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Does firm environmental performance mitigate the market reaction to COVID-19 uncertainty?☆

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ABSTRACT

This paper investigates how firms' environmental performance affected the market reaction caused by the uncertainty of the COVID-19 pandemic. Our analysis focuses on a sample of 3854 non-financial listed companies from 21 advanced economies. We find that high environmentally sustainable practices (ESP) are associated with lower returns during the COVID-19 crisis, especially when the pandemic began to spread globally. Also, our results show that ESP is not significantly related to volatility in the whole COVID-19 period. We find a positive relationship between ESP and volatility only in the early phases of the pandemic. The stronger contraction in earnings and cash flow forecasts for high ESP firms explains the negative effect of ESP on market returns. The cost structure of high ESP firms makes them more exposed to the unexpected global demand shock. Our findings suggest that firm environmental performance did not immunise against market turmoil.

1. Introduction

Did it pay to be green during the COVID-19 uncertainty? The main research objective of this paper is to investigate how firm environmental performance affected the market reaction caused by the uncertainty of the COVID-19 pandemic.

Countries worldwide reacted to the COVID-19 outbreak by imposing lockdowns, shelter-in-place policies and social distancing measures, which had an adverse effect on stock market returns (Ashraf, 2020a). This unforeseen global phenomenon has had a great impact on financial markets, with huge economic consequences (Baker et al., 2020; Goodell, 2020). Between February and March 2020, stock markets plunged all around the world and experienced a sudden increase in volatility in response to the growth of COVID-19 confirmed cases (Al-Awadhi et al., 2020; Ashraf and Goodell, 2022; Ashraf, 2021; Ashraf, 2020b; Bai et al., 2021; Erdem, 2020). The Standard & Poor's 500 lost about a third of its value, while at the same time, the Standard & Poor's 500 implied Volatility Index (VIX) reached its highest peak since the global financial crisis. In the same period, the STOXX Europe 600 and the FTSE100

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plunged more than 30%, in line with the crashes experienced by most emerging economies. Thus, the health crisis was a source of systematic risk that shook stock markets and provoked uncertainty (Ashraf, 2020b; Sharif et al., 2020; Szczygielski et al., 2021). Consequently, it has turned into an economic crisis amplified through financial channels (Ramelli and Wagner, 2020).

The disruptive effects related to the worldwide COVID-19 outbreak have fed growing attention to the determinants of cross-country and cross-sectional variations in market reactions to COVID-19. Research has demonstrated that, during the COVID-19 pandemic, stock returns and volatility strongly varied, depending on both country- (Ashraf and Goodell, 2022; Ashraf, 2021; Ashraf, 2020b; Bai et al., 2021; Erdem, 2020) and firm-level (Ding et al., 2021; Fahlenbrach et al., 2021) characteristics. Countries with greater freedom of expression (Erdem, 2020), lower uncertainty aversion (Ashraf, 2021), higher trust (Engelhardt et al., 2021) and stronger social norms (Ashraf and Goodell, 2022) had less negative returns and lower volatility during COVID-19. Firms with greater financial flexibility, stronger pre-pandemic financial conditions, less exposure to COVID-19 through global supply chains and customer locations and more corporate social responsibility (CSR) activities experienced a milder drop in their stock returns (Ding et al., 2021).

Unsurprisingly, the increasing relevance of ESG-focused investments[3] has also stimulated research focused on the effects associated with firm ESG performance during the COVID-19 crisis. In fact, firms with higher ESG performance are perceived as more trustworthy during periods of crisis because their ESG activities strengthen the relationship between the company and its stakeholders, which, in turn, helps the company cope with the crisis (Lins et al., 2017). Therefore, several studies have begun investigating whether ESG performance can be considered a downside risk protection or if it could hinder companies' resilience during the pandemic, although no clear consensus has emerged (Albuquerque et al., 2020; Broadstock et al., 2021; Demers et al., 2021).

