Research in International Business and Finance 77 (2025) 102902

Contents lists available at ScienceDirect

Research in International Business and Finance

journal homepage: www.elsevier.com/locate/ribaf

The market power of ESG index providers: The effects of rebalancing ESG-themed indices☆

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ARTICLE INFO

JEL classification:
G11
G12
G14
G23
G 24
G41
Q 56

Keywords:
Stock index review
ESG indices
Event studies
Responsible investing

ABSTRACT

This paper examines market reactions to changes in the composition of 11 MSCI ESG indices over the period 2011–2021. The results highlight the market power of ESG index providers. In summary, revisions to an index typically induce abnormal returns and abnormal trading volume, which are generally related to significant ownership changes. Abnormal trading volume is detected on the day of the effective change in the composition of the index. This is consistent with strong portfolio rebalancing. However, statistically significant abnormal returns can still be found after 30 days, especially for excluded firms. This demonstrates that composition changes can have a permanent impact on market value. Additionally, the impact is stronger in emerging markets and for heavy-polluting firms and has been more pronounced since the signing of the Paris Agreement in 2016. Both long-term and short-term institutional investors increase (reduce) their ownership in admitted (excluded) firms after the change, while strategic investors will look to reduce their equity stakes before the exclusion and then increase them once the index has been rebalanced.

1. Introduction

Institutional and individual investors are increasingly interested in integrating environmental, social, and governance-related issues into their investment decisions. There is ample literature covering the relationship between the ESG characteristics of firms and financial performance. Often, this evidence highlights a positive association between proactive sustainability initiatives and good

Abbreviations: AD, Announcement date; AR, Abnormal returns; AUM, Assets under management; AV, Abnormal volume trading volume; CAAR, Cumulative average abnormal returns; CAPM, Capital asset pricing model; CAR, Cumulative abnormal returns; CAV, Cumulative abnormal volume trading volume; CSP, Corporate sustainability performance; DJSI, Dow Jones Sustainability Index; DJSSI, Dow Jones Stoxx Sustainability Index; ED, Event date; EM, Emerging markets; ESG, Environmental, social, governance; ETFs, Exchange-traded funds; HP, Heavy-polluting; IO, Institutional ownership; LTI, Long-term institutional investors; MSCI, Global provider of equity, fixed income, real estate indices, multi-asset portfolio analysis tools, ESG and climate products; OECD, Organisation for Economic Cooperation and Development; RM, Review month; SI, Strategic investors; SRI, Sustainable and responsible Investments: a category of MSCI ESG indices with stricter ESG selection criteria; STI, Short-term institutional investors.

☆ The authors would like to thank the participants of the conference "Sustainable Capitalism and the Corporation", Monash University's Centre for Commercial Law and Regulatory Studies (CLARS) in Prato, Italy on 21-22 July 2023; of the SIIIC2023 - 7th Sustainable and Impact Investments International Conference – at Luiss University, in Rome; of the 2024 World Finance Conference, Nicosuia, Cyprus, on 30 July – 2 August for helpful comments. The authors also would like to thank the editor John W. Goodell and two anonymous referees for their helpful suggestions on this paper.

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https://doi.org/10.1016/j.ribaf.2025.102902
Received 8 April 2024; Received in revised form 30 October 2024; Accepted 6 April 2025
Available online 23 April 2025

financial outcomes (for example, the meta-analyses of Orlitzky et al., 2003; Margolis et al., 2009; Friede et al., 2015; Busch and Friede, 2018). However, in equilibrium, ESG portfolios should yield lower stock market returns, and sustainable assets should only outperform other traditional assets when positive shocks increase customer tastes for green products and/or investor preferences for green holdings (Pástor et al., 2021). Furthermore, changes in firm ESG characteristics, which are likely to lower expected stock returns, should be associated with an increase in market value. As such, the effect of disclosing new ESG information on market prices could be confounded by the nature of sustainability factors, which are mostly immaterial and also difficult to measure and monitor. Therefore, despite recent regulatory and industry developments, an inherent information asymmetry persists between firms and interested stakeholders: the lack of standardised approaches to measure, monitor and evaluate the ESG performance of firms gives significant power to ESG index providers that could be used to guide investment decisions.

With the recent exponential growth of the ESG investment sector, providers of ESG-themed indices have emerged as authoritative intermediaries, who are able to certify the superior sustainability of their constituents. The standard 'best-in-class' approach to constructing an index involves actively selecting (and excluding) companies on the basis of their comparative sustainability performance. Thus, investors receive relevant ESG and financial information simply by virtue of a stock being listed or delisted from an index.

The recent rise of index funds and EFTs over the past two decades also highlights the importance of ESG ratings providers. The selection and rebalancing criteria adopted by index providers has, and will continue to, shape the trading strategies of passive investors. For example, when an index undergoes its periodic rebalancing (usually quarterly), the ETFs and index funds tied to it will also rebalance themselves accordingly, affecting share prices (Todorov, 2024). Hence, as discussed by Petry et al. (2021), the role of the ESG index providers should be scrutinised more closely. This is because they hold a dual form of authority. First, they influence the market through passive investing. Second, they act as signallers by arbitrarily setting the sustainability-related criteria for being included in an index (or excluded from it, as the case may be).

This paper explores how the market reacts to the rebalancing of ESG indices. More specifically, we investigate whether and how investors value firms'additions and exclusions from the indices. The scope of this study is manifold. First, we test the informational relevance of ESG index reviews, i.e., that firms included in (or excluded from) the ESG indices receive stand to gain a financial premium (or penalty). Second, we examine how market reactions to ESG indices' rebalancing change when considering different industries, regions, and time periods. Finally, we study variations in ownership of different categories of shareholders in the three months preceding and following index reviews.

Using the event study methodology, we estimated the abnormal returns and abnormal trading volume for firms added to, and removed from, 11 MSCI ESG indices from 2011 to 2021 in the days around the index reviews. From this analysis, we find that, on the day the indices effectively undertake their review, there is a large and statistically significant surge in trading volume, demonstrating that market participants are strongly influenced by a firm's membership in the indices. Further, around the day of the review, firms admitted to an ESG index typically report positive and significant abnormal returns, while excluded firms experience negative abnormal returns. The impact on firm value shows some reversal effect after the change, but abnormal returns persist significantly for at least 30 trading days following the review.

Our study also reveals that shareholders tend to react more negatively to exclusions when the company is operating in either a heavily polluting sector or in an emerging market. We do not find any clear difference for firms added to (or removed from) indices with stricter ESG criteria for admission. However, the analysis does reveal that the impact of the event is significantly stronger for index reviews taking place after the Paris Agreement was signed in 2015.

Previous research on institutional ownership has suggested that long-term institutional investors, such as pension funds, tend to focus more on a firm's ESG profile, while short-term investors, like hedge funds and mutual funds, may not respond favourably to sustainability initiatives (Neubaum and Zahra, 2006; Starks et al., 2017; Kim et al., 2019; Maqbool and Zamir, 2020; Oikonomou et al., 2020). In analysing the average change in ownership for three investor categories – strategic, long-term institutional, and short-term institutional – during the three months before and after ESG index reviews, we found that institutional investors, on average, increase their ownership in included firms and significantly decrease their holdings in excluded firms. The behaviour of strategic investors appears less clear, with their ownership variations showing no pattern that can clearly be associated with ESG considerations. However, we do find a significant reduction in ownership in the month before the exclusion, followed by a positive and significant increase in ownership after the index composition changes. This behaviour is consistent with the aim of sustaining market prices during the rebalancing of financial investors' portfolios.

This study provides significant contributions to the literature on finance and sustainability.

First, by focussing on the effects of rebalancing ESG indices using a broad dataset that spans 43 reviews over 11 indices and more than ten years, this research sheds light on the relationship between ESG characteristics and market returns. This breadth allows for more robust and comprehensive evidence than previous studies, the majority of which look at specific geographic areas (see, for example, Curran and Moran, 2007; Clacher and Hagendorff, 2012) or only cover a short period of time (less than five years) (for example, Doh et al., 2010; Cheung, 2011; Robinson et al., 2011; Becchetti et al., 2012; Clacher and Hagendorff, 2012; Oberndorfer et al., 2013). This work is also relevant because of the number and types of sub-samples investigated. Our dataset let us trace the impact of index rebalancing in both cross-country and cross-industry settings, taking control factors such as region, sector, timing, and various firm characteristics into account. To the best of our knowledge, only one other study (Schmutz et al., 2020) has attempted to gauge the effects of the Paris Agreement on investor sustainability preferences. Similarly, while a number of other works consider the so-called "sin" industries when examining investor preferences related to index rebalancing, only the event study by Schmutz et al. (2020) differentiates between firms active in polluting sectors vs others. On a similar note, by using different sub-samples over the same index families, we further explore the different investor preferences concerning sustainability in developed vs emerging markets. Several studies have explored this issue by considering single countries (see, for example, Fuenzalida et al., 2013; Adamska and Dąbrowski,

2016; Lusyana and Sherif, 2017) or regions (see, among others, Cheung and Roca, 2013; Zou et al., 2020). However, these studies only involve a relatively low number of observations, and, more importantly, they do not allow for any cross-regional comparison. By contrast, this paper enriches the literature with well-grounded findings on investor preferences and the power of index providers across time, space, industry, different ESG criteria, and different degrees of those criteria.

Second, this study provides compelling evidence of the growing importance of sustainability and ESG factors for global investors. We find that the market rewards stocks added to ESG indices and penalises those excluded. This clear observation goes some way to addressing the ambiguity in previous research. For example, several early studies (e.g., Cheung, 2011; Cheung and Roca, 2013) do not reach any significant conclusions; others find significant returns only in the case of exclusions (e.g., Doh et al., 2010; Becchetti et al., 2012) or only in the case of inclusions (e.g., Chow et al., 2014). Conversely, our research shows that the market rewards sustainable companies and punishes less sustainable ones in the context of ESG index reviews. Further, this general outcome has been more prominent in recent years, after the signing of the Paris Agreements. This is consistent with the increased propensity for investors to favour stocks in sustainable firms over the same time span. It also highlights the role of ESG ratings and index providers as major signallers of sustainability.

Additionally, this research also provides support for the "sustainability taste hypothesis", as outlined in Cheung and Roca (2013). While we cannot disentangle which 'type' of value (stakeholder value, shareholder value, personal beliefs-related value, market positioning) is assigned to better sustainability performance, we can demonstrate that market players generally see corporate sustainability as a value-add. Thus, our findings contribute to the debate around these matters by providing evidence that investors now have a stronger *appetite for sustainability*. We can also confirm a strong rebalancing effect induced by passive investors that results in abnormal trading volume and returns around changes in an ESG index's composition, followed by a price reversal. This behaviour is economically significant and confirms a relevant price pressure (Harris and Gurel, 1986). However, by detecting significant and permanent abnormal returns, this research also shows that ESG index reviews carry informational value to the market. Thus, our findings offer support for the signalling hypothesis, which predicts that investors tend to interpret index reviews as indicators of a firm's future ESG and financial performance (Jain, 1987; Dhillon and Johnson, 1991; Denis et al., 2003).

Third, we offer an original contribution to the debate about institutional investor preferences by empirically demonstrating that long-term and short-term institutional investors act consistently with an ESG-driven strategy, increasing (reducing) their ownership in firms admitted to (excluded from) ESG indices for up to three months after reviews. The preference of short-term institutional investors for firms with positive ESG performance partially collides with the literature since, in many studies (e.g., Johnson and Greening, 1999; Cox et al., 2004; Cox and Wicks, 2011), this category of investor has been proven to prefer immediate profits and firms with inferior ESG performance – behaviour opposite to that of long-term investors.

Finally, this paper contributes to the emerging debate around the market power of index providers by showing that ESG index reviews carry relevant informational value for investors. As pointed out by Wigglesworth (2019), "financial indices are arguably the most under-appreciated force shaping global markets". The rise of passive investing in recent years has shown how index providers can influence corporate governance, corporate power, market competition, investor behaviour, and even state policies (Dube, 2015; Alloway et al., 2017; Fichtner et al., 2017, 2024; Robertson, 2018, 2019; Bird, 2019; Jahnke, 2019; Petry et al., 2021). Within the sustainability realm, ESG index providers not only exercise their market power by directly influencing capital allocations, they also act as quasi-standard setters in the realm of sustainable finance. Here, passive fund managers fully 'delegate' their sustainability investment decisions to ESG index providers (Petry et al., 2021), while the vast majority of active ESG fund managers employ ESG indices as a benchmark and do not significantly deviate from them (Fichtner et al., 2024).

This research, therefore, contributes to the debate by delineating and quantifying the relationship between rebalancing an ESG index and an investor's choices, further highlighting the growing power of index providers both as an indirect capital allocator and as an ESG standard setter. This emerging stream of research, which requires further investigation, appears to be raising a new agency problem that regulators should carefully consider. The growing number of alleged cases of insider trading regarding the use of private information concerning the rebalancing of stock indices highlights the actual impact of this issue.

The remainder of this paper is organised as follows. First, we review and build on the related literature to develop our hypotheses. Then, we present our data and methodology and discuss the empirical results. Finally, we draw our conclusions and discuss directions for future research.

2. Background and hypotheses

Assessing corporate sustainability performance (CSP) is challenging. First, shareholders may not be aware of a firm's sustainability activities, or if a firm undertakes such activities at all (Madsen and Rodgers, 2015). Second, their assessments can be influenced by cognitive bias. For example, shareholders may disregard or downplay any information related to CSP if it contradicts their preexisting beliefs (confirmation bias). Furthermore, companies often simultaneously engage in both socially responsible and socially irresponsible behaviours (Strike et al., 2006) while also not fully disclosing CSP-related information (Kothari et al., 2009; Testa et al., 2018). This can make it especially difficult to draw an objective evaluation.

In such a context, external certification bodies such as ESG index providers can play the role of institutional intermediaries (Doh et al., 2010), elevating their position to one of a 'morally legitimate expert' (Galaskiewicz, 1991). In this sense, a firm being included in an index 'certifies' its good reputation, while being excluded speaks to a bad reputation. Thus, index providers convey ESG information

to the market, which is used to guide investment decisions. In fact, assessments provided by impartial third parties credibly inform stakeholders about the quality of a firm's sustainability practices (Fowler and Hope, 2007; Ramchander et al., 2012).

The "best-in-class" ESG-themed indices select their constituents on an 'excellence' basis. In addition to performing negative screening to exclude firms with ties to controversial activities, such as weapons, tobacco, etc., they evaluate the different dimensions of the sustainability performance of eligible firms, either directly or by relying on evaluations produced by other ESG ratings organisations. Firms are then selected by picking the best, most sustainably-performing firms. Of course, these choices are periodically revised on the basis of their CSP.

To assess the weight placed by market participants on whether a firm is included or excluded from an ESG index, we performed an event study. An event study is a methodology widely used in corporate finance to estimate the impact of a specific event on stock returns, liquidity, and trading volume (MacKinlay, 1997).

First, we assessed the informational relevance of the signal, i.e., whether index reviews effectively inform shareholder decisions and influence the market in any way. As noted by Verrecchia (1981) and Lev and Ohlson (1982), trading volume measure the extent to which information causes investors to revise their expectations independently of price changes (Weigand, 1996). Thus, trading volume can be thought of as a proxy for the capacity of ESG index reviews to convey information to investors. In our case, trading volume is also affected by the automatic rebalancing of passive investors following composition change.

Drawing upon these assumptions, we anticipate significant and positive abnormal trading volume after a review. Hence, Hypothesis 1 is formulated as:

H1. News related to ESG indices reviews are associated to abnormal trading volume in the days surrounding the news and its effective implementation.

While past evidence on abnormal returns is mixed, the literature notes a slight tendency to reward firms included in an ESG index while penalising those that are excluded. Among 43 selected studies focussing on ESG index rebalancing, all of which employ the event study methodology,[1] 19 papers (around 42 %) report evidence that fully or partially supports this contention. Of these papers, Consolandi et al. (2008) consider whether being included or excluded from the Dow Jones Sustainability Stoxx Index (DJSSI), an index comprising only European corporations, results in a short-term stock market reaction. They find that companies experience a statistically significant, although very small, positive (negative) excess return of 0.03 % (-0.05 %) after the announcement of being added to (removed from) the DJSSI index. More recently, Luffarelli and Awaysheh (2018) examined the effect of changes in the MSCI KLD 400 Social Index. They detected large positive cumulative abnormal returns (CAR) of 0.85 % for additions and an even stronger effect for deletion, with negative CAR of −1.60 %.

However, 16 studies (around 37 %) report mixed findings, i.e., where positive (negative) abnormal returns detected for ESG index admission (exclusions) are detected for one of two types of event (e.g., Chetty et al., 2015), certain sub-samples (e.g., Qiu and Pinfold, 2007; Biktimirov and Afego, 2022a) or specific event windows (e.g., Curran and Moran, 2007; Ortas and Moneva, 2011). For example, Becchetti et al. (2012) examined 263 events of firms being added and removed from the Domini 400 Social Index between January 1990 and December 2004. Although they found no statistically significant effect for the additions, they did note a strong price decrease for the exclusions. Similarly, Doh et al. (2010) examined short-term market behaviours when firms were added to or removed from the Calvert Social Index between 2000 and 2005. They did not find any market reaction in the case of additions but did find a significant negative decline of 1.5 % for firms that had been removed. The higher relevance of exclusion events could be associated with the 'negativity bias' as described by Rozin and Royzman (2001), i.e., where shareholders pay more attention to negative information, finding it more relevant and persuasive for their investment choices. By contrast, Chow et al. (2014) detected a significant, positive CAR for companies admitted to the KLD400 Social Index with no effect for companies excluded.

