: Original Elaborations on Refinitiv and Bloomberg data

FIGURE 2 Average ESG score in top-disclosers (top 25%) and disclosure laggards (bottom 25%). ESG, environmental, social, and governance. Source: Original Elaborations on Refinitiv and Bloomberg data [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/csr.2389)]

lack of disclosure alignment moreover is commonly cited as a major problem (Beare et al., 2014). Overall, transparent sustainability reporting standards and clear rules on the amount of information disclosed are needed (Hussain et al., 2018; Lee et al., 2017).

From a regulatory point of view, the EU legal framework on sustainability reporting is evolving. In 2014, Directive 2014/95/EU—also known as the Non-Financial Reporting Directive (NFRD)—was introduced, to establish rules on the disclosure of non-financial information, supporting a responsible approach to business by companies employing more than 500 workers. The NFRD modified the earlier Directive 34/2013 and extended the reporting obligation on social and environmental issues to a wider audience of listed companies and entities of public interest. Specifically, the NFRD requires large companies to annually report information on ESG issues, providing better information for consumers and investors on firm sustainability. The NFRD took effect in all EU member States in 2018, when all 28 countries have translated the Directive into national law, and it is now up to companies to fulfill. However, the NFRD is not mandatory, thus leaving a large amount of flexibility in the implementation of its provisions. Furthermore, the NFRD imposes neither mandatory reporting standards nor disclosure bounds, leaving room for strategic disclosure.

In 2018, the European Commission outlined the EU Action Plan on Sustainable Finance (European Commission, 2020b), an ambitious package of sustainability measures, whose purpose is to encourage and promote awareness toward environmental and social issues, in line with the Paris Agreement of December 2015. The plan established three main objectives. First, to reorient investments toward sustainable business. Second, to manage the financial risks that arise from environmental and social issues. Third, to increase transparency and forward-looking behaviors in economic activities. One aspect envisaged by the EU Action Plan concerns the inclusion of ESG dimensions in the evaluation of economic activities. Additional sustainable measures are included in the European Green Deal signed in 2019, which aims to make the EU the first climate neutral continent by 2050.

In April 2021, the European Commission published its proposal for the Corporate Sustainability Reporting Directive (CSRD), aiming to replace the NFRD, by adjusting its reporting requirements. The CSRD proposal is a key element of the EU sustainable finance package, which includes a comprehensive set of measures to improve the flow of capital to sustainable businesses across the EU. The goal of the CSRD proposal is to improve sustainability reporting in the EU single market, leading firms to align to high-quality disclosure standards and ruling out strategic behaviors. The CSRD proposal indeed dictates more detailed reporting requirements and requires firms to report information according to mandatory EU sustainability reporting standards. The fundamental cornerstone that will improve sustainability reporting and support the upcoming the CSRD proposal is the EU Green Taxonomy (European Commission, 2020a). Introduced by EU Regulation 2020/852, the Green Taxonomy is to sets the technical criteria that define unambiguously eco-friendly firms, aiming to increase transparency in the EU single market. By January 2023, the criteria are expected to be delivered. It is crucial in this view that individual EU countries acknowledge the EU Green Taxonomy within their national frameworks as soon as possible, thus adhering to common reporting standards.

Concerning social washing, a major role is to be played by competition authorities. Marketing strategies based on emotional advertisement indeed may easily elude the regulations on deceptive



advertising. As many consumers lack the instruments to identify false claims on allegedly responsible practices (Mo et al., 2018), regulatory bodies are required to step in (Rizzi et al., 2020). Similar to the regulations on functional advertisement, limits need to be imposed on the claims made by firms to attract consumers. Overall, much room remains for public intervention. Several issues however remain unresolved. ESG practices are non-obvious to implement and represent a significant cost, which not all firms might be able to face (McWilliams et al., 2006). Some firms gain benefits from being socially responsible, while for others ESG practices represent “costs with no offsetting benefits”. Many of the firms that are strongly committed to ESG practices are actually successful for reasons other than their commitment (Cornell & Damodaran, 2020).