Among firm sustainable practices, environmental issues are at the heart of current academic and policy debates. The World Economic Forum (WEF) has acknowledged climate action failure, natural disasters and extreme weather events, biodiversity loss and ecosystem collapse as being at the most severe risks over a 10-year period (World Economic Forum, 2023). Investors consider environmental issues to be important risk factors in their investment strategies (Ilhan et al., 2021; Krueger et al., 2020). In fact, the direct costs related to climate change and climate disaster, the potential negative effects on firm outcomes associated with policies and regulations aimed at tackling climate change, and the increasing innovation in technology and business models to fight climate change can adversely impact returns (Krueger et al., 2020). Investors could have reassessed the value of firm environmental footprint for two main reasons (Garel and Petit-Romec, 2021). First, the experience of a rare disaster, such as the pandemic, led investors to reconsider the probability and potential impact of climate change (Mohommad and Pugacheva, 2022). This could have changed their perceptions of firm environmental performance. Second, the widespread adoption of green recovery packages may have been an advantage for firms with more sustainable practices, which can thus be rewarded by investors in terms of both performance and risk.

However, investors could have penalised firms with higher environmental performance. Structural costs of environmental activities in terms of product design, raw materials used and operational process design influence firm cost structure for a given environmental strategy (Henri et al., 2016). Therefore, the higher level of investments to enhance environmentally sustainable practices (ESP) and the corresponding higher capital rental costs (Ee et al., 2018) may have driven a negative market overreaction towards high environmental performance firms. For instance, Ashraf et al. (2022) find that the adverse impact of social distancing measures was stronger for Islamic banks than conventional banks because of their inherent complexity and higher cost structure. Similarly, the cost structure of firms that heavily invest in adopting more environmentally sustainable practices may not be easily adapted to unexpected global demand shocks. In this regard, firms with higher environmental performance can face higher decreases in their earnings and cash flow forecasts, leading to a negative relationship between environmental performance and stock returns in a period of extreme uncertainty.

For the abovementioned arguments, the understanding of the influence of firm environmental performance on market reactions during the COVID-19 pandemic is a crucial empirical question. Therefore, this paper aims to provide international evidence of how market participants perceived firm environmental performance during the COVID-19 pandemic and its related market uncertainty. We analyse a sample of 3854 listed non-financial companies from 21 developed economies. Specifically, we test the hypothesis that the market reaction to COVID-19 uncertainty was not neutral to firm environmental performance.

Our results show that high ESP are associated with lower market performance during the COVID-19 crisis, especially when the pandemic began to spread globally. We find that firm ESP are not significantly related to volatility in the whole COVID-19 period. Our results show a positive relationship between firm ESP and volatility only during the incubation and outbreak periods. We find that the more severe drops in earnings and cash flow forecasts faced by firms with better environmental performance drive the negative relationship between environmental performance and returns. Overall, our research suggests that market participants penalised firms that implement environmental initiatives to enhance their green footprints during the COVID-19 crisis.

Our research contributes to the growing literature on market reactions to COVID-19, with a deep focus on firm environmental performance as an emerging research interest. Our paper complements the literature on firm environmental commitment, market performance and volatility in periods of crisis. Empirical studies on the effect of firm ESP on market performance and volatility offer mixed evidence (Beloskar and Rao, 2023; Demers et al., 2021; Garel and Petit-Romec, 2021; Takahashi and Yamada, 2021; Yoo et al., 2021). We focus on the unexpected market reaction to the COVID-19 pandemic, exploiting the exogeneity of firm-specific environmental practices to market performance and volatility in the short term. While previous literature has extensively examined the moderating effect of high social capital on market reactions related to a lack of trust in financial markets (Lins et al., 2017), the uncharted high uncertainty associated with a global pandemic represents an unfortunate but interesting ground for research. Furthermore, the literature suffers from limited and conflicting empirical evidence supporting the link between ESG performance,

[3] According to the 2021 Global Sustainable Investment Review, at the beginning of 2021, sustainable investing assets reached over 42 trillion USD globally with a 49% increase in two years (Global Finance Review, 2021).

market returns and volatility during the COVID-19 crisis. This research, contextualised around environmental activities, provides evidence of a negative relationship between environmental and market performance channelled through higher structural costs linked with environmental initiatives. Furthermore, this study provides evidence of the stock market reaction from an international perspective. Most previous studies have focused on the domestic dimension, with results that can be significantly influenced by the different country-specific market microstructure.

The remainder of the paper is organised as follows. Section 2 addresses the literature review, Section 3 presents the research methodology, Section 4 describes the empirical findings and Section 5 concludes.