Only nine studies (around 21 %) found little or no evidence to support the idea that investors reward ESG index inclusion and penalise exclusion. For instance, Oberndorfer et al. (2013) find significant negative abnormal returns of around −2 % for companies added to the Dow Jones Sustainability Index DJSI World between 1999 and 2022 in the event window [0; 5]. Adopting a different approach but considering the same index, Cheung and Roca (2013) find that Asia-Pacific-based companies added to the index between 2002 and 2010 reported negative and significant abnormal returns after the rebalancing announcement, followed by an upward trend in pricing in the days after the announcement. Joshi et al. (2017) also find that, on the announcement date, firms admitted to the DJSI index report a negative CAR with poor or no statistical significance. Yet positive but non-significant CARs were detected for the excluded firms. When looking at the event date, the negative CARs of the included firms are highly statistically significant, while, depending on the event window considered, ambiguous and non-significant findings emerge for the excluded firms.

Clearly, findings on the reaction to ESG index rebalancing are disparate and inconsistent. Hence, we will test the assumption with the most evidence in the literature, which is that there is a positive link between CSP and general financial performance, as mediated by index rebalancing events.

H2. *Stocks added to (removed from) ESG indices experience positive (negative) market returns after the announcement and implementation of a review.*

We further expanded our analysis to test H2 with different sub-samples. Following the classifications developed by Fujii and Managi (2016), (2013) and Rehfeldt et al. (2020), we focussed on the most polluting sectors in the OECD area, i.e., the Energy,

[1] See Appendix B for the full list of papers, categorised according to their degree of consistency with the proposed hypothesis H2 and organised chrnologically.

Materials and Utilities industries,[2] and compared the level of abnormal returns after the review of the ESG indices with the returns posted in the "cleaner" sectors. In a similar study concerning the Dow Jones Sustainability Index, Schmutz et al. (2020) find significant negative abnormal returns following the inclusion of polluting firms in the index, perhaps indicating that profit-orientated shareholders view the ESG initiatives of polluting firms as resource-dispersive. However, in this study, we assume that investors would still value the recognition from a reputable third party of best-in-class CSP of polluting firms since it may indicate more efficient risk management practices and better long-term perspectives. All else being equal, we assume that the higher riskiness of heavily polluting firms worsens the market reaction experienced by firms in cleaner industries, both in case of being added or removed from the index. This leads to Hypothesis 2a:

H2a. *Stocks of firms in heavily polluting sectors that are added to (removed from) ESG indices experience positive (negative) abnormal returns inferior to that experienced by firms in cleaner industries.*

Shareholder reaction to ESG index reviews may also depend on a geographical element. Firms located in emerging markets (EM) operate in different institutional, legal, and cultural contexts, limiting access to information on firm sustainability and reducing its quality and reliability (Mishra and Suar, 2010). We, therefore, compared the abnormal returns of firms operating in emerging markets with those located in the developed areas of the world. Here, we expect that the ESG index reviews concerning firms in emerging countries will convey more significant informational power. Therefore, we hypothesise that:

H2b. *Stocks of firms located in emerging markets will experience a relatively higher positive (negative) share of abnormal returns than those in other regions when added to (removed from) ESG indices.*

Among the 11 different MSCI ESG indices we examined, five belong to the 'SRI family'. The ESG admission criteria for these five indices are stricter than the other six. We therefore examined the investor's propensity to invest in companies recognised as sustainability champions, that is, those admitted to the SRI index family, versus all other companies. Assuming that compliance with stricter ESG requirements represents a stronger signal to investors, we theorise that:

H2c. *Stocks added to (removed from) indices with stricter ESG requirements experience higher positive (negative) abnormal returns relative to stocks added to (removed from) other ESG indices.*

Finally, we expect that both portfolio rebalancing by passive investors and the reaction to ESG index reviews determined by the release of new information exert a larger impact in the years following the Paris Agreement. Considering the increase in ESG investing and the evolving regulatory framework, we assume that

H2d. *Stocks added to (removed from) ESG indices experience larger positive (negative) market returns as a result of reviews in the years after the Paris Agreement was signed.*

The analysis of trading volume and abnormal returns can be expanded and better interpreted, taking into account the changes in institutional ownership linked to the ESG index rebalancing. As previously highlighted, the global equity ownership landscape has evolved significantly over the past 50 years, marked by the rise of ownership of institutional investors. This trend, jointly with the sharp increase in the delisting of public companies, has strengthened the concentration of institutional ownership (De La Cruz et al., 2019). More specifically, in 2021 in the US, the equity stakes of institutional investors had grown to 68 % (Medina et al., 2021), representing a dramatic increase from the 20 % registered in the 1970s (Fichtner, 2020). Moreover, ownership structures significantly influence the allocation of resources in firms, as institutional investors tend to favour responsible firms (Juholin, 2004; Abreu et al., 2005; Jo and Harjoto, 2011; Liu and Zhang, 2017), while strategic owners, in particular family firms, are often associated with lower environmental and social performance (Canavati, 2018; Miroshnychenko et al., 2022). This relationship is driven by various factors, including risk mitigation, market opportunities, superior corporate management, and capital market success associated with firm sustainability (Petersen and Vredenburg, 2009), but also social norms and social returns, including reputational gains (Durand et al., 2019; Dyck et al., 2019). Thus, the literature demonstrates a positive link between institutional ownership and firm sustainability performance (Mahoney and Roberts, 2007; Oh et al., 2011; Waheed et al., 2021) and especially firm environmental management (Alda, 2019; Ilhan et al., 2023).

However, institutional investors are not a homogeneous group. Rather, they are often categorized as either short-term or long-term investors. Short-term investors tend to prioritise immediate profits and exhibit myopic behaviour, while long-term investors are more patient and emphasise the eventual benefits of sustainability engagement (Porter, 1992). Research indicates that short-term investors may allocate fewer resources to sustainability commitments due to their short-term focus, while long-term investors are more attracted to firms with better sustainable performance (Cox et al., 2004; Cox and Wicks, 2011; Johnson and Greening, 1999). A great deal of empirical evidence highlights this heterogeneity in attitudes towards corporate sustainability (Neubaum and Zahra, 2006; Starks et al., 2017; Erhemjamts and Huang, 2019; Nofsinger et al., 2019; Oikonomou et al., 2020). As such, many predict that including a firm in an

[2] The Energy industry includes the following sub-industries: Oil & Gas Drilling; Oil & Gas Equipment & Services; Integrated Oil & Gas; Oil & Gas Exploration & Production; Oil & Gas Refining & Marketing; Oil & Gas Storage & Transportation; Coal & Consumable Fuels. The Materials industry includes the following sub-industries: Commodity Chemicals; Diversified Chemicals; Fertilizers & Agricultural Chemicals; Industrial Gases; Specialty Chemicals; Construction Materials; Metal & Glass Containers; Paper Packaging; Aluminium; Diversified Metals & Mining; Copper; Gold; Precious Metals & Minerals; Silver; Steel; Paper & Forest Products; Forest Products; Paper Products. The Utilities industry includes the following sub-industries: Electric Utilities; Gas Utilities; Multi-Utilities; Water Utilities; Independent Power Producers & Energy Traders; Renewable Electricity.

ESG index can lead to increased institutional ownership, particularly from long-term investors (Graves and Waddock, 1994; Kang et al., 2021).

Drawing upon these assumptions, we postulate that:

H3. *Following the addition to (removal from) an ESG index, the added (excluded) firm will experience an increase (decrease) in institutional ownership by long-term investors and a decrease (increase) in institutional ownership by short-term investors.*

3. Data and methodology

3.1. Data sampling

We analysed the constituents of 11 different MSCI ESG-themed indices,[3] built on a mix of different geographical areas, including: EM, emerging markets[4]; EU, referring to 'developed Europe';[5]; USA; WORLD, referring to 'developed world';[6]; and ACWI, all of the above). The KLD 400 social index only considers the US market. All indices are constructed using the 'best-in-class' approach that follows a three-step screening process. First, companies in the parent index are screened for their involvement in certain controversial business activities. Second, they are selected on the basis of their MSCI ESG score. Third, they are selected on the basis of their MSCI controversies score. Their weight within the index is proportionate to their market capitalisation. In cases of equal ESG ranking, the company with a higher market cap is preferred. The SRI index family has stricter admission criteria and lower diversification, as it targets the top 25 % of companies in each sector of the parent indices versus the 50 % target of the other ESG indices. The weight within the index is proportional to its market capitalisation.[7]

We selected these indices for a number of reasons. First, this group of 11 indices allowed us to analyse a significant time span (all except two were launched in 2011). Second, they are built upon different territorial dimensions, allowing us to perform cross-regional comparisons. Third, MSCI is the leading ESG index provider in the market, owning an estimated 57 % of the market share (Fichtner et al., 2024). Fourth, the selected MSCI indices provide consistent and homogenous assessments of firms' corporate sustainability performance, as they all use the same ESG rating methodology and criteria.

We considered all 43 index reviews that occurred from May 2011 to December 2021. The announcement date (AD) and review date (RD) are specified in Table 1, together with the number of events (N) assessed per review. This information was directly extracted from official MSCI press releases, which are available on their website. Index rebalancing occurred roughly every quarter, although the frequency is not perfectly standardised due to weekends and festivals.

A total number of 4605 unique events were analysed for 2336 companies. As shown in Table 2, more than 10,000 additions and deletions occurred, with many firms being added or removed from more than one ESG index at the same time. From the initial sample of 5082 unique events, 477 observations had to be removed. These events involved index changes that occurred outside standard rebalancing dates and were therefore related to external factors (102 obs.), as well as those presenting missing or anomalous data or those involved in potentially confounding events (375 obs.). Specifically, 8 addition and 94 exclusion events were ruled out. Removed addition events were mainly related to mergers and acquisitions. Removed exclusion events were mainly related to delistings or, less frequently, to M&A transactions. 375 more events were excluded from the computations due to missing data (mainly a lack of data on a company's historical or daily returns), detected confounding events, data incongruencies or data anomalies. In the computations to test H1, 21 extra anomalies emerged. Therefore 21 extra events (pertaining to abnormal trading volume) were ruled out of the calculations. To detect any potential confounding events, we conducted extensive checks for market news, announcements, analyst reports and information available through the dedicated Refinitiv 'News Monitor App' around the date of index announcements and rebalancing reviews for a sample of companies whose detected daily abnormal returns (AR) on either of those dates were on the lowest and highest quantiles of the AR distribution.

3.2. Methodology

The event study methodology measures the impact of a specific event on firm value using financial market data. Hence, it essentially detects the reaction of the stock market to the disclosure of new information (MacKinlay, 1997; McWilliams and Siegel, 1997).

We measured abnormal returns using the capital asset pricing model, using the three-factor model of Fama and French (1993) as a robustness check. A methodological note regarding the application of the Fama-French model is discussed in the robustness section,

[3] MSCI ACWI ESG Leaders Index; MSCI WORLD ESG Leaders Index; MSCI EU ESG Leaders Index; MSCI USA ESG Leaders Index; MSCI EM ESG Leaders Index; MSCI ACWI SRI Index; MSCI WORLD SRI Index; MSCI EU SRI Index; MSCI USA SRI Index; MSCI EM SRI Index; MSCI KLD 400 Social Index.

[4] EM countries include: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, South Korea, Kuwait, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates.

[5] EU countries include: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the UK.

[6] WORLD countries include the USA, all EU countries and Australia, Canada, Hong Kong, Israel, Japan, New Zealand and Singapore.

[7] See Appendix D for a detailed description of index selection criteria, rebalancing mechanisms, ESG materiality approach and ESG parameters taken into account for the evaluation.

Table 1
Announcement and review dates.

Review	AD	RD	N	Review	AD	RD	N
1	19/05/2011	01/06/2011	166	**23**	18/11/2016	01/12/2016	54
2	19/08/2011	01/09/2011	24	**24**	16/02/2017	01/03/2017	23
3	18/11/2011	01/12/2011	39	**25**	19/05/2017	01/06/2017	174
4	17/02/2012	01/03/2012	29	**26**	21/08/2017	01/09/2017	25
5	21/05/2012	01/06/2012	286	**27**	20/11/2017	01/12/2017	56
6	21/08/2012	03/09/2012	37	**28**	16/02/2018	01/03/2018	25
7	20/11/2012	03/12/2012	55	**29**	21/05/2018	01/06/2018	354
8	18/02/2013	01/03/2013	36	**30**	21/08/2018	03/09/2018	28
9	21/05/2013	03/06/2013	314	**31**	20/11/2018	03/12/2018	76
10	20/08/2013	02/09/2013	25	**32**	18/02/2019	01/03/2019	29
11	14/11/2013	27/11/2013	81	**33**	16/05/2019	29/05/2019	314
12	18/02/2014	03/03/2014	46	**34**	15/08/2019	28/08/2019	30
13	20/05/2014	02/06/2014	235	**35**	14/11/2019	27/11/2019	79
14	19/08/2014	01/09/2014	15	**36**	18/02/2020	02/03/2020	35
15	13/11/2014	26/11/2014	45	**37**	19/05/2020	01/06/2020	381
16	17/02/2015	02/03/2015	39	**38**	19/08/2020	01/09/2020	36
17	19/05/2015	01/06/2015	213	**39**	18/11/2020	01/12/2020	163
18	19/08/2015	01/09/2015	32	**40**	16/02/2021	01/03/2021	51
19	18/11/2015	01/12/2015	66	**41**	17/05/2021	28/05/2021	456
20	17/02/2016	01/03/2016	16	**42**	19/08/2021	01/09/2021	23
21	19/05/2016	01/06/2016	246	**43**	18/11/2021	01/12/2021	102
22	19/08/2016	01/09/2016	46				

AD refers to the day of the announcement of the index review; RD, the review date, refers to the day during which the changes get implemented. N is the total number of events analysed per review date.

Table 2
Number of events analysed per index; average number of constituents; and starting date of analysis.

Index	N additions	N deletions	N constituents	Starting date
KLD400	326	236	400 (fixed)	May 2011
WORLD ESG	889	872	700 +	May 2011
EU ESG	249	259	200 +	May 2011
USA ESG	335	314	250 +	May 2011
EM ESG	658	363	250 +	June 2013
ACWI ESG	1271	1093	1000 +	June 2013
WORLD SRI	631	643	350 +	June 2011
EU SRI	187	206	120 +	June 2011
USA SRI	219	214	120 +	June 2011
EM SRI	199	165	120 +	March 2014
ACWI SRI	646	616	500 +	March 2014
Total	**5610**	**4981**		

N additions and N deletions include the total number of events analysed per ESG index; N constituents indicates the size of the index in terms of number of shares included; the Starting date includes the first revision included in the analysis. May 2011 is the first day available for data on the compositions of existing indices. More recent starting dates indicate that the relative indices have been launched on such dates.

while the full results are given in Appendix B.

The CAPM formula for expected returns is as follows:

(Eq. 1)

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

where $E(R_i)$ is the expected return of stock i; R_f is the risk-free rate of return of the market, namely the interest rate on a 1-month US treasury bond; β_i is the beta coefficient of stock i, computed through an OLS regression over an estimation window of 5 years, ending the month preceding the announcement date. 667 companies were found with a non-significant β estimate, mainly due to a very low number of market return data points in the estimation period. With the aim of not including outliers, these coefficients were set to 1, which is the average market beta. The impact of this approach is discussed in the robustness section. Market returns were calculated as logs, using regional market indices according to the geographical location of the firm. Stock returns for all firms were downloaded from the Refinitiv database; R_f and R_m for the estimation and event windows were extracted from the website of Kenneth R. French.[8]

Following the estimation of expected returns, the abnormal return of stock *i* at time *t* (AR_{it}) is defined as the difference between the realized return (R_{it}) and its expected return ($E(R_{it})$) in the absence of the event:

[8] URL: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.

(Eq. 2)

$$AR_{it} = R_{it} - E(R_{it})$$

The mean effect on day t of the event is computed as the mean of abnormal returns for the companies $i = 1, \ldots, N$:
(Eq. 3)

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it}$$

Similarly, for an aggregation over time, the cumulative abnormal returns (CAR_i) during the event period (t_1; t_2) is the sum of the estimated $AR_{i,t}$ for all days from t_1 to t_2, and, for all affected firms, the cumulative average abnormal returns (CAAR) is the mean of CAR_i for all companies $i = 1,\ldots, N$:
(Eq. 4)

$$CAR_i = \sum_{t=t_1}^{t_2} AR_{it}$$

(Eq. 5)

$$CAAR = \frac{1}{N}\sum_{i=1}^{N} \mathrm{CAR}_i$$

For each company, the complete event window runs from 10 days before the announcement day (AD) through to 30 days after the event date (ED). We subsequently divided the complete window into seven event sub-windows, each designed to assess different aspects of investor behaviour around the events

1) A pre-announcement window that lies between AD-10 and AD-1, aimed at detecting the existence of any anticipation effect or leakage of information;
2) The announcement date (AD) day, to control for the immediate impact of releasing information on rebalancing the index;
3) The day preceding the review date, i.e., the event date (ED), to control for the impact of the review when effectively occurring through the market. The event date is checked instead of the review date because implementation takes place when the stock market opens on the review day. Therefore, the impact of portfolio rebalancing according to the stock prices should take place the day before the review, on the event date;
4) The run-up window that spans from the day after the announcement date through to the day before the event date (ED-8; ED-1) to test for possible price changes between the announcement and the date of the index review;
5) A post-implementation window that runs from ED+ 1 to ED + 10, which can be useful to check for a reversal in returns during the ten trading days after the review;
6) A 'permanent' price impact window, which covers the period from ED + 11 to ED+ 30, to assess the overall medium term-impact;
7) The post-event window, spanning from the announcement date up to ED+ 30, that controls the net, overall impact of the event considering the whole period going from the day of the announcement to 30 trading days after the implementation of the review;
8) The full event window that also considers the market behaviour before the announcement date.