Based on the above, it should not be surprising that ESG practices worsen firm performance on average. This is not however a sufficient reason to stop investing on them. The short-run effect of ESG practices turns out to be negative, but it is very possible that in the long run, following a structural transformation of business activities, technological endowments, and regulatory schemes, they will yield an economic return. The short-run cost increase induced by ESG practices, calls for public intervention. Governments should provide incentive plans for firms adopting sustainable long-term goals, so as to help them bear the costs of ESG practices. Additional *hard measures* may include the imposition of sustainability-related taxes, such as carbon taxes.

7 | CONCLUSIONS

This work aims to establish the relationship between ESG practices and profitability using a sample of listed EU firms belonging to the Eurozone. In order to discriminate firms featuring an actual ESG commitment from those inflating their commitment through strategic disclosure of ESG information, we introduce the Comprehensive ESG Score, a composite indicator that penalizes incomplete disclosure. In line with a recent strand of literature, our results indicate that ESG practices worsen profitability on average. Thus, we find evidence in support of stakeholder theory, according to which sustainable practices imply a substantial increase in costs. This point should not be surprising, given the nature of ESG practices.

This study paves the way for a strand of future works. First, more accurate implications may be drawn by analyzing each pillar of ESG practices separately. Additional research may be conducted in the future in order to test the relationships between the individual pillars and firm profitability, possibly looking for cross-pillar interactions. The availability of disclosure data disaggregated by pillar may also allow to separate, within the phenomenon of strategic disclosure, the extent of greenwashing from that of social washing. Moreover, this study calls for further empirical works extending the indicator proposed outside the Eurozone. Data covering other developed and/or emerging markets may be the key to draw deeper and more solid conclusions on the long-standing problem that surrounds the link between sustainability and profitability.

ACKNOWLEDGMENT

Open Access Funding provided by Università degli Studi di Napoli Parthenope within the CRUI-CARE Agreement.

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How to cite this article: Cerciello, M., Busato, F., & Taddeo, S. (2023). The effect of sustainable business practices on profitability. Accounting for strategic disclosure. *Corporate Social Responsibility and Environmental Management*, 30(2), 802–819. <https://doi.org/10.1002/csr.2389>

APPENDIX A

This section provides further methodological information on the Mazziotta–Pareto procedure, employed to compute the comprehensive ESG score.

A.1. | The Mazziotta–Pareto index

The Mazziotta–Pareto index (MPI) is a composite indicator that does not allow for full substitutability among components. In other words, the MPI prevents high values in one component from compensating low values in another (Agovino et al., 2018; Mazziotta & Pareto, 2016). It is based on a nonlinear function that assigns a penalty to units featuring unbalances across components (De Muro et al., 2011; Mazziotta & Pareto, 2011, 2013, 2016). Rather than providing information aimed at creating a ranking of the units under

investigation, the MPI provides information on the *intensity* the phenomenon of interest. Moreover, it is independent of any benchmark or ideal unit. These characteristics make the method particularly suitable when it comes to measuring the extent of ESG practices. Although the MPI allows for the inclusion of a large number of elementary variables, further aggregated into pillars, in this work we use only two variables, that is, the ESG score and the ESG disclosure score. Each variable may be viewed as a separate pillar.

Variable standardization is the first methodological step for the calculation of the comprehensive ESG score. The variables are rescaled around a mean of 100, so that at least 89% of the observations range between 70 and 130. In order to standardize, vertical (i.e., cross-firm) variability M_j is computed as:

$$M_j = \frac{1}{n} \sum_{i=1}^n x_{ij} \quad S_j = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_{ij} - M_j)^2}, \quad (A1)$$

where X is an $n \times m$ matrix, whose elements $\{x_{ij}\}$ are the elementary values. The n rows represent firms, whereas the m columns are the dimensions of the indicator (in our case two). Consider now matrix Z , whose elements $\{z_{ij}\}$ are defined as:

$$z_{ij} = 10 * \frac{x_{ij} - M_j}{S_j} \pm 100. \quad (A2)$$

The sign in Equation (A2) depends on the economic interpretation of the indicator. In our case, both dimensions increase the comprehensive ESG score, so they get positive signs. Horizontal variability (i.e., cross-pillar or within firm variability) is defined as:

$$M_i = \frac{1}{m} \sum_{j=1}^m z_{ij} \quad S_i = \sqrt{\frac{1}{m} \sum_{j=1}^m (z_{ij} - M_i)^2}. \quad (A3)$$