2. Literature review

2.1. Theoretical considerations of ESG activities, stock market performance and volatility in periods of crisis

Two opposing theories explain the relationship between CSR[4] and firm value and risk. On the one hand, according to Friedman's (Friedman, 1970) shareholder theory, the sole responsibility of a company is to increase its profits. CSR activities are viewed as residuals to the core business. Managers address CSR activities as a whitewashing tool to hide firm irresponsibility at the expense of shareholders (Zhou et al., 2021) or as a wasteful managerial self-serving expenditure to enhance managers' entrenchment strategy (Demers et al., 2021; Surroca and Tribó, 2008). Therefore, ESG activities generate insufficient results by bearing high costs. Empirical evidence shows that ESG expenses decrease financial performance and reduce shareholder value (Lys et al., 2015).

On the other hand, stakeholder theory suggests that companies create value for stakeholders from a long-term perspective (Freeman, 1984). Creating value for and among stakeholders means addressing stakeholders' reciprocal interests and involving stakeholders in the decision-making process; thereby, stakeholders can support business operations and monitor the management. This curbs agency costs and enhances shareholders' value (Masulis and Reza, 2015; Zhou et al., 2021). Empirical studies document that CSR activities increase corporate financial performance (Margolis and Walsh, 2003; Waddock and Graves, 1997), mitigate stock price crash risk (Feng et al., 2022; Kim et al., 2014; Zhou et al., 2021), are beneficial to shareholders (Dyck et al., 2019), are negatively associated with financial constraints or access to finance (Banerjee et al., 2020; Cheng et al., 2014) and, in the case of negative firm's ESG news, are associated with economic and financial losses (Capelle-Blancard and Petit, 2019). Furthermore, high ESG commitment strengthens the relationship between companies and stakeholders, and this tie is especially rewarding in times of crisis because ESG activities constitute a form of insurance-like protection against downside risks (Godfrey et al., 2009).

As the depth of research investigating the relationship between CSR and firm value and risk yields mixed results, several studies have taken a different tack by testing the value relevance of CSR activities during financial crises (Amiraslani et al., 2017; Havlinova and Kukacka, 2021; Lins et al., 2017; Zhou et al., 2021). For instance, the feverish market reaction related to the Global Financial Crisis has been at the heart of several empirical studies. Lins et al. (2017) investigate whether having a high level of social capital paid off during the financial crisis from August 2008 to March 2009 on a sample of 1673 non-financial firms. They show that companies with a high level of social capital in the form of CSR activities benefit from higher stock returns, profitability, growth and sales per employee in comparison to low CSR firms. This suggests that companies with high social capital are more trustworthy during periods of financial distress when overall trust is lower and that stakeholders are more inclined to sustain high CSR firms in this period because they have engaged with them in the past (e.g. reciprocity concept). This perspective is consistent for bondholders as well, as high CSR firms benefitted from a lower bond spread in the secondary market during the financial crisis of 2007 − 2009 (Amiraslani et al., 2017). Havlinova and Kukacka (2021) examine the impact of CSR on firm market performance in the period after the global financial crisis by distinguishing between strategic socially responsible activities directly related to core business and secondary CSR activities (e.g. philanthropic projects). The results show a positive and statistically significant impact of strategic activities on stock market performance. Considering the effect of ESG activities on overall firm risk as measured by stock price volatility, Ezzine (2018) based on a sample of French and Saudi firms, finds that compliance with CSR alone does not explain financial volatility during global financial crisis. Conversely, the study by Bouslah et al. (2018) examines the impact of the financial crisis (2008–2009) on the relationship between firm risk and social performance (SP) using a sample of non-financial U.S. firms covering the period 1991–2012. The findings show that the relationship between SP and risk is significantly different in the crisis period (post-crisis period) compared to the pre-crisis period. Social performance reduces volatility during the financial crisis.

These results support the strategic theoretical view of business strategists, who advocate that companies that strategically address socially responsible initiatives related to their core businesses will increase their share prices (Porter and Kramer, 2006). Overall, prior research supports the theoretical view, also known as 'doing well by doing good', which suggests that firms can do well during a crisis by doing good in normal times, and ESG activities are good for shareholders and for society, as well (Eccles et al., 2014).

In recent years, the COVID-19 crisis has provoked intense fluctuations in the stock markets and severe consequences for the worldwide economy, such as an immediate GDP growth contraction. Therefore, several studies have started to investigate whether ESG activities are correlated with share price resilience during the COVID-19 crisis. We discuss the empirical findings of these studies in the next section.

[4] Based on Demers et al. (2021), we use the terms ESG and corporate social responsibility ("CSR") interchangeably throughout the paper.