The same event windows are used to compute abnormal volume. Abnormal volume (AV) is the stock i trading volume at time t adjusted for market-wide movements. Like Harris and Gurel (1986) and Cheung (2011), we computed AV_{it} as follows.
(Eq. 6)

$$AV_{it} = \frac{V_{it}}{V_i} \Big/ \frac{V_{mt}}{V_m} - 1$$

where V_{it} and V_{mt} are, respectively, the trading volume of stock i and the market portfolio at time t; and V_i and V_m are the average trading volume of stock i and of the market portfolio in the 8 weeks before the event window. Thus, AV_{it} is a standardized change in trading volume of stock i at time t, adjusted for market-wide changes in trading volume.

Firm AV_{it} is then averaged to obtain the daily average abnormal trading volume for all companies across the whole sample, AAV_t. Finally, when considering multiple days, we calculate the mean value of AAV_t across all the days taken into account, shown as the mean average abnormal volume (MAAV) during the period (t_1; t_2):

(Eq. 7) $AAV_t = \frac{1}{N}\sum_{i=1}^{N} AV_{it}$

(Eq. 8)

$$MAAV = \frac{1}{t_2 - t_1 + 1}\sum_{t=t_1}^{t_2} AAV_t$$

All volume data were extracted from Refinitiv. The market portfolio figures (V_{mt} and V_m) refer to the local stock exchange of each

firm, measured as the trading volume of the largest index available in each country. Note, however, that no market index was available for some developing countries. In these circumstances, we used data from countries with comparable financial and economic features (see Appendix 3 for the full list). Additionally, since AV is a ratio, what is ultimately essential is not the local exchange index coverage, but its capacity to track market movements and trading volume.

To examine changes in institutional ownership after an index had been rebalanced, we extracted monthly ownership data from Refinitiv from three months before the review date to three months after. Ownership percentages for individual shareholders were aggregated and classified into the three groups outlined above: strategic investors (SI), long-term institutional investors (LTI), and short-term institutional investors (STI).[9]

To assess the extent of ownership changes during the months surrounding the review of the ESG index, we calculated the average change in the aggregated equity stake for all investors belonging to the three categories described. For example, the formula to calculate the net monthly variation of ownership by strategic investors across all firms in month t ($\Delta Own_{SI,t}$) is:

(Eq. 9)

$$\Delta Own_{SI,t} = \frac{1}{n}\sum_{i=1}^{n} SI_{i,t} - \frac{1}{n}\sum_{i=1}^{n} SI_{i,t-1}$$

where $SI_{i,t}$ is the average ownership of the strategic investors in firm i during the month t. The average values are calculated for the n firms affected by the event. To interpret the economic impact of the change in ownership for each investor class x, we also calculated the ratio between $\Delta Own_{x,t}$ and the average equity stake observed through the entire period for the investor class x.

With the aim of testing Hypotheses 2a – 2d, we controlled for the effects of abnormal returns and volume associated with:

- HP – a dummy variable used to differentiate between heavily polluting firms vs cleaner ones;
- EM – a dummy variable used to differentiate between firms located in developed versus emerging markets;
- SRI – a dummy variable used to control for changes in different MSCI ESG index families: the SRI indices, characterised by stricter admission criteria, are contrasted with other ESG indices.
- ParAgr – a dummy variable used to control for changes in AR and AV before and after the signing of the Paris Agreement in 2015.

Finally, we controlled for the effect of the following continuous explanatory variables:

- N_REB, the number of ESG indices in which a share is simultaneously included or excluded.
- SIZE, measured as the logarithm of the company's market capitalisation at time AD-10, expressed in USD millions;
- ESG, the firm's environmental, social, and governance score provided by LSEG (previously Refinitiv).

These additional variables capture specific firm characteristics that could relate market reactions to changes in an ESG index. Thus, these factors will be examined through multiple regressions.

Sometimes, a firm is included in or excluded from a single ESG index (19.5 % of the total of the index changes), but it is quite common for a stock to simultaneously enter or exit two (47.3 %) or three indices (23.0 %) at the same time, and 10.4 % of the firms in the sample saw their stock change in between four and seven indices. The number of indices that have changed a particular stock (as captured by the variable N_REB) can be thought of as an indicator of the strength with which passive investors will rebalance their portfolios. Therefore, a large number of indices including/excluding the stock is expected to result in a stronger market reaction,.

SIZE is a proxy of the liquidity of the shares. We assume that – all other things being equal – a larger market cap will be negatively correlated to the effect of rebalancing since greater liquidity reduces the impact of trading by passive investors. Further, from an informational point of view, we can expect that analysts will give more coverage to large firms, so there should be less surprise over any index revisions and, in turn, abnormal returns should be lower.

We included the LSEG ESG ratings as a proxy of the sustainability characteristics already perceived by market participants and used them to estimate the surprise related to a stock's inclusion in/exclusion from an ESG index. For inclusions, markets should have a stronger positive reaction to firms with lower LSEG ratings, as this would be consistent with a stronger informational effect of the rebalancing. Similarly, excluding shares with a high rating may come as a surprise, which could result in poorer price performance and a larger abnormal volume. Therefore, a negative coefficient associated with LSEG ratings is consistent with more information conveyed by the revision. Notably, this would be at odds with the pure effect of passive investors rebalancing their portfolios.

4. Findings and discussion

4.1. Abnormal volume: the relevance of ESG index reviews on trading activity

First, we tested the relevance of the information on investment decisions made by the market participants using abnormal volume

[9] Ownership categories provided by Refinitiv have been classified as follows. Strategic Investors (SI) includes Corporation, Individual Investor, Other Insider Investor, Holding Company, Institution, Government Agency; Long-Term Institutional investors (LTI) includes Pension Fund, Closed-End Fund, Foundation, Endowment Fund, Pension Fund Portfolio, Sovereign Wealth Fund, Private Equity, Venture Capital; Short-Term Institutional investors (STI) includes Investment Advisor/Hedge Fund, Mutual Fund, Insurance Company, Bank and Trust, Hedge Fund, Independent Research Firm, Investment Advisor, Research Firm, Hedge Fund Portfolio.

as a proxy. Table 3 reports the MAAV values for firm additions and removals over all event sub-windows.

The abnormal volume is positive and statistically significant for all event windows, both for inclusions and exclusions. This evidence is consistent with the hypotheses that ESG index reviews contain relevant information that influences investor behaviour. In fact, abnormal trading volume is detected not only at the effective change date since there is an average increase of 7.4 % for added firms and 16.7 % for removed firms, excluding the event date.

The most evident result is, however, the peak of abnormal trading volume on the event date, with an uptick of 67.6 % for included stocks and a huge 181.8 % for removed firms (Fig. 1). The extreme peak at the event date is consistent with the strong impact of passive investors and raises some questions about the role of different market participants in determining the magnitude of the abnormal trading volume. Even if we are not able to shed light on this issue directly, we expect that portfolio rebalancing by passive investors should result in similar abnormal volume for additions and deletions from the index. By contrast, the data clearly show that abnormal trading volume is systematically higher for exclusions, and not just at the change date but also for the other days around the event. Abnormal trading volume is higher for exclusions, which is consistent with the notion of a negativity bias toward ESG information in the market (Panico et al., 2014; Rothenhoefer, 2018; Miller et al., 2020; Sabbaghi, 2023). It also marks a significant revision to the expectations of active investors.

4.2. *The market reaction: abnormal returns*

Our analysis of the abnormal returns sheds light on investors' attitudes towards the firm's ESG characteristics. Assuming that revisions to an index do convey new relevant information on firm sustainability to the market, we expect investors to reward added firms and punish excluded firms.

The abnormal returns in Table 4 broadly support our hypothesis. Even if the market does not swiftly incorporate the newly released information on the announcement date, in the run-up window (that spans from the day after the announcement date (AD) through to the day before the event date (ED), included firms show a positive and significant abnormal CAAR, close to 0.82 % (0.44 % in run-up window and 0.39 % on the event date). For excluded firms, the CAAR is negative and close to −0.75 %, a value significantly different from a statistical and economic perspective. This effect stands out clearly when looking at the graph in Fig. 2, which shows the daily CAAR as green (included) stocks and red (excluded) stocks across the whole event window.

After the event date, we find a temporary reversal effect – one that is particularly evident for excluded firms – which suggests investors are seeking profit opportunities after previous price changes. However, considering abnormal returns across the full event window from AD to ED+ 30 (-1.13 %), we find that the average abnormal returns are significantly lower for excluded stocks than for added stocks.

These findings support the hypothesis that the market significantly prices the information conveyed by the index rebalancing, rewarding firms included in ESG indices (and penalising exclusions) in a persistent way. The total difference between CAARs for admissions and exclusions amounts to nearly 1.2 % across the entire event window, which indicates that such events have a significant economic impact.

Comparing these results with the existing literature, a few key points stand out. First, it appears that CAAR values are substantially affected by ESG index rebalancing – a finding that runs counter to some prior studies where lesser magnitudes are reported (Consolandi et al., 2008; Doh et al., 2010; Becchetti et al., 2012). It is reasonable that this could be the result of increased investor attention toward ESG – probably pushed by growing regulatory pressures, as well as the outstanding growth of ESG investing in recent times.[10] To explore this notion, we undertook an additional analysis of the subsamples around the signing of the Paris Agreement (see Section 4.3, d)), and the results support this view.

Second, the permanent effect contradicts the price pressure hypothesis, which suggests that abnormal demand changes following index reviews are temporary (Harris and Gurel, 1986; Woolridge and Ghosh, 1986; Biktimirov et al., 2004; Cheung, 2011). Instead, our findings seem to lend support to the signalling hypothesis (Jain, 1987; Dhillon and Johnson, 1991; Denis et al., 2003; Cai, 2007; Platikanova, 2008). The signalling hypothesis indicates that investors interpret ESG index reviews as signals of an increase (decrease) in sustainability efforts, affecting a firm's reputation and future financial performance. Our results may also be seen as falling in line with those of Robinson et al. (2011), who find a positive, significant CAR for additions in the 60 days after the announcement date, with a mean CAR of 2.1 %.[11] Moreover, we challenge the investor awareness hypothesis (Chen et al., 2004), which posits that firms excluded from financial indices see no value changes due to their exclusion. Our study reveals that, in the ESG realm, being excluded from an index, even if it follows a best-in-class methodology, has a stronger and more significant negative impact on firm value than the positive impacts of being included. This confirms the presence of a negativity bias in valuations of firm sustainability. Lastly, in contrast to the assumption by Hawn et al. (2018), we show that ESG indices can be an efficient channel for communicating information about a firm's ESG performance. In their study on the market reaction to the DJSI World index rebalancing, they consider the event to be the outcome of a diffuse evaluation process that, given the nature of ESG index construction mechanisms, was conducted by a set of "private decentralised institutions" (index providers, ESG raters). Their conclusion that ESG indices are ineffective channels for

[10] As of December 2021, the latest period considered in our study, a report by PwC estimates global ESG AuM to be worth around $127.5 trillion, almost doubling since the same period in 2015 (PwC Asset and Wealth Management report, 2022).

[11] Quite interestingly, in this study positive abnormal returns appear only 30 days after the event date, and keep increasing until day 60. To explain such findings, the authors consider stakeholder theory: drawing upon Cornell and Shapiro (1987), it takes time to build the ESG reputation of a company and determine a positive impact on market valuation.

Table 3
Mean average abnormal volume (MAAV) for each sub-window and the difference between additions and deletions.

Window	Additions (N = 2358)			Deletions (N = 1956)			Difference		
AD−10; AD−1	0076	8187	***	0155	13,164	***	- 0079	- 5237	***
AD	0052	3843	***	0132	8073	***	- 0080	- 3757	***
ED−9;ED−1	0089	8544	***	0209	14,571	***	- 0120	- 6743	***
ED	0676	15,217	***	1818	21,108	***	- 1142	- 11,783	***
ED+ 1; ED+ 10	0068	7005	***	0188	13,728	***	- 0120	- 7119	***
ED+ 11;ED+ 30	0055	6075	***	0096	8809	***	- 0041	- 2883	***
AD;ED+ 30	0087	10,240	***	0199	16,540	***	- 0112	- 7603	***

T-stats are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

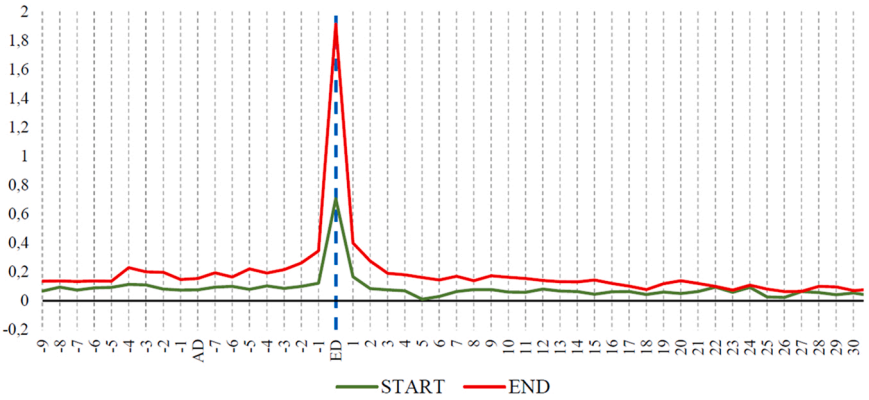

Fig. 1. – Daily abnormal average trading volume (AAV). 'Start' refers to included firms; 'End' refers to firms excluded from index rebalancing.

Table 4
CAAR estimates (in %) for each sub-window, and the difference between additions and deletions.

Window	Additions (N = 2478)			Deletions (N = 2120)			Difference		
AD−10; AD−1	- 0127	−0,64		- 0405	- 1703	*	0278	1564	
AD	0094	1,44		0034	0468		0060	1050	
AD+ 1;ED−1	0453	2,74	***	- 0266	- 1442		0719	5053	***
ED	0398	5,56	***	- 0365	- 4184	***	0763	11,755	***
ED+ 1; ED+ 10	- 0199	−1,02		0712	3224	***	- 0911	- 5390	***
ED+ 11;ED+ 30	- 0232	−0,88		- 0776	- 2791	***	0545	2485	***
AD;ED+ 30	0543	1,48		- 0655	- 1684	*	1198	3908	***

T-stats adjusted according to Kolari and Pynnönen (2010) are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

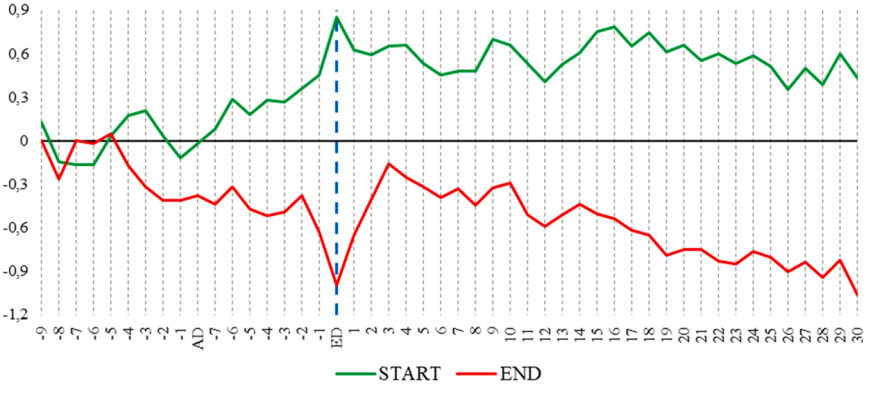

Fig. 2. Cumulative Abnormal Returns (CAR) computed through the CAPM model. *'Start' refers to included firms; 'End' refers to firms excluded from index rebalancing.*

assessing and pricing corporate sustainability performance is at odds with our results.

4.3. The moderating effects of firm and index characteristics

In this section, we investigate whether the market reaction to the inclusion in (exclusion from) ESG indices varies in relation to specific characteristics of the firms or indices. For brevity, we have deferred all the results obtained by comparing the different subsamples, as well as the outcomes of the multivariate regressions to Appendix A. Hence, this section summarises the main outcomes of the analysis.

a) Firms operating in heavy-polluting sectors

When considering companies operating in heavy-polluting (HP) sectors (Tables A1-A2), we find that shareholders react more negatively to exclusions from ESG indices on the event date and the previous days, as predicted by hypothesis *H2a*. However, this effect is not persistent. In fact, when taking exclusions over the whole window into account, the abnormal returns are very similar and not statistically different. Looking at trading volume, we only observe higher abnormal trading activity at the event date for HP firms.

Focusing on additions, we do not find significant differences between the subsamples. Our results, therefore, challenge the thesis of Chen et al. (2021), who argue that heavy-polluting firms may benefit more from an indirect signal certifying their above-average environmental performance. Rather, our results are, to a certain extent, consistent with those of Schmutz et al. (2020), who find significant negative abnormal returns following the inclusion of polluting firms in the DJSI. In our sample, in the window ED+ 1 - ED+ 10, heavy polluting firms added to the index show negative returns, which is marginally statistically different from other firms, and, over the whole window, abnormal returns are lower by −0.970 % (albeit not statistically significant).

b) Firms located in emerging markets

Turning to firms domiciled in emerging markets (EM), we show that ESG index reviews have a strong impact, particularly for additions (Tables A3 and A4). In the window that runs from the announcement date to the event date, the CAAR of the added firms is positive and statistically higher than those observed for the firms of developed countries by more than 1 %. Further, abnormal trading volume on the event date is significantly higher for EM firms. Hypothesis H2b is therefore confirmed for additions.

However, the picture is different for excluded stocks: a clear anticipation of the rebalancing effect arises for EM firms, given the highly significant CAAR coefficient of −1.44 % detected in the time window preceding the announcement date. This suggests a potential information leak that would be consistent with the abnormal trading volume depicted in Table A4. Abnormal returns are, however, very volatile, and, even though the abnormal returns are lower than that of the firms in the developed markets over the whole window, the difference is not statistically significant. This is also associated with a higher increase in trading volume compared to firms in developed markets.