The variation coefficient cv_i is defined as the ratio between S_i and M_i . The MPI for unit i is then computed as:

$$MPI_i = M_i \mp S_i cv_i. \quad (A4)$$

In summary, the MPI adjusts the mean of each variable by adding or subtracting an amount proportional to the mean square error. This amount is known as the *penalty*, since it penalizes units (i.e., firms in our case) featuring large differences in the standardized variables. The larger the gap between the ESG score and the ESG disclosure score for one firm, the larger the penalty. Similar to Equation (A2), the sign in Equation (A4) depends on the interpretation of the phenomenon.

A.2. | Robustness of the Mazziotta-Pareto procedure

When measuring multidimensional phenomena, different aggregation methods may be used. To ensure the robustness of the comprehensive ESG score, we compare the results obtained under several

different approaches. A brief description of each alternative method is provided below:

1. Method of the rankings

The values of the variables $\{x_{ij}\}$ are transformed into *ranking* values $\{t_{ij}\}$, representing the relative positions of each observation in the overall ranking of units. This transformation removes the measurement unit and yields an integer, regardless of the original elementary value.

$$Ranking_i = \frac{1}{p} \sum_{j=1}^p t_{ij}. \quad (A5)$$

2. Method of the relative indices

The values of the variables $\{x_{ij}\}$ are rescaled in the (0, 1) interval. The relative indices $\{t_{ij}\}$ are defined as:

$$t_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}. \quad (A6)$$

This transformation removes the measurement unit. The final index is computed as

$$RI_i = \frac{1}{p} \sum_{j=1}^p t_{ij}. \quad (A7)$$

3. Wroclaw's taxonomic method

An ideal value is identified for each variable—usually based on the unit featuring the highest value in the sample. The elementary values $\{x_{ij}\}$ are normalized by subtracting the mean and dividing by the standard deviation, so as to obtain the transformed value $\{t_{ij}\}$.

$$t_{ij} = \frac{x_{ij} - \bar{x}_j}{\sigma_j}. \quad (A8)$$

Then the Euclidean distance between the transformed values and the ideal unit is computed

$$D_i = \sqrt{\sum_{j=1}^p (t_{ij} - \max\{t_{ij}\})^2}, \quad (A9)$$

$$Wroclav_i = \frac{D_i}{D_0}, \quad D_0 = \bar{D}_0 + 2\sigma_0, \quad (A10)$$

where \bar{D}_0 is the mean distance and σ_0 is the mean square error. The resulting index yields non-negative values, representing the adjusted distance from the ideal unit. The observations are ranked accordingly.



4. Method of the standardized values

$$SV_i = \frac{1}{p} \sum_{j=1}^p t_{ij}. \quad (\text{A12})$$

The elementary values $\{x_{ij}\}$ are standardized by subtracting the mean and dividing by the standard deviation.

$$t_{ij} = \frac{x_{ij} - \bar{x}}{\sigma_j}. \quad (\text{A11})$$

Then the index is then computed as

We implement all the methods above to compute the comprehensive ESG score. The correlation coefficients obtained when comparing the results are shown in Tables A1 and A2, that refer to the first and last year of our panel. Similar results emerge for all other years.

TABLE A1 Correlation matrix (2010)

	Rankings	Standard values	Relative indices	Mazziotta-Pareto	Wroclaw
Rankings	1				
Standard values	0.9773	1			
Relative indices	0.9773	1	1		
Mazziotta-Pareto	0.9781	0.9992	0.9993	1	
Wroclaw	0.9700	0.9963	0.9960	0.9925	1

TABLE A2 Correlation matrix (2019)

	Rankings	Standard values	Relative indices	Mazziotta-Pareto	Wroclaw
Rankings	1				
Standard values	0.9280	1			
Relative indices	0.9275	0.9988	1		
Mazziotta-Pareto	0.9286	0.9991	0.9983	1	
Wroclaw	0.9188	0.9941	0.9896	0.9899	1