Table 1
Summary of prior research on the relationship between ESG activity, market performance and volatility during COVID-19.

Reference	Paper title	Academic Journal	Sample	Dependent variable	Main independent variable	Main findings	
Abedifar, P., Bouslah, K., Neumann, C., & Tarazi, A. (2022).	Resilience of Environmental and Social Stocks under Stress: Lessons from the COVID-19 Pandemic.	Financial Markets, Institutions & Instruments.	330 firms operating in five developed countries: Canada, France, Japan, the UK and the US.	Abnormal returns and return volatility: 1. daily abnormal returns as the difference between the actual return of a share and its expected return; 2. range-based measure of daily volatility calculated as the daily high price minus the daily low price divided by the mid-price as the dependent variable.	ES_high is a dummy variable equal to one for firms with high ES score (top quartile) and to zero for ES_low firms (the lowest quartile).	The impact of ES ratings on daily abnormal return and price range volatility significantly differs across countries.	No association
Albuquerque, R., Koskinen, Y., Yang, S., & Zhang, C. (2020).	Resiliency of environmental and social stocks: An analysis of the exogenous COVID-19 market crash.	The Review of Corporate Finance Studies.	2171 U.S. firms with 134,689 firm-day return observations.	Three different dep. variables: 1. quarterly abnormal returns; 2. return volatility (total and idiosyncratic volatility); 3. operating performance (measured by return on assets, operating profit margin, and asset turnover).	Environmental and social rating of firm *i* in 2018.	Stock prices for firms with high ES scores perform much better than other firms. Stocks with higher ES ratings have significantly higher returns, lower return volatility, and higher operating profit margins during the first quarter of 2020.	Positive
Bae, K. H., El Ghoul, S., Gong, Z. J., & Guedhami, O. (2021).	Does CSR matter in times of crisis? Evidence from the COVID-19 pandemic.	Journal of Corporate Finance,	1750 U.S. firms.	Stock returns during the crisis period (February 18–March 20, 2020) captured using raw returns and market model–adjusted returns.	CSR_MSCI: CSR ratings based on the MSCI ESG Stats database followingLins et al. (Lins et al., 2017) and CSR_REFINITIV: average of the environment and social scores at the end of 2019 from the Refinitiv ESG database.	No evidence that CSR affected stock return.	No evidence
Beloskar and Rao (2023).	Did ESG Save the Day? Evidence From India During the COVID-19 Crisis.	Asia-Pacific Financial Markets.	ESG rated firms listed on the Bombay Stock Exchange.	Stock return is the daily price returns of the stock at day.	ESG score measures firms' ESG performance. COVID is a dummy variable that equals to 1 for observations during the COVID-19 period and 0 for those during the previous year.	ESG scores are positively associated with cumulative returns during the COVID-19 crisis. Thus, firms with high ESG scores perform relatively well during crisis periods.	Positive
Broadstock, D. C., Chan, K., Cheng, L. T., &	The role of ESG performance during times of	Finance research Letters.	China's CSI300 constituents.	Stock return volatility during the COVID-19	ESG scores during the 2020 COVID-	ESG performance is positively associated with the	Positive

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Table 1 (*continued*)