In summary, these results are weakly consistent with hypothesis H2b, i.e., the assumption that index reviews offer more informational value in the context of emerging markets. On the one hand, these regions are subject to growing ESG concerns due to their higher exposure to environmental risks, as well as to their peculiar cultural circumstances (Zou et al., 2020). On the other hand, lower liquidity may explain a relevant volatility around the event date due to the rebalancing of institutional investors (see, in particular, the large price reversal for excluded firms). Additionally, weak law enforcement measures (Mishra and Suar, 2010) may be related to an anticipation effect detected before the index reviews are officially disclosed.

c) The membership in the SRI indices

Tables A5 and A6 show the behaviour of firms involved in the reviews of SRI indices, i.e., indices with stricter ESG criteria for admissions. These results are not consistent with our hypothesis H2c, which assumes that rebalancing stocks on an SRI index will prompt a more powerful market reaction. However, this expected behaviour is only visible for stocks included in SRI indices in the run-up window, from AD+ 1 to ED-1, with a higher CAAR of 0.52 % versus non-SRI stocks.

In terms of stocks excluded from SRI indices, taking into account their better performance (which is, albeit, only significant in the pre-announcement window) the evidence shows that excluding a stock from a SRI index has a lower negative impact. One explanation for this result is that the stocks might still be included in less restrictive ESG indicess. The study of abnormal trading volume is weakly consistent with this argument since we detected a lower increase in trading volume for deletions from SRI indices vs firms excluded from non-SRI indexes.

d) Before and after the paris agreement

Splitting the sample by time, we next considered whether index revisions before and after the Paris Agreement differed significantly. In other words, did the Paris Agreement prompt greater interest in ESG investments and/or more portfolio rebalancing by passive ESG funds? Table A7 shows that a significant increase in trading volume is generally confirmed in both sub-periods but, after the Paris Agreement, the impact of index revisions is significantly higher (at the event date, +90 % vs +39 % for additions, and +225 % vs +125 % for deletions). These results are consistent both with the growing impact of passive investors and the idea that ESG index reviews offer significant informational relevance.

Table A8 shows that abnormal returns are also amplified in the post-Paris Agreement years. From the announcement date to the event date, abnormal returns for inclusions are consistently higher (by 1.95 % in total). However, also the price reversal become significant since the Paris Agreement. Over the whole event window, returns are positive and increasing, but the difference vs the previous period is only marginally significant. A similar behaviour emerges for exclusions, with a stronger negative impact after the Paris Agreement at the event date, followed by a significant reversal, with similar results over the whole window.

Therefore, we can conclude that, in recent years, the positive and negative effect of the rebalancing seems amplified around the event date, which is consistent with stronger trading by passive investors and confirmed by a significant increase in trading volume.

e) Results of regression analysis

Finally, we performed a multivariate analysis, in which abnormal returns (or abnormal trading volume) were regressed against a number of explanatory variables. The results, reported in the Appendix, Tables A9 – A10, add some additional evidence to the effects experienced from multiple inclusions/exclusions (N_REB), the market capitalization of the firm (SIZE), and the ESG ratings disclosed by LSEG.

The number of revisions affecting the stock, captured by the variable N_REB, is positively correlated with abnormal returns in all the event windows for additions and is statistically significant for the period between the announcement date and event date, as well as across the whole event window. At the effective date, abnormal returns for exclusions significantly decline with N_REB, confirming the expectation that the membership in multiple indices amplifies the negative impact on returns.

Looking at trading volume, both multiple inclusions and exclusions significantly amplify the effect of portfolio rebalancing, in particular at the event date. Consistent with previous results, the size of the coefficient is almost double for exclusions, confirming an informational effect that adds to the mechanical portfolios rebalancing by passive investors.

Firm SIZE is not significantly correlated with abnormal returns for stocks added to ESG indices, but for exclusions, the coefficients are positive and often statistically significant – showing a smaller negative return associated with deletion from an index. This is especially evident across the whole event window and around the event date. These results are also consistent with a stronger negative informational effect linked to exclusions for smaller firms.

For larger firms, being included in an index is associated with a significantly lower increase in trading volume at the event date. Yet, for exclusions, the impact is even stronger, with negative size coefficients that are strongly significant in all event windows. As expected, their higher stock liquidity and higher media exposure reduce the impact of the exit from ESG indices, in line with the findings of Clacher and Hagendorff (2012).

We also find some evidence of a negative correlation between a firm's ESG profile, as measured by LSEG ESG scores, and abnormal returns. For additions, this means that companies with high ESG scores may experience lower abnormal returns on the announcement day and over the whole event window, suggesting that the market may have already factored their ESG performance into the stock prices. Conversely, companies with low ESG ratings experience higher abnormal returns, consistent with a high information content in the news. Similarly, the negative coefficient found for deletions at the effective date implies that firms with higher ESG ratings, that are then unexpectedly excluded from the index, experience a worse abnormal return.

Estimates on trading volume are consistent with this story: the negative coefficients for additions reflect a lower increase in trading for firms with high LSEG ESG score that have been added to an index, whereas the positive coefficients for deletions indicate a strong wave of selling due to unexpected exclusions.

Overall, these findings highlight the issue of ESG ratings divergence, a well-documented phenomenon in the literature (Pagano et al., 2018; Billio et al., 2021; Berg et al., 2022).

4.4. *Institutional investors' preferences and ownership changes*

With the aim of tracing the behaviour of different types of shareholders around the rebalancing of ESG indices, we computed the average variation of the aggregate ownership for three categories of investors, i.e., strategic investors (SI), long-term institutional investors (LTI), and short-term institutional investors (STI), over a period of three months before and after the event date.

The results, which appear in Tables 5–7, show that the trading behaviour of short-term investors is clearly linked to ESG index

Table 5
Variation of the average ownership of short-term institutional investors.

Month	Absolute Variations			Relative Variations *(Avg = 42.8 %)*	
	Add	Del	*Diff*	Add	Del
3	0.039	−0.027	0.067	0.093	−0.065
	(0.594)	(−0.345)	(0.645)		
2	−0.023	0.078***	−0.101*	−0.053	0.184
	(−0.447)	(3.158)	(−1.777)		
1	−0.042	−0.075**	0.033	−0.098	−0.177
	(−0.991)	(−2.04)	(0.596)		
RM	0.233***	−2.483***	2.716***	0.545	−5.805
	(3.404)	(−8.232)	(8.781)		
−1	0.079***	−0.356***	0.435***	0.185	−0.832
	(2.931)	(−6.269)	(6.92)		
−2	−0.047	0.001	−0.048	−0.111	0.002
	(−1.585)	(0.031)	(−0.994)		
−3	0.322***	0.120*	0.202**	0.753	0.281
	(4.604)	(1.697)	(2.029)		

Additions to the indices comprise 2536 firms, while exclusions equate to 2216 firms. RM is review month, while 'Add', 'Del' and 'Diff' refer, respectively, to ownership variations related to firm additions, deletions and the difference between the two values (Add – Del). On the right side of the table, the monthly variations are calculated in relative terms to the average ownership share ('Avg'), indicated in the first row of the section. Values are expressed in percentage terms. T-stats are reported under the coefficients in brackets. *, **, *** indicates statistical significance at the 10 %, 5 %, and 1 % levels.

reviews. We observe a significant increase in ownership equal to 0.23 % during the review month (RM) for additions and a reduction of nearly 2.5 % for exclusions. Cumulatively, this translates to more than 0.6 % growth for additions and a 2.7 % decline for exclusions up to the review month, which in relative terms – i.e., computed versus their average ownership stake – appears even more relevant, equal to + 1.4 % and −6.3 %, respectively.

Long-term institutional investors show a slight and statistically insignificant increase in ownership for added firms (Table 6). However, the impact of the index rebalancing is clearly visible for excluded firms. LTIs consistently reduce ownership from month −3, with a nadir of −0.12 % in the review month. The decrease in ownership continues across the following months, demonstrating a consistent, ESG-driven investment strategy. Taking the relative ownership change into account, the decrease in LTI ownership is quite significant: −2.3 % in the review month and −4.9 % over all the analysed months.

However, the patterns are less clear with strategic investors (Table 7). In terms of additions, we find a significant increase in the review month, preceded and followed by a reduction in ownership stakes. Taking the entire period into account, the aggregate relative change in the ownership of strategic investors only weighs + 0.18 %. For deletions, we find a decline in ownership across the three months before the revision, equal to a relative change of −1.71 %. This is followed in the month of the review by a corresponding positive change equal to + 1.73 % and then by an average relative increase of + 1.25 % over the following three months.

These changes in cumulative ownership of different types of shareholders, also highlighted in Fig. 3, suggest that ESG index revisions do have a relevant impact on the behaviour of financial investors, a topic that deserves greater consideration in future research. As a preliminary exercise, we considered the variations in ownership for different sub-samples of firms (heavy-polluting firms, emerging markets, SRI indices, etc.). The results of this analysis are provided in Appendix A, Tables A11-A16. In summary, we find no relevant differences in the trading activity of short-term investors when it comes to additions to an index (see Table A11). However, there is a weak dip in trading for excluded firms active in heavy-polluting industries and for those excluded from SRI indices (see Table A12).

Although not statistically significant, we also find a slight decrease in trades for firms domiciled in emerging markets (-1.8 % versus −2.8 % for firms in developed countries).

The results for long-term institutional investors show similar trends, i.e., no statistically significant results emerged for added firms (see Table A13), and the same results were obtained for excluded firms in the HP, EM and SRI sub-samples.

Moreover, we did not find significant differences among the sub-samples when examining the choices of strategic investors (Tables A15 and A16).

In summary, the results highlight that ESG index reviews have a significant impact on changes in corporate ownership and that the decisions of different categories of investors could be related to peculiar strategic considerations, which are shaped by their goals and time horizons. Long-term investors, in line with their orientation towards sustainability, are influenced by the revisions of ESG indices, but, quite surprisingly, they seem to be less responsive to index reviews than short-term investors. Overall, their preference for sustainable stocks, as suggested by Zou et al. (2025), may fall in line with the perceived reduction of operational risks and improved net profits. The growing weight of stockholders traditionally considered to be short-term oriented (for example, mutual funds and investment advisors) who are increasingly focussed on sustainability goals, as well as the diffusion of passive products linked to ESG indices, could explain the strong impact of index revisions for the short-term investors' group. Portfolio turnover, especially for index deletions, appears to have a substantial impact on market behaviour, affecting listed firm ownership; however, against expectations, the impact seems lower for firms in heavy-polluting sectors, for those located in emerging markets, and for companies removed from the stricter SRI indices.

Table 6 –
Variation of the average ownership of long-term institutional investors.

Month	Absolute Variations			Relative Variations *(Avg = 5.2 %)*	
	Add	Del	*Diff*	Add	Del
3	0.010	−0.035**	0.045**	0.198	−0.675
	(0.65)	(−2.566)	(2.167)		
2	0.001	−0.003	0.004	0.020	−0.067
	(0.111)	(−0.553)	(0.401)		
1	−0.006	−0.016	0.010	−0.122	−0.319
	(−0.562)	(−1.529)	(0.654)		
RM	0.016	−0.122***	0.138***	0.306	−2.331
	(1.004)	(−4.138)	(4.117)		
−1	−0.003	−0.033*	0.030	−0.061	−0.648
	(−0.307)	(−1.908)	(1.485)		
−2	−0.037***	−0.042***	0.004	−0.721	−0.802
	(−2.806)	(−3.199)	(0.223)		
−3	−0.024	−0.003	−0.020	−0.459	−0.064
	(−0.935)	(−0.213)	(−0.687)		

Additions comprised 2536 firms, while deletions equal 2216 firms. RM is the review month, while 'Add', 'Del' and 'Diff' refer, respectively, to ownership variations related to firm additions, deletions and the difference between the two values (Add – Del). On the right side of the table, the monthly variations are calculated in relative terms to the average ownership share ('Avg'), indicated in the first row of the section. Values are expressed in percentage terms. T-stats are reported under the coefficients in brackets. *, **, *** indicates statistical significance at the 10 %, 5 %, and 1 % levels.

Table 7
Variation of the average ownership of strategic investors.

Month	Absolute Variations			Relative Variations *(Avg = 22.6 %)*	
	Add	Del	*Diff*	Add	Del
3	0.012	−0.017	0.030	0.054	−0.079
	(0.202)	(−0.259)	(0.328)		
2	−0.045	−0.038	−0.006	−0.199	−0.170
	(−1.114)	(−0.776)	(−0.103)		
1	−0.050*	−0.330***	0.280**	−0.221	−1.464
	(−1.828)	(−2.92)	(2.408)		
RM	0.132**	0.391***	−0.259**	0.586	1.732
	(1.982)	(3.558)	(−2.012)		
−1	0.006	0.164	−0.158	0.027	0.729
	(0.115)	(1.54)	(−1.325)		
−2	−0.067**	0.001	−0.068	−0.299	0.005
	(−1.998)	(0.014)	(−0.738)		
−3	0.052	0.115**	−0.062	0.234	0.511
	(0.92)	(2.374)	(−0.829)		

Additions comprise 2536 firms, while deletions equal 2216 firms. RM stands for review month, while 'Add', 'Del' and 'Diff' refer, respectively, to ownership variations related to firm additions, deletions and the difference between the two values (Add – Del). On the right side of the table, the monthly variations are calculated in relative terms to the average ownership share ('Avg'), indicated in the first row of the section. Values are expressed in percentage terms. T-stats are reported under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels.

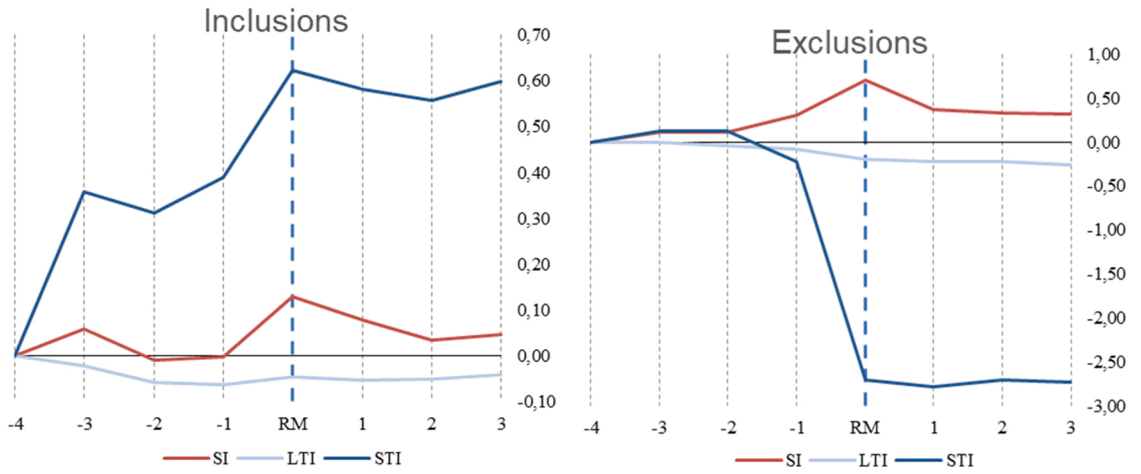

Fig. 3. – Cumulative change in ownership for shares included in (section a) or excluded from (section b) ESG indices. *SI refers to strategic investors, LTI to long-term institutional investors, and STI refers to short-term financial investors.*

Taking this perspective, we could try to explain the apparently erratic behaviour of strategic investors around ESG index reviews. They appear to support the positive impact of additions (buying shares in the month of the review and selling equity before and after the event, with a net effect close to zero). Yet, when looking at deletions, they reduce their ownership in the three months before the review and then significantly increase their equity stake, especially if they are large shareholders. These preliminary results, of course, may require a more careful examination, for example, by disentangling the different types of ownership. At the same time, we believe that the evidence we found clearly highlights the market power of ESG index providers and the soaring of a new agency problem, which should be cautiously addressed by regulators. It is worth mentioning that a growing number of legal proceedings relate to insider trading or unauthorised and malicious use of non-public information regarding the rebalancing of stock indices involving the index providers themselves or fund managers (see Table A17).

5. Robustness

This section discusses the design of the empirical analysis, along with the results of a battery of tests aimed at checking the robustness of the evidence provided.

We start by recalling that we tried to remove all events that could be affected by potential confounding events. These included: a) any rebalancing that occurred outside the standard dates because these revisions are mainly to do with delisting or M&A transactions; and b) any significant abnormal returns (in the lowest and highest quantiles) associated to market-relevant news found on the Refinitiv 'News Monitor App'.

After excluding 477 events, we decided to control for the effect of potential outliers by winsorising all return and volume data to the 1st and 99th percentiles. The results included in the paper are based on this sample. They have a lower volatility than the unadjusted data, but the results are qualitatively the same. We also checked the impact of winsorising the data at the 5th and 95th percentiles, and, again, we obtained similar results. We can therefore conclude that our results are not affected by extreme outliers.

As we estimated the abnormal returns, we found that the CAPM β coefficients were not statistically significant for 667 companies, mainly due to a very low number of available market returns. Hence, to avoid anomalous estimations of the expected returns, we set these beta coefficients to 1, which is the average market beta. A similar standardisation was applied to the Fama and French three-factor model. We checked the robustness of this procedure, excluding all these observations and obtained qualitatively similar results.

Next, we split the sample of added firms into two groups: the first containing firms that were being included in an ESG index for the first time; and the second containing firms re-entering an index after having been previously excluded. We conjectured that if the first inclusion had a stronger impact than subsequent inclusions, it would indicate that index revisions carry higher informational content. Unfortunately, our contention could not be clearly confirmed. Over the whole post-event window, spanning from the announcement date up to ED+ 30, CARs were higher for first inclusions (+0,66 % vs. −0,04 %) but the differences were not statistically significant at conventional levels.