Reference	Paper title	Academic Journal	Sample	Dependent variable	Main independent variable	Main findings	
Wang, X. (2021).	financial crisis: Evidence from COVID-19 in China.			period measured as the standard deviation of 2-month daily returns.	19 pandemic period.	short-term cumulative returns of CSI300 stocks around the COVID-19 crisis.	
Cheema-Fox, A., LaPerla, B. R., Serafeim, G., & Wang, H. (2020).	Corporate resilience and response during COVID-19.	Working Paper 20–108 Harvard Business School.	3023 companies with $57 trillion USD in market value across 47 countries.	Crisis Returns calculated as the cumulated firm stock returns (in USD) minus cumulated country stock returns between February 20th and March 23rd, 2020.	Crisis Response is the sentiment measure capturing a company's action (inaction) on Human Capital, Supply Chain, Products and Services by averaging the three measures related to HC, SC, and PS.	More positive sentiment around a company's response is associated with less negative returns.	Positive
Demers, E., Hendrikse, J., Joos, P., & Lev, B. (2021).	ESG did not immunize stocks during the COVID-19 crisis, but investments in intangible assets did.	Journal of Business Finance & Accounting.	1652 U.S. firm.	Buy-and-hold abnormal returns for January through March 2020.	ESG score measured using Refinitiv's pre-April 2020 overall summary score of ESG performance.	ESG did not immunize stocks during the COVID-19 crisis.	No evidence
Demir, E., & Danisman, G. O. (2021).	Banking sector reactions to COVID-19: The role of bank-specific factors and government policy responses.	Research in International Business and Finance.	1927 publicly listed banks from 110 countries.	Stock price data from Thomson Reuters Datastream.	Pre-pandemic ESG scores (2018).	Environment and governance scores of banks do not have a significant impact. Higher social and CSR strategy scores intensify the negative stock price reaction to COVID-19.	No evidence
Ding, W., Levine, R., Lin, C., & Xie, W. (2021).	Corporate immunity to the COVID-19 pandemic.	Journal of Financial Economics.	6744 firms in 61 countries.	Weekly Stock Return (in percentage) using dividend-adjusted closing prices on the last trading day of the week. Weekly abnormal returns are weekly stock returns of each firm minus beta times domestic market returns, with beta provided by Thomson Reuters and calculated using monthly data on the domestic stock markets (value-weighted) over the last five years.	Firms' CSR performance from the Thomson Reuters ASSET4 ESG database.	Firms with stronger CSR activities prior to the pandemic experience superior stock price performance in response to COVID-19, and the CSR-resilience nexus is stronger among economies which address ES issues.	Positive
Fernández-Méndez & Pathan (2022)	Environmental stocks, CEO health risk and COVID-19.	Research in International Business and Finance.	126 Australian firms.	Cumulative abnormal returns from February-19 to March-23.	Environment component of the firm's weighted ESG score.	Firms with environmentally sustainable practices generated higher abnormal returns.	Positive
Garel, A., & Petit-Romec, A. (2021)	Investor rewards to environmental	Journal of Corporate Finance.	1626 large U. S. listed firms.	Buy-and-hold stock return during	Firm's environmental score measured as	Firms with good environmental scores have	Positive

(*continued on next page*)

Table 1 (*continued*)

Reference	Paper title	Academic Journal	Sample	Dependent variable	Main independent variable	Main findings	
	responsibility: Evidence from the COVID-19 crisis.			the COVID-19 crisis.	of 2018, and three subcomponents: i) Resource Use, ii) Emission Reduction, and iii) Green Innovation.	significantly higher returns during the COVID-19 crisis indicates that investors have started to reward companies with responsible strategies on climate change.	
Li et al. (Li et al., 2021)	The Role of Corporate Culture in Bad Times: Evidence from the COVID-19 Pandemic.	Journal of Financial and Quantitative Analysis.	2894 U.S. firms.	Firm's return data (buy-and-hold return in percentage points) to be available from Jan. 2 through Mar. 20, 2020.	Firm-level measure of corporate culture covers innovation, integrity, quality, respect, and teamwork; the year 2017 is the most recent year with available data.	Firms with a strong corporate culture outperform their peers without a strong culture. Firms with a strong culture are more likely to support their community, embrace digital transformation, and develop new products, and they are no more likely to cut costs than their peers without a strong culture.	Positive
Shan, C., & Tang, D. Y. (2022).	The value of employee satisfaction in disastrous times: Evidence from COVID-19.	Review of Finance.	1781 Chinese publicly listed firms.	Stock returns on February 3, 2020.	Employees' satisfaction.	Chinese firms with high employee satisfaction outperform those with low employee satisfaction on the first trading day following the outbreak of the pandemic.	Positive
Yoo et al. (2021).	Does sustainability activities performance matter during financial crises? Investigating the case of COVID-19.	Energy Policy.	2887 companies from Arabesque S-Ray.	Monthly raw return (%), abnormal returns (the raw returns minus the expected returns) and volatility.	ESG scores derived from ESG activities, GC score indicates firm's reputation for following the UN GC norms.	An increase in the ESG score, especially the E score component, is related to higher returns and lower volatility. Conversely, increasing GC score is correlated with lower stock returns and higher volatility.	Positive (E), negative (G)
Takahashi, H., & Yamada, K. (2021).	When the Japanese stock market meets COVID-19: Impact of ownership, China and US exposure, and ESG channels.	International Review of Financial Analysis.	3349 Japanese firms.	Buy-and-hold abnormal return (BHAR). The abnormal return is calculated as the difference between the daily logarithm return and the expected return of the market model.	Refinitiv's ESG Data of December 2019.	No evidence on firms that have highly rated ESG scores have higher abnormal returns.	No evidence

2.2. *Prior research on ESG activities, stock market performance and volatility during the COVID-19 crisis*

More recent research analyses the relevance of ESG activities during the COVID-19 crisis (Abedifar et al., 2022; Albuquerque et al., 2020; Bae et al., 2021; Broadstock et al., 2021; Cheema-Fox et al., 2020; Demers et al., 2021; Fernandez-Mendez and Pathan, 2022; Yoo et al., 2021; Takahashi and Yamada, 2021; among the others). Table 1 synthetises the main findings of previous studies on the

relationship between ESG activities, market performance, and volatility during the COVID-19 crisis, from which we can derive the following main streams. In one stream, the positive effect of ESP emerges, while in the other, an insignificant or negative relationship sorts out.

With reference to the positive relationship between ESG activities and market performance, we can include the studies by Albuquerque et al. (2020), Broadstock et al. (2021), Beloskar and Rao (2023), Cheema-Fox et al. (2020), Ding et al. (2021), Fernandez--Mendez and Pathan (2022), Garel and Petit-Romec (2021), Li et al. (2021) and Yoo et al. (2021). Albuquerque et al. (2020) analyse the effect of firm environmental and social (ES) practices during the market collapse caused by the COVID-19 pandemic. Gathering ESG data from both Refinitiv MSCI on a sample of 2171 U.S. firms, their results show that firms with high ES scores achieved significantly higher returns and faced lower volatility during the first quarter of 2020. In addition, consistent with the customer loyalty hypothesis, they find that high ES firms were able to increase margins despite a remarkable decrease in sales. Broadstock et al. (2021) investigate whether ESG performance was priced during COVID-19. Based on a sample of China's CSI300 constituents, this research shows that ESG performance is positively associated with short-term cumulative returns. This suggests that ESG performance is a signal of future stock performance and/or risk mitigation in times of crisis. In addition, the study shows that during the financial distress of the pandemic period, investors increased the trade activity of low ESG firms' shares in comparison to high-ESG firms, which were more resilient because less affected by fire sales. Furthermore, firms with high performance in the environmental and governance spheres are better prepared to recover from periods of crisis. Beloskar and Rao (2023) examine the investment performance, trading volumes and return volatility of ESG stocks in an emerging market like India during the COVID-19 crisis. Their results show that ESG performance reduces stock return volatility during that period. Li et al. (2021) show that firms with strong corporate culture, measured as the sum of five cultural value scores in innovation, integrity, quality, respect and teamwork, outperform their peers without a strong culture. These firms are more likely to support their community, embrace digital transformation and develop new products. Furthermore, they are no more likely to cut costs than their peers without a strong culture. Ding et al. (2021) examine how firm-specific characteristics (basic financial conditions, international networks of suppliers and customers, corporate social responsibility, corporate governance systems and ownership structures) influence stock price reactions to the pandemic. With respect to CSR, the findings show that firms that engaged more in CSR activities before the pandemic enjoyed better performance in response to the pandemic. Yoo et al. (2021) show similar results for environmental performance, while it has opposite findings for the governance sphere. More specifically, the study empirically shows that an increase in the environmental component of the ESG score is related to higher returns and lower volatility, while the governance sphere is correlated with lower stock returns and higher volatility. Other studies focused on a single dimension of firms' sustainable practices, considering the social dimension (Cheema-Fox et al., 2020; Shan and Tang, 2022) or the environmental dimension (Garel and Petit-Romec, 2021; Fernandez-Mendez and Pathan, 2022). For instance, Garel and Petit-Romec (2021) investigate the value relevance of firm environmental footprint during the COVID-19 crisis and its main mechanisms. Based on a sample of 1626 large U.S.-listed firms, their analysis points out that firms with better environmental practices had higher returns. Specifically, their results suggest that investors mainly rewarded firm initiatives aimed at addressing climate change, i.e. practices related to CO2 emission reduction and resource use. In a similar vein, Fernandez-Mendez and Pathan (2022) find that Australian firms with environmentally sustainable practices generated higher abnormal returns. With a focus on green finance markets, Lu et al. (2023) explore the influence of the COVID-19 pandemic on return and volatility connectedness among green bonds, clean energy and socially responsible stocks. They show that clean energy has the greatest return and volatility spillovers, while green bonds receive the most return and volatility spillovers.