In the literature on the event study methodology, several statistical tests have been used to control issues such as cross-correlation, heteroscedasticity, and autocorrelation when estimating and testing for abnormal returns. Taking into account the characteristics of our dataset, we employed the test proposed by Kolari and Pynnönen (2010) to control for the cross-sectional correlation of returns. When large-scale events (e.g., regulatory reforms or industry-wide announcements) occur simultaneously across the analysed time windows, the cross-sectional dependence of abnormal returns can bias test statistics, overestimating the statistical significance of the findings.

Our sample is spread over 43 index rebalancing events, so the potential impact on clustering is not expected to be as relevant as in other studies in which all the considered events occur on a few or even a single date. Nonetheless, by applying the test proposed by Kolari and Pynnönen (2010) we found that the historical average cross-correlation, albeit low, reduced considerably the t-statistic values of abnormal returns computed through standard t-tests.

In addition, we included also the standardized cross-sectional test proposed by Boehmer et al. (1991) to further check the robustness of results. The test is designed to adjust abnormal returns for cross-sectional correlation and event-induced variance. Results of the BMP test are consistent with the ones reported in the paper, based on the Kolari and Pynnönen methodology.

Furthermore, to control for the robustness of the methodology employed to compute the abnormal returns, i.e., the CAPM model, we also computed ARs by adopting the Fama and French three-factor model. We obtained qualitatively the same results reported throughout this study. (For brevity, the description of the Fama and French model and the obtained results are included in the supplemental material of this article, available online *[alternatively, or are available on request from the corresponding author]*).

Recent literature has sparked an extensive debate on identifying equilibrium models that offer meaningful improvements in explaining cross-sectional equity returns. While CAPM model only takes into account the sensitivity to the market portfolio, the three-factor model proposed by Fama and French (1993) was the first of many extended models: for example, Carhart (1997) added the momentum factor, while Fama and French (2015) added profitability and investment factors. Fama and French (2018) and Barillas and Shanken (2018) compared several multi-factor models, finding that, even if more complex models may better explain certain anomalies in cross-sectional returns, no model is clearly dominant. Furthermore, multi-factor models have been found to provide better benchmarks for long-horizon event studies, such as those examining post-event drift (Barber and Lyon, 1997; Kothari and Warner, 1997); at the same time, they don't perform significantly better in short-term studies. In fact, empirical evidence suggests that more complex models may introduce additional noise due to factor estimation errors, thus potentially offsetting gains in model accuracy when the event window is short (Brown and Warner, 1985; MacKinlay, 1997).

On these bases, we argue that the evidence provided in this study is a robust estimation of the effect of ESG index revisions. Nonetheless, we are aware that standard equilibrium models may lead to lack of consideration of industry-specific shocks, since they are not captured by the market or mimicking portfolios. We do not believe that these industry-specific shocks are systematically linked to ESG revision dates. However, the counterfactual approach proposed by Rudkin and Cai (2023) could offer an interesting robustness check. This approach adopts stock returns of firms within the same industry as a benchmark for the 'treated' group affected by index revisions, rather than relying on an equilibrium model with historical parameters. This methodology provides a valuable perspective for conducting event studies and may warrant further research.

6. Conclusions

This research delves deep into the intersection of ESG-driven strategies, financial markets, and investor behaviour. The substantial surge in trading volume, in particular for those stocks removed from an index, reflects the market's recognition of ESG indices as pivotal sources of insight, guiding investment decisions in the realm of sustainability. Further, firms included in ESG indices appear to receive a vote of confidence, as evidenced by substantial and statistically significant abnormal returns. Conversely, firms excluded from these indices face market penalties, experiencing marked declines in stock value. This response persists up to 30 days after the event for excluded companies, challenging the assumption (as in Cheung, 2011) that market reactions to the rebalancing of ESG indices

are merely the outcome of price pressure mechanisms. Moreover, in contrast with the "investor awareness hypothesis" (Chen et al., 2004), we demonstrate that exclusions from best-in-class ESG indices are irrelevant to investors. The evidence emerging from this study is also helpful for demonstrating that ESG indices can be effective "sustainability pricing intermediaries" as they efficiently transmit ESG information to market participants that price it consistently.

Taking the specific characteristics of the firms and ESG indices into account, we show that companies operating in heavy-polluting sectors suffer stronger market penalties whether they are excluded from the index, in line with Schmutz et al. (2020). We also show that ESG index reviews have a more pronounced impact on firms in emerging markets, indicating their ESG performance suffers higher levels of scrutiny through third-party signals. We also examined market reactions to changes in SRI indices, which have stricter admissions criteria than the other ESG indices. And, counter to our expectations, we found no clear differences in the market's reaction to these more discerning indices.

While firm size is not affecting results for included firms, we found evidence supporting the assumption that a stronger negative informational effect is linked to exclusions for smaller firms. We also found that the number of revisions affecting a single stock has an effect on the abnormal returns detected: it is positively correlated to admissions, while also negatively affecting excluded firms, confirming the expectation that the membership in multiple indices amplifies the negative impact on returns.

Furthermore, detected a negative correlation between a firm's ESG profile, as measured by LSEG ESG scores, and abnormal returns: firms with high ESG scores tend to experience lower abnormal returns upon index addition, suggesting their ESG performance may already be priced in, while firms with low ESG scores see higher returns, indicating stronger market reactions; similarly, high-ESG firms suffer greater negative returns upon unexpected index exclusion. Our exploration of institutional investors' trading activity offers some significant insights. Both short- and long-term investors seemingly instigate significant ownership changes in response to ESG index reviews. However, quite surprisingly, short-term investors show a stronger reaction than long-term investors. This could be the result of an increased focus on sustainability goals and/or the spread of passive investing strategies linked to ESG indices. Strategic investors, however, show a trading behaviour that seems aimed at sustaining the positive effect of being included in an index and, even more clearly, at reducing the negative effects of being excluded from an index.

The evidence found opens promising avenues for future research. First, a deeper analysis focused on disentangling the price effects stemming from active versus passive portfolio rebalancing could offer richer insights into the influence of financial indices on share prices. Second, it would be useful to explore the differences in ESG ratings and their implications on responsible investment and market efficiency. More specifically, it could be interesting to incorporate ESG ratings into an event study and analyse the market response to rating changes in parallel with index rebalancing. Third, examining how investor behaviour varies in response to ESG index reviews within different market contexts, regulatory environments, or cultural settings could shed light on the global adoption of ESG strategies. Fourth, another promising path to deepen this work could be that of unravelling and, thus, analysing the exact reasons why firms get removed from an index(es), and then assessing the specific impacts of those reasons on the market. Finally, and perhaps more importantly, while exploring the multifaceted relationship between sustainability metrics, information providers, and global stock markets, this study highlights the market power of ESG index providers and the soaring of a new agency problem, which should be carefully addressed by regulators and academic research.

CRediT authorship contribution statement

Barontini Roberto: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gioja Luigi:** Writing – original draft, Investigation, Data curation, Conceptualization.

Appendix A

Table A1 –
CAAR coefficients for firms active in heavy-polluting industries (HP) and those active in other sectors (non-HP), and the difference between HP and non-HP firms

	Additions								Deletions							
Window	HP (N = 397)			Non-HP (N = 2081)			Difference			HP (N = 427)			Non-HP (N = 1690)			Difference		
AD−10; AD−1	−0341	−1032		−0086	−0426		−0254	−0827		−0289	−0691		−0434	−1826	*	0146	0378	
AD	0095	0820		0094	1426		0001	0008		0330	2630	***	−0040	−0533		0370	3164	***
AD+ 1;ED−1	0288	1072		0485	2844	***	−0197	−0780		−0741	−2377	**	−0145	−0778		−0596	−2053	**
ED	0392	3033	***	0400	5546	***	−0008	−0064		−0802	−5502	***	−0254	−2874	***	−0549	−4037	***
ED+ 1; ED+ 10	−0664	−2047	**	−0111	−0558		−0552	−1828	*	0817	2038	**	0685	3137	***	0132	0360	
ED+ 11;ED+ 30	−0154	−0332		−0246	−0929		0093	0217		−0430	−0906		−0865	−3072	***	0435	0987	
AD;ED+ 30	−0031	−0051		0652	1729	*	−0683	−1223		−0748	−1090		−0632	−1624		−0116	−0183	
AD−10 - ED+ 30	−0414	−0629		0556	1311		−0970	−1568		−1063	−1323		−1056	−2301	**	−0007	−0010	

T-stats adjusted according to Kolari and Pynnönen (2010) are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A2 –
MAAV coefficients for firms active in heavy-polluting industries (HP) and those active in other sectors (non-HP), and the difference between HP and non-HP firms

	Additions									Deletions							
Window	**HP (N = 395)**			**Non-HP (N = 1965)**			**Difference**			**HP (N = 422)**			**Non-HP (N = 1533)**			**Difference**		
AD−10; AD−1	0043	2024	***	0083	8018	***	−0041	−1728	*	0149	6436	***	0157	11,523	***	−0007	−0269	
AD	0033	0988	***	0056	3768	***	−0023	−0622		0164	4582	***	0123	6711	***	0041	1016	
AD+ 1;ED−1	0047	1982	***	0098	8424	***	−0051	−1937	*	0200	6936	***	0211	12,829	***	−0011	−0325	
ED	0815	6875	***	0649	13,579	***	0166	1300		2277	11,231	***	1691	17,922	***	0586	2619	***
ED+ 1; ED+ 10	0053	2140	***	0072	6726	***	−0019	−0714		0219	7297	***	0180	11,660	***	0040	1173	
ED+ 11;ED+ 30	0052	2389	***	0056	5584	***	−0003	−0138		0125	5155	***	0088	7210	***	0038	1378	
AD;ED+ 30	0078	3813	***	0089	9507	***	−0011	−0502		0226	8499	***	0191	14,209	***	0035	1158	
AD−10 - ED+ 30	0072	3712	***	0089	10,102	***	−0017	−0782		0214	8550	***	0186	14,746	***	0028	0999	

T-stats are reported are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A3 –
CAAR coefficients for firms domiciled in emerging market economies (EM), and those domiciled in more developed economies (DEV), and the difference between EM and DEV firms

	Additions									Deletions								
Window	**EM (N = 766)**			**DEV (N = 1711)**			**Difference**			**EM (N = 548)**			**DEV (N = 1571)**			**Difference**		
AD−10; AD−1	−0376	−1254		−0016	−0080		−0360	−1381		−1440	−3557	***	−0045	−0195		−1395	−3843	***
AD	0273	2631	***	0013	0216		0259	2925	***	0259	2115	**	−0045	−0621		0304	2745	***
AD+ 1;ED−1	0737	2696	***	0327	2167	**	0410	1777	*	−0034	−0101		−0347	−2010	**	0313	1066	
ED	0641	5587	***	0290	4348	***	0351	3587	***	−0503	−3367	***	−0317	−3759	***	−0187	−1395	
ED+ 1; ED+ 10	−0314	−1015		−0148	−0808		−0166	−0626		1723	4377	***	0360	1744	*	1363	3907	***
ED+ 11;ED+ 30	−0330	−0811		−0188	−0743		−0142	−0404		−1692	−3713	***	−0458	−1665	*	−1234	−2986	***
AD;ED+ 30	1076	1840	*	0305	0884		0771	1543		−0155	−0238		−0829	−2176	**	0674	1147	
AD−10 - ED+ 30	0712	1113		0262	0663		0450	0816		−1565	−2030	**	−0881	−1968	**	−0684	−0985	

T-stats adjusted according to Kolari and Pynnönen (2010) are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A4 –
MAAV coefficients for firms domiciled in emerging market economies (EM), and those domiciled in more developed economies (DEV), and the difference between EM and DEV firms

	Additions								Deletions							
Window	**EM (N = 738)**			**DEV (N = 1623)**			**Difference**		**EM (N = 513)**			**DEV (N = 1446)**			**Difference**	
AD−10; AD−1	0058	3027	***	0085	8166	***	−0026	−1202	0270	9310	***	0115	9508	***	0155	4943	***
AD	0057	1904	***	0050	3469	***	0006	0194	0244	5985	***	0092	5537	***	0152	3453	***
AD+ 1;ED−1	0089	3999	***	0089	7895	***	0000	0010	0345	9496	***	0161	11,207	***	0184	4719	***
ED	0920	9001	***	0570	12,532	***	0350	3125	***	3737	15,237	***	1160	16,182	***	2577	10,085	***
ED+ 1; ED+ 10	0049	2398	***	0077	7163	***	−0029	−1249	0359	9856	***	0128	9828	***	0231	5981	***
ED+ 11;ED+ 30	0052	2670	***	0057	5772	***	−0005	−0216	0120	4551	***	0088	7675	***	0032	1117	
AD;ED+ 30	0089	4945	***	0086	9300	***	0003	0163	0333	10,814	***	0152	12,768	***	0182	5501	***
AD−10 - ED+ 30	0086	5038	***	0086	9883	***	−0001	−0031	0325	11,193	***	0145	13,131	***	0179	5773	***

T-stats are reported are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A5 –
CAAR coefficients for firms affected by SRI index reviews (SRI) versus reviews of other indices (non-SRI), and the difference between the two

	Additions									Deletions								
Window	**SRI (N = 837)**			**Non-SRI (N = 1620)**			**Difference**			**SRI (N = 808)**			**Non-SRI (N = 1285)**			**Difference**		
AD−10; AD−1	0052	0221		−0223	−1020		0275	1214		0055	0189		−0646	−2471	**	0701	2465	**
AD	0041	0540		0104	1431		−0063	−0846		0019	0207		0025	0312		−0007	−0075	
AD+ 1;ED−1	0802	3901	***	0275	1534		0527	2730	***	−0195	−0918		−0397	−1893	*	0202	0936	
ED	0356	4049	***	0419	5363	***	−0063	−0755		−0422	−4040	***	−0299	−3128	***	−0123	−1196	
ED+ 1; ED+ 10	−0401	−1699	*	−0115	−0539		−0286	−1276		0678	2480	**	0733	3095	***	−0055	−0210	
ED+ 11;ED+ 30	−0357	−1155		−0169	−0580		−0188	−0628		−0836	−2549	***	−0694	−2220	**	−0143	−0434	
AD;ED+ 30	0487	1102		0554	1378		−0067	−0158		−0780	−1729	*	−0621	−1403		−0159	−0347	
AD−10 - ED+ 30	0471	0962		0350	0773		0122	0259		−0703	−1296		−1278	−2499	**	0575	1064	

T-stats adjusted according to Kolari and Pynnönen (2010) are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A6 –
MAAV coefficients for firms affected by SRI index reviews (SRI) versus reviews of other indices (non-SRI), and the difference between the two

	Additions								Deletions								
Window	SRI (N = 795)			Non-SRI (N = 1542)			Difference		SRI (N = 740)			Non-SRI (N = 1193)			Difference		
AD−10; AD−1	0071	4676	***	0079	6722	***	−0008	−0391	0130	7145	***	0170	11,082	***	−0041	−1703	*
AD	0044	1884	***	0057	3373	***	−0013	−0452	0088	3545	***	0159	7390	***	−0071	−2146	**
AD+ 1;ED−1	0089	5283	***	0089	6754	***	0000	0002	0162	7658	***	0237	12,434	***	−0076	−2653	***
ED	0687	11,002	***	0671	11,349	***	0017	0193	1604	12,071	***	1950	17,339	***	−0346	−1987	**
ED+ 1; ED+ 10	0069	4222	***	0068	5598	***	0001	0043	0169	7726	***	0200	11,370	***	−0032	−1125	
ED+ 11;ED+ 30	0071	4462	***	0047	4262	***	0024	1233	0068	4090	* **	0114	7903	***	−0046	−2089	**
AD;ED+ 30	0093	6397	***	0084	8020	***	0008	0468	0161	8696	***	0222	14,142	***	−0061	−2501	**
AD−10 - ED+ 30	0089	6477	***	0085	8574	***	0004	0257	0157	8946	***	0213	14,585	***	−0056	−2430	**

T-stats are reported are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A7 –
CAAR coefficients for firms affected by SRI index reviews (SRI) versus reviews of other indices (non-SRI), and the difference between the two

	Additions									Deletions								
Window	**Post PA (N = 1367)**			**Pre PA (N = 1112)**			**Difference**			**Post PA (N = 1191)**			**Pre PA (N = 928)**			**Difference**		
AD−10; AD−1	−0208	−0892		−0027	−0124		−0181	−0830		−0383	−1366		−0433	−1620		0050	0178	
AD	0285	3608	***	−0143	−2131	**	0427	6001	***	0067	0752		−0007	−0092		0074	0865	
AD+ 1;ED−1	0891	4395	***	−0085	−0507		0976	5419	***	−0084	−0375		−0500	−2519	**	0416	1948	*
ED	0646	7278	***	0095	1361		0551	7135	***	−0576	−5443	***	−0094	−1024		−0482	−4814	***
ED+ 1; ED+ 10	−0165	−0695		−0242	−1203		0077	0361		1424	5616	***	−0200	−0791		1624	6320	***
ED+ 11;ED+ 30	−0829	−2639	***	0502	1815	*	−1331	−4628	***	−1471	−4520	***	0113	0360		−1583	−4895	***
AD;ED+ 30	0883	1960	*	0125	0336		0758	1890	*	−0584	−1294		−0746	−1664	*	0162	0355	
AD−10 - ED+ 30	0642	1278		0105	0249		0537	1191		−0974	−1829	*	−1165	−2210	**	0191	0356	

T-stats adjusted according to Kolari and Pynnönen (2010) are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A8 –
MAAV coefficients for firms affected by SRI index reviews (SRI) versus reviews of other indices (non-SRI), and the difference between the two

	Additions									Deletions							
Window	**Post PA (N = 1322)**			**Pre PA (N = 1039)**			**Difference**			**Post PA (N = 1124)**			**Pre PA (N = 837)**			**Difference**		
AD−10; AD−1	0061	5149	***	0096	6442	***	−0036	−1870	*	0165	10,433	***	0141	8045	***	0024	1012	
AD	0035	1956	***	0073	3541	***	−0038	−1403		0131	6146	***	0133	5233	***	−0003	−0078	
AD+ 1;ED−1	0075	5649	***	0108	6441	***	−0033	−1564		0232	11,830	***	0177	8546	***	0055	1925	*
ED	0901	13,391	***	0390	7468	***	0511	5999	***	2246	18,195	***	1249	11,098	***	0997	5971	***
ED+ 1; ED+ 10	0043	3509	***	0101	6410	***	−0058	−2883	***	0176	9875	***	0205	9554	***	−0028	−1009	
ED+ 11;ED+ 30	0043	3639	***	0071	5001	***	−0028	−1507		0090	6337	* **	0105	6129	***	−0015	−0665	
AD;ED+ 30	0074	6885	***	0103	7605	***	−0029	−1695	*	0208	12,994	* **	0187	10,250	***	0021	0880	
AD−10 - ED+ 30	0071	7120	***	0105	8070	***	−0035	−2113	**	0201	13,345	* **	0181	10,605	***	0020	0879	

T-stats are reported are reported on the right side of the coefficients. * , * *, * ** indicates statistical significance at the 10 %, 5 %, and 1 % levels. The population (N) for each category is the average value of the sample populations in the different event windows.

Table A9 -
Multivariate regression coefficients for the CAAR values of each event window for firms added (section a)) and removed (seciotn b)) to ESG indices.
Section a) Additions

	Intercept			N_REB			SIZE			ESG		
AD−10; AD−1	−2604	−2488	**	0137	1248		0210	1701	*	0005	0964	
AD	−0348	−0998		0039	1091		0059	1430		−0004	−2084	**
AD+ 1;ED−1	0138	0157		0234	2548	**	−0078	−0752		0010	2142	**
ED	0838	2212	**	0051	1287		−0067	−1489		0001	0462	
ED+ 1; ED+ 10	−0788	−0768		0020	0184		0062	0514		0000	−0077	
ED+ 11;ED+ 30	−1248	−0899		0095	0651		0245	1493		−0029	−3949	***
AD;ED+ 30	−0824	−0426		0431	2126	**	0153	0669		−0020	−1999	**

Section b) Deletions

	Intercept			N_REB			SIZE			ESG		
AD−10; AD−1	0222	2501	**	0007	0736		−0016	−1530		0000	−0694	
AD	0107	0825		0028	2082	**	−0009	−0565		−0001	−1292	
AD+ 1;ED−1	0130	1343		0021	2056	**	−0001	−0095		−0002	−3303	***
ED	1750	4248	***	0282	6552	***	−0194	−3988	***	0001	0312	
ED+ 1; ED+ 10	0215	2324	**	−0007	−0731		−0008	−0705		−0001	−2572	**
ED+ 11;ED+ 30	0116	1352		0018	1970	**	−0008	−0800		−0001	−1297	
AD;ED+ 30	0390	4884	***	0037	4348	***	−0023	−2450	**	−0002	−4562	***

N_REB is the number of ESG indices in which a share is simultaneously included or excluded.; 'ESG' stands for the LSEG ESG rating of the company at the time of the review; 'SIZE' represents the market capitalisation of the firm at the time of the review. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels.

Table A10 -
Multivariate regression coefficients for the MAAV values of each event window for firms added (section a)) and removed (seciotn b)) to ESG indices.
Section a) Additions

	Intercept			N_REB			SIZE			ESG		
AD−10; AD−1	−4460	−3750	***	−0088	−0733		0442	3074	***	0007	0911	
AD	0019	0051		0010	0268		−0005	−0105		0000	0185	
AD+ 1;ED−1	−1232	−1333		0079	0845		0082	0736		0000	0007	
ED	−0356	−0828		−0170	−3929	***	0111	2135	**	−0011	−4141	***
ED+ 1; ED+ 10	0915	0838		0081	0736		−0171	−1300		0022	3272	***
ED+ 11;ED+ 30	−2813	−2021	**	−0133	−0950		0395	2351	**	−0022	−2542	**
AD;ED+ 30	−3595	−1839	*	−0165	−0837		0435	1841	*	−0010	−0852	

Section b) Deletions

	Intercept			N_REB			SIZE			ESG		
AD−10; AD−1	0829	8431	***	0030	3000	***	−0081	−6855	***	0000	−0760	
AD	0789	5785	***	0038	2685	***	−0081	−4871	***	−0001	−0725	
AD+ 1;ED−1	1079	9036	***	0045	3592	***	−0112	−7745	***	0000	0330	
ED	11,834	17,140	***	0597	8359	***	−1363	−16,356	***	0013	3083	***
ED+ 1; ED+ 10	1068	9224	***	0044	3636	***	−0103	−7361	***	−0001	−1884	*
ED+ 11;ED+ 30	0467	4943	***	0003	0310		−0039	−3406	***	−0001	−1138	
AD;ED+ 30	2030	20,442	***	0084	8141	***	−0201	−16,784	***	−0001	−1486	

N_REB is the number of ESG indices in which a share is simultaneously included or excluded.; 'ESG' stands for the LSEG ESG rating of the company at the time of the review; 'SIZE' represents the market capitalisation of the firm at the time of the review. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels.

Table A11 –
Absolute average monthly ownership variations for short-term institutional investors (STI), considering different sub-samples of firms added to the ESG indices

IO variations for STI – ADDITIONS

M	HP vs non-HP			EM vs DEV			SRI vs non-SRI		
	HP (N = 408)	non-HP (N = 2128)	Diff	EM (N = 917)	DEV (N = 1619)	Diff	SRI (N = 837)	non-SRI (N = 1621)	Diff
3	0.285 ***	−0.007	0.292 **	0.134	−0.013	0.148	0.019	0.058	−0.039
	(2.829)	(−0.091)	(2.296)	(1.487)	(−0.149)	(1.151)	(0.196)	(0.643)	(−0.290)
2	0.053	−0.037	0.091	0.015	−0.044	0.060	0.084 **	−0.081	0.165 *
	(1.248)	(−0.619)	(1.226)	(0.403)	(−0.575)	(0.694)	(2.040)	(−1.049)	(1.883)
1	−0.100 *	−0.031	−0.069	−0.121 **	0.002	−0.124	−0.083 *	−0.016	−0.067

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Table A11 – (*continued*)

IO variations for STI – ADDITIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
	(−1.96)	(−0.624)	(−0.969)	(−2.570)	(0.043)	(−1.607)	(−1.853)	(−0.268)	(−0.874)
RM	0.164	0.246 ***	−0.081	0.237 ***	0.230 **	0.006	0.188 **	0.263 ***	−0.074
	(1.620)	(3.107)	(−0.633)	(2.829)	(2.399)	(0.05)	(1.964)	(2.967)	(−0.571)
−1	0.079	0.079 ***	0.001	0.134 ***	0.048	0.086	0.090 *	0.074 **	0.016
	(1.448)	(2.599)	(0.009)	(2.962)	(1.427)	(1.528)	(1.744)	(2.287)	(0.264)
−2	−0.059	−0.045	−0.013	−0.016	−0.065 *	0.049	−0.076 *	−0.056	−0.020
	(−1.044)	(−1.331)	(−0.206)	(−0.319)	(−1.759)	(0.778)	(−1.746)	(−1.584)	(−0.356)
−3	0.435 **	0.300 ***	0.135	0.210 *	0.385 ***	−0.175	0.366 ***	0.339 ***	0.027
	(2.553)	(3.916)	(0.721)	(1.803)	(4.409)	(−1.200)	(3.706)	(4.191)	(0.217)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets; SRI refers to firms involved in SRI index reviews, while non-SRI refers to all the others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A12 –
Absolute average monthly ownership variations for short-term institutional investors (STI), considering different sub-samples of firms deleted from the ESG indices

IO variations for STI - DELETIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
3	0.115	−0.064	0.179	0.030	−0.058	0.088	0.044	0.017	0.026
	(0.770)	(−0.681)	(1.014)	(0.34)	(−0.512)	(0.613)	(0.417)	(0.153)	(0.173)
2	0.122 ***	0.067 * *	0.054	0.065	0.085 ***	−0.02	0.078 *	0.061 **	0.017
	(2.649)	(2.338)	(1.003)	(1.513)	(2.813)	(−0.381)	(1.856)	(2.032)	(0.333)
1	−0.080	−0.074 *	−0.006	−0.168 ***	−0.026	−0.141 **	−0.037	−0.094 **	0.057
	(−1.431)	(−1.683)	(−0.086)	(−3.525)	(−0.527)	(−2.023)	(−0.520)	(−2.128)	(0.681)
RM	0.388 *	−3.206 ***	3.595 ***	−1.870 ***	−2.808 ***	0.938	−1.335 ***	−2.660 ***	1.325 **
	(1.910)	(−8.614)	(8.476)	(−4.014)	(−7.204)	(1.544)	(−3.812)	(−6.428)	(2.444)
−1	−0.192 **	−0.397 ***	0.205 *	−0.392 ***	−0.337 ***	−0.055	−0.236 ***	−0.271 ***	0.035
	(−1.989)	(−5.949)	(1.743)	(−4.690)	(−4.505)	(−0.490)	(−2.982)	(−5.184)	(0.375)
−2	0.147	−0.035	0.182 *	0.039	−0.019	0.058	−0.024	0.006	−0.030
	(1.611)	(−0.830)	(1.811)	(0.659)	(−0.379)	(0.749)	(−0.475)	(0.158)	(−0.469)
−3	0.082	0.129	−0.047	−0.128	0.252 ***	−0.381 ***	0.180	0.119	0.061
	(0.562)	(1.609)	(−0.283)	(−1.437)	(2.594)	(−2.882)	(1.365)	(1.574)	(0.400)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets. SRI refers to firms involved in SRI index reviews, while non-SRI refers to all the others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A13 –
Absolute average monthly ownership variations for long-term institutional investors (LTI), considering different sub-samples of firms added to the ESG indices

IO variations for LTI - ADDITIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
3	−0.011	0.014	−0.025	0.022	0.003	0.019	−0.055 *	0.039 **	−0.095 ***
	(−0.228)	(0.876)	(−0.496)	(1.273)	(0.144)	(0.673)	(−1.774)	(2.158)	(−2.621)
2	0.015	−0.001	0.016	0.005	−0.001	0.007	0.013	−0.005	0.019
	(0.977)	(−0.150)	(0.885)	(0.304)	(−0.179)	(0.352)	(1.348)	(−0.416)	(1.127)
1	−0.005	−0.006	0.001	−0.004	−0.007	0.003	−0.003	−0.010	0.007
	(−0.297)	(−0.505)	(0.067)	(−0.237)	(−0.523)	(0.133)	(−0.398)	(−0.619)	(0.376)
RM	−0.034	0.025	−0.060	0.034	0.005	0.029	0.013	0.020	−0.006
	(−0.606)	(1.644)	(−1.022)	(1.503)	(0.25)	(0.94)	(0.462)	(1.018)	(−0.198)
−1	0.008	−0.005	0.013	0.011	−0.011	0.022	−0.025	0.010	−0.035
	(0.753)	(−0.435)	(0.822)	(0.602)	(−0.911)	(1.008)	(−1.172)	(0.891)	(−1.456)

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Table A13 – (*continued*)

IO variations for LTI - ADDITIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
−2	−0.039 *	−0.037 **	−0.001	−0.050 ***	−0.030	−0.019	−0.059 ***	−0.024	−0.034
	(−1.862)	(−2.416)	(−0.061)	(−3.304)	(−1.601)	(−0.78)	(−4.525)	(−1.27)	(−1.48)
−3	−0.046	−0.019	−0.026	−0.027	−0.022	−0.005	0.004	−0.039	0.044
	(−0.607)	(−0.734)	(−0.327)	(−0.950)	(−0.602)	(−0.11)	(0.087)	(−1.426)	(0.719)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets. SRI refers to firms involved in SRI index reviews, while non-SRI refers to all the others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A14 –
Absolute average monthly ownership variations for long-term institutional investors (LTI), considering different sub-samples of firms deleted from the ESG indices

IO variations for LTI - DELETIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
3	−0.072	−0.025 **	−0.046	−0.005	−0.051 * **	0.045 *	−0.054 * *	−0.014	−0.040
	(−1.591)	(−2.020)	(−0.982)	(−0.28)	(−2.839)	(1.647)	(−2.247)	(−0.866)	(−1.338)
2	0.012	−0.007	0.020	−0.006	−0.001	−0.005	−0.015	−0.002	−0.013
	(0.811)	(−1.091)	(1.186)	(−0.844)	(−0.194)	(−0.439)	(−1.590)	(−0.326)	(−1.130)
1	−0.010	−0.018	0.007	−0.029	−0.009	−0.019	−0.002	−0.022	0.020
	(−0.736)	(−1.386)	(0.411)	(−1.304)	(−0.850)	(−0.772)	(−0.118)	(−1.621)	(0.826)
RM	0.045	−0.164 ***	0.209 ***	−0.065 *	−0.152 ***	0.086	−0.025	−0.161 ***	0.136 **
	(1.122)	(−4.630)	(3.906)	(−1.797)	(−3.728)	(1.581)	(−0.435)	(−5.197)	(2.075)
−1	−0.026	−0.035 *	0.009	−0.022	−0.04 **	0.017	−0.003	−0.029	0.025
	(−1.220)	(−1.661)	(0.315)	(−0.589)	(−2.186)	(0.422)	(−0.199)	(−1.250)	(0.826)
−2	−0.064 *	−0.036 ***	−0.027	−0.051 *	−0.036 ***	−0.014	−0.029	−0.054 ***	0.024
	(−1.841)	(−2.620)	(−0.744)	(−1.809)	(−2.790)	(−0.465)	(−1.198)	(−3.334)	(0.828)
−3	0.004	−0.005	0.009	0.026	−0.018	0.045	−0.010	−0.003	−0.006
	(0.117)	(−0.305)	(0.236)	(1.116)	(−0.922)	(1.448)	(−0.452)	(−0.161)	(−0.229)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets. SRI refers to firms involved in SRI index reviews, while non-SRI refers to all the others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A15 –
Absolute average monthly ownership variations for Strategic Investors (SI), considering different sub-samples of firms added to the ESG indices

IO variations for SI - ADDITIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
3	0.145	−0.013	0.158	0.012	0.012	0.001	−0.045	0.043	−0.088
	(0.984)	(−0.198)	(0.978)	(0.128)	(0.156)	(0.006)	(−0.377)	(0.73)	(−0.659)
2	0.035	−0.060	0.095	−0.120	−0.002	−0.118	0.015	−0.068	0.084
	(0.562)	(−1.294)	(1.226)	(−1.333)	(−0.062)	(−1.208)	(0.491)	(−1.132)	(1.23)
1	−0.064	−0.047	−0.016	−0.068 **	−0.039	−0.029	−0.032	−0.060	0.028
	(−1.321)	(−1.513)	(−0.292)	(−2.197)	(−1.01)	(−0.584)	(−1.23)	(−1.511)	(0.595)
RM	0.137	0.131 *	0.005	0.251 **	0.065	0.186	0.162	0.169 **	−0.006
	(1.161)	(1.722)	(0.041)	(2.199)	(0.792)	(1.322)	(1.556)	(2.153)	(−0.05)
−1	0.038	0.001	0.038	−0.100	0.066	−0.167	0.072	−0.070	0.143
	(0.191)	(0.001)	(0.185)	(−1.135)	(0.995)	(−1.506)	(0.624)	(−1.617)	(1.157)
−2	−0.119	−0.057	−0.061	−0.066	−0.068 **	0.001	−0.084 *	−0.072	−0.011
	(−1.488)	(−1.546)	(−0.699)	(−0.929)	(−1.997)	(0.021)	(−1.948)	(−1.542)	(−0.183)
−3	−0.039	0.070	−0.110	−0.085	0.131 *	−0.217 *	0.116	−0.001	0.117
	(−0.397)	(1.074)	(−0.922)	(−0.888)	(1.834)	(−1.807)	(1.239)	(−0.014)	(0.996)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets. SRI refers to firms involved in SRI index reviews, while non-SRI refers to all the others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *,

* ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A16 –
Absolute average monthly ownership variations for Strategic Investors (SI), considering different sub-samples of firms deleted from the ESG indices

IO variations for SI - DELETIONS									
M	**HP vs non-HP**			**EM vs DEV**			**SRI vs non-SRI**		
	HP (N = 408)	**non-HP** (N = 2128)	**Diff**	**EM** (N = 917)	**DEV** (N = 1619)	**Diff**	**SRI** (N = 837)	**non-SRI** (N = 1621)	**Diff**
3	−0.108	0.004	−0.113	−0.099	0.025	−0.125	−0.075 *	0.048	−0.123
	(−0.654)	(0.066)	(−0.622)	(−0.876)	(0.294)	(−0.876)	(−1.808)	(0.563)	(−1.301)
2	0.032	−0.056	0.089	−0.103	−0.004	−0.099	−0.101	0.002	−0.103
	(0.533)	(−0.940)	(1.038)	(−0.753)	(−0.191)	(−0.715)	(−0.794)	(0.084)	(−0.794)
1	−0.151	−0.375 ***	0.224	−0.206	−0.397 **	0.190	−0.212	−0.434 **	0.221
	(−1.293)	(−2.710)	(1.235)	(−1.505)	(−2.521)	(0.915)	(−1.509)	(−2.525)	(0.997)
RM	0.175 *	0.445 ***	−0.27	0.537 ***	0.313 **	0.224	0.195 *	0.432 ***	−0.236
	(1.75)	(3.293)	(−1.605)	(2.679)	(2.405)	(0.936)	(1.771)	(2.692)	(−1.215)
−1	0.025	0.199	−0.174	0.077	0.211	−0.133	0.175	0.154	0.020
	(0.818)	(1.494)	(−1.271)	(0.495)	(1.494)	(−0.633)	(1.319)	(1.566)	(0.126)
−2	−0.164 *	0.042	−0.206	0.018	−0.008	0.026	−0.081	−0.056	−0.024
	(−1.796)	(0.403)	(−1.476)	(0.231)	(−0.063)	(0.178)	(−0.445)	(−1.616)	(−0.132)
−3	0.132	0.111 *	0.021	0.159	0.092 *	0.066	0.043	0.116	−0.073
	(1.591)	(1.944)	(0.214)	(1.555)	(1.812)	(0.585)	(0.855)	(1.572)	(−0.819)

'M' stands for month, where 'RM' is the review month. HP refers to firms active in heavily-polluting sectors; EM refers to firms located in emerging market economies, while DEV refers to those domiciled in developed markets. SRI refers to firms involved in SRI index reviews, while non-SRI refers to all others. 'Diff' refers to the difference between the smaller and the larger sub-samples. T-stats appear under the coefficients in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

Table A17 –
Cases of legal proceedings for insider trading or misuse of non-public information in relation with indices' rebalancing

Date	Case	Description	Final Outcome
2007	Deutsche Bank and Russell Index Front-Running	Deutsche Bank employees were found to have front-run trades based on early knowledge of Russell index changes.	Deutsche Bank faced regulatory scrutiny and implemented stricter internal controls; no formal charges were filed.
2011	Spencer Mindlin - Front-Running Case	Spencer Mindlin was accused of front-running using confidential information on index trades to benefit from stock price changes before index rebalancing.	SEC filed charges; sought to bar Mindlin and his father from the industry and pursued disgorgement and penalties.
2012	Wilshire Associates and the MSCI Rebalancing Case	Wilshire Associates accused of using non-public MSCI rebalancing information to gain trading advantages.	Wilshire Associates faced internal reprimands; no formal regulatory action was reported.
2013	FTSE Russell Insider Trading Scandal	An insider trading scandal involving FTSE Russell where employees allegedly profited from index rebalancing announcements.	FTSE Russell employees involved were terminated, and internal controls were strengthened.
2017	S&P Dow Jones Indices and Stifel Nicolaus Case	Stifel Nicolaus employees were found to have accessed non-public S&P Dow Jones index information to trade ahead of announcements.	Stifel Nicolaus was fined, and employees involved faced regulatory sanctions.
2019	BlackRock (Alleged Case)	Scrutiny over whether BlackRock used non-public information about MSCI index changes to gain an unfair trading advantage.	No formal charges; case led to increased scrutiny on asset managers' access to index information.
2019	Barclays and the iShares ETF Rebalancing Case	Barclays employees were accused of front-running iShares ETF trades based on non-public information about rebalancing.	No charges were formally filed; Barclays faced internal disciplinary actions.
2021	S&P Dow Jones Indices - SEC Investigation	Investigation into whether traders used non-public information on upcoming S&P 500 and other index changes to front-run trades.	Investigation ongoing; no public charges as of yet.
2023	S&P Global – Investigations	Investigation into whether traders had access to non-public information on changes in S&P Global indices, possibly leading to unfair trading advantages.	Investigation ongoing as of 2023, with no public charges announced yet.
2000s	Goldman Sachs - S&P 500 Index Case	Goldman Sachs was investigated for allegedly using early access to information on S&P 500 index changes to profit before the changes were made public.	No charges brought against Goldman Sachs, but led to calls for more transparency in index communication.
Ongoing	The SEC vs. Index Arbitrage	Ongoing regulatory concerns about institutional investors using early information about index rebalancing to front-run trades.	Ongoing concern; no specific cases but increased regulatory focus on preventing misuse of index information.

Appendix B

List of selected studies related to ESG indices' rebalancing, employing the event study methodology

Table E1 –
Full list of selected studies employed to analyse the literature, organised chronologically

Authors	Title	Source	Year	Consistency	Market	E, S or G?
Curran, MM; Moran, D	*Impact of the FTSE4Good Index on firm price: An event study*	Journal of Environmental Management	2007	Mixed results	Developed Europe	Two or more dimensions
Qiu, M; Pinfold, J	*Price and trading volume reactions to index constitution changes. The Australian evidence*	Managerial Finance	2007	Mixed results	Developed World	Two or more dimensions
Consolandi, C; Jaiswal-Dale, A; Poggiani, E; Vercelli, A	*Global Standards and Ethical Stock Indices: The Case of the Dow Jones Sustainability Stoxx Index*	Journal of Business Ethics	2009	Partially confirmed	Developed Europe	Two or more dimensions
Doh, JP; Howton, SD; Howton, SW; Siegel, DS	*Does the Market Respond to an Endorsement of Social Responsibility? The Role of Institutions, Information, and Legitimacy*	Journal of Management	2010	Mixed results	USA	Two or more dimensions
Robinson, M; Kleffner, A; Bertels, S	*Signaling Sustainability Leadership: Empirical Evidence of the Value of DJSI Membership*	Journal of Business Ethics	2011	Partially confirmed	Global	Two or more dimensions
Cheung, AWK	*Do Stock Investors Value Corporate Sustainability? Evidence from an Event Study*	Journal of Business Ethics	2011	Mixed results	USA	Two or more dimensions
Ortas, E; Moneva, JM	*Sustainability stock exchange indices and investor expectations: Multivariate evidence from DJSI-Stoxx*	Revista Española De Financiación Y Contabilidad	2011	Mixed results	Developed Europe	Two or more dimensions
Detre, JD; Gunderson, MA	*The Triple Bottom Line: What is the Impact on the Returns to Agribusiness?*	International Food And Agribusiness Management Review	2011	Rejected	USA	Two or more dimensions
Becchetti, L; Ciciretti, R; Hasan, I; Kobeissi, N	*Corporate social responsibility and shareholder's value*	Journal of Business Research	2012	Partially confirmed	USA	Two or more dimensions
Ramchander, S; Schwebach, RG; Staking, K	*The informational relevance of corporate social responsibility: evidence from DS400 index reconstitutions*	Strategic Management Journal	2012	Confirmed	USA	Two or more dimensions
Clacher, I; Hagendorff, J	*Do Announcements About Corporate Social Responsibility Create or Destroy Shareholder Wealth? Evidence from the UK*	Journal of Business Ethics	2012	Partially rejected	Developed Europe	Two or more dimensions
Lackmann, J; Ernstberger, J; Stich, M	*Market Reactions to Increased Reliability of Sustainability Information*	Journal of Business Ethics	2012	Partially confirmed	Developed Europe	Two or more dimensions
Chipeta, C; Gladysek, O.	*The impact of socially responsible investment index constituent announcements on firm price: evidence from the JSE*	South African Journal Of Economic And Management Sciences	2012	Mixed results	Emerging markets	Two or more dimensions
Oberndorfer, U; Schmidt, P; Wagner, M; Ziegler, A	*Does the stock market value the inclusion in a sustainability stock index? An event study analysis for German firms*	Journal of Environmental Economics And Management	2013	Rejected	Developed Europe	Two or more dimensions
Cheung, AWK; Roca, E	*The effect on price, liquidity and risk when stocks are added to and deleted from a sustainability index: Evidence from the Asia Pacific context*	Journal of Asian Economics	2013	Partially rejected	Emerging markets	Two or more dimensions
Fuenzalida, D; Mongrut, S; Arteaga, JR; Erausquin, A	*Good corporate governance: Does it pay in Peru?*	Journal of Business Research	2013	Partially confirmed	Emerging markets	Governance
Nakai, M; Yamaguchi, K; Takeuchi, K	*Sustainability Membership And Stock Price: An Empirical Study Using The Morningstar-SRI Index*	Applied Financial Economics	2013	Partially confirmed	Developed World	Two or more dimensions
Chow, GWS; Durand, RB; Koh, S	*Are ethical investments good?*	Australian Journal of Management	2014	Mixed results	USA	Two or more dimensions
Chetty, S; Naidoo, R; Seetharam, Y	*The Impact of Corporate Social Responsibility on Firms'Financial Performance in South Africa*	Contemporary Economics	2015	Mixed results	Emerging markets	Two or more dimensions
Adamska, A; Dabrowski, TJ	*Do Investors Appreciate Information about Corporate Social Responsibility? Evidence from the Polish Equity Market*	Inzinerine Ekonomika-Engineering Economics	2016	Confirmed	Emerging markets	Two or more dimensions

(*continued on next page*)

Table E1 – (*continued*)

Authors	Title	Source	Year	Consistency	Market	E, S or G?
Kappou, K; Oikonomou, I.	*Is There a Gold Social Seal? The Financial Effects of Additions to and Deletions from Social Stock Indices*	Journal of Business Ethics	2016	Mixed results	USA	Two or more dimensions
Wang, YS; Chen, YJ	*Corporate social responsibility and financial performance: event study cases*	Journal of Economic Interaction And Coordination	2017	Mixed results	Global	Two or more dimensions
Lusyana, D; Sherif, M	*Shariah-compliant investments and stock returns: evidence from the Indonesian stock market*	Journal of Islamic Accounting And Business Research	2017	Partially confirmed	Emerging markets	Two or more dimensions
Joshi, S; Pandey, V; Ross, RB.	*Asymmetry in Stock Market Reactions to Changes in Membership of the Dow Jones Sustainability Index*	The Journal of Business Inquiry	2017	Rejected	Global	Two or more dimensions
Hawn, O; Chatterji, AK; Mitchell, W	*Do investors actually value sustainability? New evidence from investor reactions to the Dow Jones Sustainability Index (DJSI)*	Strategic Management Journal	2018	Mixed results	Global	Two or more dimensions
Luffarelli, J; Awaysheh, A	*The Impact of Indirect Corporate Social Performance Signals on Firm Value: Evidence from an Event Study*	Corporate Social Responsibility and Environmental Management	2018	Confirmed	USA	Two or more dimensions
Park, JW; Lee, CW	*Performance of stock price with changes in SRI governance index*	Corporate Social Responsibility and Environmental Management	2018	Confirmed	Developed World	Two or more dimensions
Durand, R; Paugam, L; Stolowy, H	*Do investors actually value sustainability indices? Replication, development, and new evidence on CSR visibility*	Strategic Management Journal	2019	Mixed results	Global	Two or more dimensions
Lee, S; Kim, I; Hong, CH	*Who Values Corporate Social Responsibility in the Korean Stock Market?*	Sustainability	2019	Partially confirmed	Emerging markets	Two or more dimensions
Cimen, A	*The impact of sustainability index on firm performance: an event study*	International Journal of Contemporary Economics And Administrative Sciences	2019	Partially confirmed	Emerging markets	Two or more dimensions
Zou, P; Wang, Q; Xie, JH; Zhou, CX	*Does doing good lead to doing better in emerging markets? Stock market responses to the SRI index announcements in Brazil, China, and South Africa*	Journal Of The Academy of Marketing Science	2020	Partially confirmed	Emerging markets	Two or more dimensions
Su, CH; Chen, CD	*Does sustainability index matter to the hospitality industry?*	Tourism Management	2020	Partially rejected	Developed World	Two or more dimensions
Yilmaz, MK; Aksoy, M; Tatoglu, E	*Does the Stock Market Value Inclusion in a Sustainability Index? Evidence from Borsa Istanbul*	Sustainability	2020	Rejected	Emerging markets	Two or more dimensions
Schmutz, B; Tehrani, M; Fulton, L; Rathgeber, AW	*Dow Jones Sustainability Indices, Do They Make a Difference? The US and the European Union Companies*	Sustainability	2020	Mixed results	Developed World	Two or more dimensions
Adamska, A; Dabrowski, TJ	*Investor reactions to sustainability index reconstitutions: Analysis in different institutional contexts*	Journal of Cleaner Production	2021	Partially confirmed	Global	Two or more dimensions
Tehrani, M; Rathgeber, A; Fulton, L; Schmutz, B	*Sustainability & CSR: The Relationship with Hofstede Cultural Dimensions*	Sustainability	2021	Mixed results	Global	Social
Kaur, J.; Kaur, P.	*Impact of S&P BSE sustainability indices membership and delisting on stock liquidity: Evidence from volume and spread event study*	Environmental Challenges	2021	Rejected	Emerging markets	Environmental
Biktimirov, EN; Afego, PN	*Do investors value environmental sustainability? Evidence from the FTSE Environmental Opportunities 100 index*	Finance Research Letters	2022b	Partially confirmed	Developed Europe	Environmental
Janik, B; Bartkowiak, M	*Are sustainable investments profitable for investors in Central and Eastern European Countries (CEECs)?*	Finance Research Letters	2022	Mixed results	Emerging markets	Two or more dimensions
Biktimirov, EN; Afego, PN	*Does investors' valuation of corporate environmental activities vary between developed and emerging market firms?*	Finance Research Letters	2022a	Mixed results	Global	Environmental
Labidi, C; Laribi, D; Ureche-Rangau, L	*Price and volume effects around Islamic index revisions: the case of DJIM-GCC*	Managerial Finance	2022	Confirmed	Emerging markets	Two or more dimensions

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Table E1 – (*continued*)

Authors	Title	Source	Year	Consistency	Market	E, S or G?
Suresha, B; Srinidhi, VR; Verma, D; Manu, KS; Krishna, TA.	*The impact of ESG inclusion on price, liquidity and financial performance of Indian stocks: Evidence from stocks listed in BSE and NSE ESG indices*	Investment Management and Financial Innovations	2022	Partially rejected	Emerging markets	Two or more dimensions
Shrestha, C; Andrikopoulos, P; Aryal, NP.	*Does it matter to be a part of the sustainability index?*	Journal of Sustainable Finance and Investment	2024	Partially confirmed	Developed Europe	Two or more dimensions

Through the parameter "consistency", we attempted to categorise each paper depending on its degree of consistency with H2, i.e., the market rewarding (penalising) firms admitted to (excluded from) ESG indices on the event of rebalancing.

We propose to include the text starting from Appendix C in supplemental material, available online (otherwise, on request from the corresponding author)

Appendix C

The Fama-French three factors model: methodology and results

The Fama-French three-factor model (Fama and French, 1996) estimates expected excess returns as:

(Eq. B1)

$$E(R_i) - R_f = \beta_{i1}[E(R_m) - R_f] + \beta_{i2}(SMB) + \beta_{i3}(HML)$$

where β_{i2} is the sensitivity of stock i to the size factor SMB, while β_{i3} measures the sensitivity of stock i to the value factor HML. β_{i1}, β_{i2} and β_{i3} are computed for each company in the event study by means of a univariate OLS regression.

In this study, the SMB and HML factors for the estimation and event windows were extracted from Kenneth R. French's online database.[12]

The Fama-French daily factors for emerging markets are not available on French's website. Therefore, we computed them as follows. First, we determined the correlation values between the monthly EM factors (Rm-Rf, SML and HML) and those of each of the other regions (USA, EU, WORLD). Here, the highest correlations for all three factors were found for the WORLD observations. This helped select the region for which to construct the daily EM values.

Second, for each factor, we calculated a unique variability parameter to assess the extent to which the two regions' values varied in each specific month. To this end, for each of the factors, we calculated the ratio between the standard deviation of all monthly returns over the five years preceding the intended month. See the formula below for how to calculate the Small-Minus-Big in EM (it is the same for all factors).

(Eq. B2)

$$var_{SMB} = \frac{\sigma_{EM}}{\sigma_{WORLD}}$$

Third, for each WORLD factor, we computed the daily variation with respect to the corresponding month's average return. This served to extract a daily variation factor.

(Eq. B3)

$$\Delta day_t = R_t - \mu(R_m)$$

where R_t is the daily return, and R_m the total monthly return. The average value $\mu(R_m)$ is computed as $\frac{R_m}{N\ days\ in\ month\ m}$. Once we obtained the daily delta for each day, we could then compute each day's EM factors using the following formula (example with SML):

(Eq. B4)

$$EM_{SMB_t} = \quad \text{var}_{SMB_t} \bullet \Delta day_t$$

Once the betas had been estimated for each company and relative event, we checked for the statistical significance of the results by means of a *t*-test. In the case of non-significance, β_1 was manually set to a value of 1, i.e., the same as the volatility of the market, whereas β_{i2} and β_{i3}, were manually set to 0, which assumes no size or value effects affects from stock i. Using the French-Fama model, 583 companies were found to have a non-significant β_{i1}. Further, only 826 companies had a significant β_{i2}, while 1110 had a significant β_{i3}.

For details on how the SMB and HML factors were constructed, refer to Kenneth French's website.[13]

[12] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.

[13] URL: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.

Results

The results we obtained from the Fama-French model are fully compatible and almost equal to those detected through the CAPM model. Some slight (but negligible) variations were expected since, as illustrated above, two more factors are considered in the computation.

Yet, for the sake of simplicity, we have only shared the results relative to the full sample of events and firms, i.e., the abnormal returns detected for all firms added to and removed from the 11 ESG indices considered. The results of the analysis for the sub-samples have not been included but are available upon request. These results include those for the firms' domicile, industry, and SRI index.

Table B1 –
CAAR estimates (in %) for each sub-window, and the difference between additions and deletions obtained through the Fama-French three-factors model

h	Additions (N = 2473)	Deletions (N = 2119)	Difference (Add – Del)
AD−10; AD−1	−0.05	−0.464 * **	0.413 * *
	(−0.412)	(−3.158)	(2.168)
AD	0.091 *	0.057	0.033
	(1.81)	(1.001)	(0.444)
AD+ 1; ED−1	0.393 * **	−0.296 * *	0.69 * **
	(4.053)	(−2.564)	(4.571)
ED	0.35 * **	−0.325 * **	0.675 * **
	(8.095)	(−6.097)	(9.834)
ED+ 1; ED+ 10	−0.154	0.663 * **	−0.817 * **
	(−1.323)	(4.77)	(−4.507)
ED+ 11; ED+ 30	−0.321 * *	−0.62 * **	0.298
	(−2.084)	(−3.639)	(1.299)
AD; ED+ 30	0.374 *	−0.523 * *	0.898 * **
	(1.748)	(−2.159)	(2.775)

T-stats appear under the coefficient in brackets. * , * *, * ** indicates statistical significance at the 10 %, 5 % and 1 % levels. The population (N) for each category is the average value of the sample populations across the different event windows.

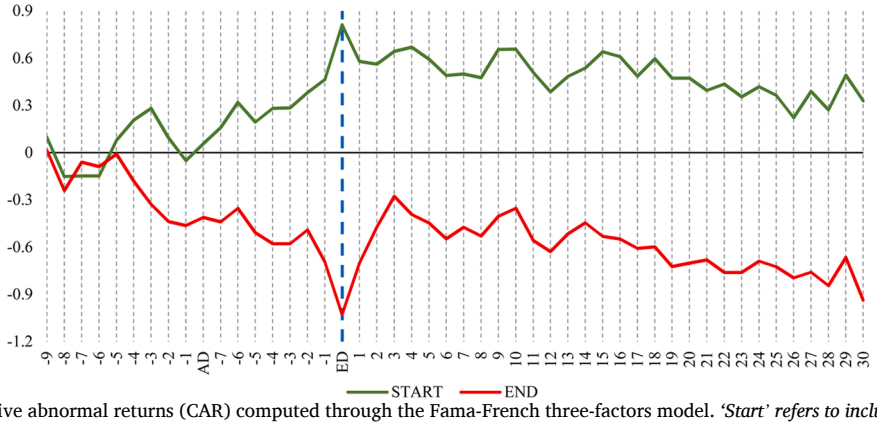

Chart B1. – Cumulative abnormal returns (CAR) computed through the Fama-French three-factors model. *'Start' refers to included firms; 'End' refers to firms excluded from index rebalancing.*

Appendix D

List of national stock market indices used for AV computation

Country	Main Exchange	Index
Australia	Australian Securities Exchange	All Ordinaries (XAO)
Austria	Vienna Stock Exchange	ATX
Belgium	Euronext Brussels	BEL 20
Brazil	B3	IBOVESPA
Canada	Toronto Stock Exchange	S&P/TSX Composite
Chile	Santiago Stock Exchange	IBOVESPA
China	Shanghai Stock Exchange	SHANGHAI SE COMPOSITE INDEX

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(*continued*)

Country	Main Exchange	Index
Colombia	Bolsa de Valores de Colombia	IBOVESPA
Czech Republic	Prague Stock Exchange	PX-PRAGUE SE IND
Denmark	NASDAQ Copenhagen	OMXC All-Share
Egypt	Egyptian Exchange	EGX 100
Finland	NASDAQ Helsinki	OMX Helsinki All-Share
France	Euronext Paris	CAC All-Shares
Germany	Frankfurt Stock Exchange	Classic All Share Index
Greece	Athens Stock Exchange	ASE All Share
Hong Kong	Hong Kong Stock Exchange	Hang Seng Composite Index
Hungary	Budapest Stock Exchange	BUX
India	Bombay Stock Exchange	Nifty 500
Indonesia	Indonesia Stock Exchange	IDX Composite
Ireland	Irish Stock Exchange	ISEQ All-Share
Israel	Tel Aviv Stock Exchange	TA Allshare (TAALLSHARE)
Italy	Borsa Italiana	FTSE Italia All-Share
Japan	Tokyo Stock Exchange (TSE)	TSE All-Share Index
Kuwait	Boursa Kuwait	Kuwait Stock Exchange Index
Malaysia	Bursa Malaysia	FTSE Bursa Malaysia All-Share Index
Mexico	Mexican Stock Exchange	S&P/BMV IPC CompMx (MXXCP)
Morocco	Casablanca Stock Exchange	EGX 100
Netherlands	Euronext Amsterdam	AEX All-Share
New Zealand	New Zealand Exchange	NZX All-Share Index
Norway	Oslo Stock Exchange	OBX All-Share
Pakistan	Pakistan Stock Exchange	KSE 100
Peru	Lima Stock Exchange	IBOVESPA
Philippines	Philippine Stock Exchange	PHS All Shares (PSAL)
Poland	Warsaw Stock Exchange	WIG All-Share
Portugal	Euronext Lisbon	PSI All Share Gross Return (BVLG)
Qatar	Qatar Exchange	QE All-Share
Russia	Moscow Exchange	RTS Broad Market Index
Saudi Arabia	Tadawul Exchange	Tadawul All Share Index
Singapore	Singapore Exchange	FTSE ST All-Share Index
South Africa	Johannesburg Stock Exchange	FTSE/JSE All Share Index
South Korea	Korea Exchange	KOSPI All-Share
Spain	Bolsa de Madrid	IBEX All-Share
Sweden	NASDAQ Stockholm	OMX Stockholm All-Share
Switzerland	SIX Swiss Exchange	Swiss All-Share Index
Taiwan	Taiwan Stock Exchange	Taiwan Stock Exchange TAIEX Index
Thailand	Stock Exchange of Thailand	Stock Exchange of Thailand (SET) Index
Turkey	Borsa Istanbul	BIST All Shares (XUTUM)
UAE	Abu Dhabi Securities Exchange (ADSE)	ADSE General Index
United Kingdom	London Stock Exchange	FTSE 100
United States	New York Stock Exchange	S&P 500 COMPOSITE

Appendix E

MSCI Index construction methodologies

All the considered indices are constructed on the basis of a three-step ESG screening process. First, companies in the parent index are screened for their involvement in certain controversial business activities, such as producing weapons or nuclear power (see below for a detailed list). Second, they are selected on the basis of their MSCI ESG score, and, third, they are selected on the basis of their MSCI controversies score. Their weight within the index is proportionate to their market capitalisation. In cases of equal ESG ranking, the company with a higher market cap is preferred.

As reported in the factsheet detailing the MSCI ESG ratings methodology, the MSCI adopts a single-materiality approach. Citing the factsheet: "MSCI ESG Ratings provide an opinion of companies' management of financially relevant ESG risks and opportunities" (ESG Ratings Methodology, 2024). Essentially, the rater examines the potential "unanticipated costs" or "opportunities" that may arise for companies in the medium-long term as a result of the "negative externalities" and "ESG issues" generated by the companies themselves or affecting their industry. In other words, the MSCI does not comprehensively consider the socio-environmental impact of its rated companies, but only the way such companies manage the medium-long term ESG risks associated with their activities, i.e., only items material to a company's overall financial sustainability.

MSCI analysts select between two and seven Key Environmental/Social Issues (out of 35 total Key Issues – see a detailed list in Table D5). These issues are industry-specific, material ESG issues that might pose risks to a company's operations. Companies are then scored on an industry-relative, seven-point AAA-CCC scale based on their ability to manage their ESG risk exposure through the company's: organisational capabilities and commitments to address the risks; the strength and scope of the initiatives/programs set out; and the company's track record of risk management practices. With regards to governance, MSCI employs a "deduction-based scoring model, whereby each company starts with a "perfect 10" score and deductions are applied based on an assessment of key governance metrics" (ESG Ratings Methodology, 2024). Each ESG pillar is first assessed singularly following its key metrics and the

score is then adjusted to the industry and by geography. Then, these single pillar ESG scores are aggregated to form the final ESG Letter Rating (AAA-CCC scale).

The MSCI ESG Controversies score, on the other hand, aims to provide an assessment of ESG controversies involving companies on the basis of actual or alleged involvement in adverse impact activities as reported by legal authorities, institutions, media, NGOs and other reliable, screened stakeholders. Each controversy is linked to an E, S or G theme. These thematic indicators (see the detailed list in Table D6) are based on international norms and standards, and include but are not limited to the United Nations Global Compact (UNGC), the United Nations General Principles of Business and Human Rights (UNGP), and the International Labour Organization (ILO) Conventions. The final score is based on the seriousness of the controversy, which, in turn is assessed on the basis of: the severity of the case, depending on the nature and scale of alleged impact; the role of the company implicated in the case – direct or indirect; and the status of the case – concluded, partially concluded, ongoing or achieved.

The following three tables summarise the indices' inclusion and exclusion criteria.

Table D1 –
KLD Social Index selection criteria

KLD400 Social Index					
Launch date	May 1990				
ESG screen methodology:	Negative screening Best-in-class: maintaining the same sectoral representation of the parent index the **400** companies with the highest MSCI ESG Rating				
Negative screening for business involvement in	Conventional Weapons Alcohol	Civilian Firearms Gambling	Nuclear Power Tobacco	Adult Entertainment Nuclear Weapons	Genetically Modified Organisms Controversial Weapons
Minimum ESG Rating					
for addition:	> =BBB				
for constituents to remain:	> =BB				
Minimum MSCI controversies score					
for addition:	> =3				
for constituents to remain:	> =1				
Conditions for removal	Corporate actions (M&S, delisting, etc.) Removal from parent index Failing eligibility criteria				

Table D2 –
ESG Leaders indices selection criteria

MSCI ESG Leaders					
Launch date	January 2001				
ESG screen methodology:	Negative screening Best-in-class: maintaining the same sectoral representation of the parent index, the companies with the highest ESG rating representing the **50 %** of each sector's market capitalisation of the parent index				
Negative screening for business involvement in	Conventional Weapons Alcohol	Civilian Firearms Gambling	Nuclear Power Tobacco	Fossil Fuel Extraction Nuclear Weapons	Thermal Coal Power Controversial Weapons
Minimum ESG Rating					
for addition:	> =BB				
for constituents to remain:	> =BB				
Minimum MSCI controversies score					
for addition:	> =3				
for constituents to remain:	> =1				
Conditions for removal	Corporate actions (M&S, delisting, etc.) Removal from parent index Failing eligibility criteria				

Table D3 –
SRI indices selection criteria

MSCI SRI					
Launch date	April 2011				
ESG screen methodology:	Negative screening Best-in-class: maintaining the same sectoral representation of the parent index, the companies with the highest ESG rating representing the **25 %** of each sector's market capitalisation of the parent index				
Negative screening for business involvement in	Conventional Weapons Alcohol	Civilian Firearms Gambling	Nuclear Power Tobacco	Adult Entertainment Nuclear Weapons	Genetically Modified Organisms Fossil fuel reserves ownership

(*continued on next page*)

Table D3 – (*continued*)

MSCI SRI			
	Fossil fuel extraction	Controversial Weapons	Thermal Coal Power
Minimum ESG Rating			
for addition:	> =A		
for constituents to remain:	> =BB		
Minimum MSCI controversies score			
for addition:	> =4		
for constituents to remain:	> =1		
Conditions for removal	Corporate actions (M&S, delisting, etc.)		
	Removal from parent index		
	Failing eligibility criteria		

The considered indices present several commonalities and a few relevant differences. First, by looking at the ESG screening methodology as well as at the ESG and controversies scores, it appears that the SRI indices have stricter ESG requirements for inclusion than the other indices. 25 % of this sector represents the parent index in terms of market capitalisation, which reduces diversification but ensures a higher average ESG performance for its constituents. It follows that SRI indices have a lower number of constituents, obviously depending on the represented region. Moreover, the SRI index family covers the widest number of exclusionary controversial business activities, implying a lower exposure to ESG risks. The KLD400 index and the ESG Leaders index family have different profiles. On the one hand, the first prescribes a minimum BBB rating of companies to be considered for inclusion; on the other hand, the second, while imposing a lower rating threshold for admission, presents a more environment-aware profile, as it includes some key business areas that companies are screened for which the KLD400 misses, such as fossil fuel extraction and thermal coal power.

The table below summarises each ESG index's size in terms of the number of constituencies and its parent index.

Table D4 -
Summary of selected indices' constituents and related parent indices

Index	N Constituents	Parent index
KLD400	400 (fixed)	MSCI USA IMI Index
WORLD ESG	700 +	MSCI WORLD Index
EU ESG	200 +	MSCI Europe & Middle East Index (only selected countries)
USA ESG	250 +	MSCI USA IMI Index
EM ESG	250 +	Aggregation of regional MSCI EM Indices: EM Asia, Latin America, and EM EMEA
ACWI ESG	1000 +	MSCI ACWI Index
WORLD SRI	350 +	MSCI WORLD Index
EU SRI	120 +	MSCI Europe & Middle East Index (only selected countries)
USA SRI	120 +	MSCI USA IMI Index
EM SRI	120 +	Aggregation of regional MSCI EM Indices: EM Asia, Latin America, and EM EMEA
ACWI SRI	500 +	MSCI ACWI Index

MSCI controversial activities screening list

Controversial Weapons:

All companies with any tie to Controversial Weapons (cluster munitions,landmines, depleted uranium weapons, biological/chemical weapons, blinding lasers, non-detectable fragments and incendiary weapons), as defined by the methodology of the MSCI Global Ex-Controversial Weapons Indices available at https://www.msci.com/index-methodology.

Civilian Firearms:

All companies classified as "Producer" of firearms and small arms ammunitions for civilian markets. It does not include companies that cater to the military, government, and law enforcement markets. All companies deriving 5 % or more aggregate revenue from the production and distribution (wholesale or retail) of firearms or small arms ammunition intended for civilian use.

Nuclear Weapons:

All companies that manufacture nuclear warheads and/or whole nuclear missiles. All companies that manufacture components that were developed or are significantly modified for exclusive use in nuclear weapons (warheads and missiles). All companies that manufacture or assemble delivery platforms that were developed or significantly modified for the exclusive delivery of nuclear weapons. All companies that provide auxiliary services related to nuclear weapons. All companies that manufacture components that were not developed or not significantly modified for exclusive use in nuclear weapons (warheads and missiles) but can be used in nuclear weapons. All companies that manufacture or assemble delivery platforms that were not developed or not significantly modified for the exclusive delivery of nuclear weapons but have the capability to deliver nuclear weapons. All companies that manufacture components for nuclear-exclusive delivery platforms.

Tobacco:

All companies classified as a "Producer". All companies deriving 5 % or more aggregate revenue from the production, distribution, retail, supply and licensing of tobacco-related products. Adult Entertainment. All companies deriving 5 % or more revenue from the production of adult entertainment materials. All companies deriving 15 % or more aggregate revenue from the production, distribution and retail of adult entertainment materials.

Alcohol:

All companies deriving 5 % or more revenue from the production of alcohol-related products. All companies deriving 15 % or more aggregate revenue from the production, distribution, retail and supply of alcohol-related products. Conventional Weapons. All companies deriving 5 % or more revenue from the production of conventional weapons and components. All companies deriving 15 % or more aggregate revenue from weapons systems, components, and support systems and services.

Gambling:

All companies deriving 5 % or more revenue from ownership of operation of gambling-related activities. All companies deriving 15 % or more aggregate revenue from gambling-related business activities. Genetically Modified Organisms (GMO). All companies deriving 5 % or more revenue from activities like genetically modifying plants, such as seeds and crops, and other organisms intended for agricultural use or human consumption.

Nuclear Power:

All companies generating 5 % or more of their total electricity from nuclear power in a given year. All companies that have 5 % or more of installed capacity attributed to nuclear sources in a fiscal year. All companies deriving 15 % or more aggregate revenue from nuclear power activities.

Fossil Fuel Reserves Ownership:

All companies with evidence of owning proven & probable coal reserves and/or proven oil and natural gas reserves used for energy purposes, a defined by the methodology of the MSCI Global Ex Fossil Fuels Indices available at https://www.msci.com/index-methodology.

Fossil Fuel Extraction:

All companies deriving any revenue (either reported or estimated) from thermal coal mining or unconventional oil and gas extraction. Thermal Coal Mining: Revenue from the mining of thermal coal (including lignite, bituminous, anthracite and steam coal) and its sale to external parties. It does not cover revenue from metallurgical coal coal mined for internal power generation (e.g. in the case of vertically integrated power producers). Intra-company sales of mined thermal coal. Revenue from coal trading.

Thermal Coal Power:

All companies deriving 5 % or more revenue (either reported or estimated) from thermal coal-based power generation.

MSCI ESG Ratings Key Issue hierarchy

Table D5 -
MSCI ESG Ratings Key Issue hierarchy

3 Pillars	10 Themes	35 ESG Key Issues
Environment	Climate Change	Carbon emissions
		Climate change vulnerability
		Financing environmental impact
		Product carbon footprint
	Natural Capital	Biodiversity & land use
		Raw material sourcing
		Water stress
	Pollution & Waste	Electronic waste
		Packaging material & waste
		Toxic emissions & waste
	Environmental Opportunities	Opportunities in Clean Tech
		Opportunities in Green Building
		Opportunities in Renewable Energy
Social	Human Capital	Health & safety
		Human capital development
		Labor management
		Supply chain labor standards
	Product Liability	Chemical safety
		Consumer financial protection
		Insuring health & demographic risk
		Privacy & data security
		Product safety & quality
		Responsible investment
	Stakeholder Opposition	Community relations
		Controversial sourcing
	Social Opportunities	Access to Communications
		Access to Finance
		Access to Health Care
		Opportunities in Nutrition & Health
Governance	Corporate Governance	Board
		Pay
		Ownership & control
		Accounting
	Corporate Behavior	Business ethics
		Tax transparency

MSCI ESG Controversy Sub-Pillars and Thematic Indicators

Table D6 -
MSCI ESG Controversy Sub-Pillars and Thematic Indicators

Sub-Pillar		Thematic Indicators
Environment		Biodiversity & Land Use
		Toxic Emissions & Waste
		Energy & Climate Change
		Water Stress
		Operational Waste (Non-Hazardous)
		Supply Chain Management
		Other
Social	Customers	Anticompetitive Practices
		Customer Relations
		Privacy & Data Security
		Marketing & Advertising
		Product Safety & Quality
		Other
	Human rights & community	Impact on Local Communities
		Human Rights Concerns
		Civil Liberties
		Other
	Labor rights & supply chain	Labor Management Relations
		Health & Safety
		Collective Bargaining & Union
		Discrimination & Workforce Diversity
		Child Labor
		Supply Chain Labor Standards
		Other
Governance		Bribery & Fraud
		Governance Structures
		Controversial Investments
		Other

Data availability

The data that has been used is confidential.

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