When considering the studies that provide an insignificant or negative relationship between ESG activities, stock market performance and volatility, we can include Abedifar et al. (2022), Bae et al. (2021), Demers et al. (2021), Demir and Danisman (2021), and Takahashi and Yamada (2021). Takahashi and Yamada (2021) show that Japanese firms with higher ESG performance did not experience higher abnormal returns during the pandemic outbreak. Moreover, their findings highlight that higher holdings from ESG-focused funds are associated with lower abnormal returns during a severe market downturn. In a similar vein, Abedifar et al. (2022) show that more engagement with environmental and social activities is not associated with more resilience during a crisis. Similar evidence is provided by Demers et al. (2021). They show that ESG activities are uncorrelated with returns during the COVID crisis. Bae et al. (2021) analyse a sample of 1750 U.S. non-financial firms over the crisis period (February 18–March 20, 2020) and the post-crisis period (March 23–June 5, 2020). Their results show no evidence that CSR affected stock returns, suggesting that pre-crisis CSR is not effective in protecting shareholder wealth from the adverse effects of a crisis. Similarly, in analysing an international sample of more than 1900 banks, Demir and Danisman (2021) do not find any significant effect of either the governance or the environmental dimensions of bank sustainability and market returns. Only bank social practices are negatively related to market performance.

From this literature analysis, the following considerations can be identified. First, there is no clear-cut evidence of the linkage between ESG levels, stock returns and volatility from an international viewpoint. Second, there is scant evidence that solely considers firm environmental footprint and no consensus has been reached on its impact on market performance and volatility. Investors may positively perceive environmental activities that enhance sustainable models of production and sustainable infrastructures, and, moreover, they may evaluate environmental risks of climate change and biodiversity loss. However, they may negatively reward environmentally sustainable firms if they consider the structural costs related to product innovation, emission reduction and resource use to be too penalising for firms' earnings during this period of huge uncertainty. In fact, environmental costs influence the firms' cost in terms of product design, raw materials used and operational process design at a structural level (Henri et al., 2016).

Therefore, research on the relationship between environmental commitment and stock market performance is worthy of in-depth exploration, and we cover this gap.

3. Data and methodology

3.1. Data

To investigate the relationship between firm ESP, market performance and volatility during the COVID-19 crisis, we collect firm-level environmental information from Refinitiv Asset4, a widely used database in the ESG literature. We focus on non-financial listed firms from 21 advanced economies with environmental information available at the end of 2018, excluding firms with fewer than 120 daily price observations during 2019. We consider the data on environmental information at the end of 2018 because it was the last set of ESG data available to investors before the COVID-19 outbreak (Demers et al., 2021; Garel and Petit-Romec, 2021). Our final sample consists of 3854 firms. Table A.1 in the Appendix summarises its geographical distribution.

We obtain accounting and market-related data from Refinitiv and the earnings and cash flow forecasts from the I/B/E/S database. For consistency with the environmental data, we measure all control variables at the end of 2018. To limit the relevance of outliers, both the dependent and independent variables are winsorized at the 1% level. Table A.2 in the Appendix describes the variables used in the analysis.

3.2. Dependent variables

We use two different dependent variables to test our main hypothesis. First, we measure the market performance using firms' abnormal return (*Abnormal return*), which equals the raw return minus the expected return obtained from a market model based on the previous 60 monthly returns, ending in December 2019.[5] Second, we use the standard deviation of daily returns to measure firms' volatility (*Volatility*).

We refer to Ramelli and Wagner (2020) in defining the timing of the COVID-19 spread. Our overall crisis period goes from January 2 (i.e. the first trading day after the discovery of cases of pneumonia and the closure of the Huanan Seafood Wholesale Market) to March 20 (i.e. the first trading day before the announcement of the massive support plan undertaken by the Federal Reserve).[6]

Ramelli and Wagner (2020) point out that, within the crisis period, the overall attention and media coverage of the COVID-19 spread was strongly heterogeneous. For this reason, in addition to the overall period, we deepen our analysis by studying the relationship between ESP, market performance and volatility in three different sub-periods, namely, the incubation (from January 2 to January 17), the outbreak (from January 20 to February 21) and the fever (February 24 to March 20).

Panels A and B in Table 2 show the descriptive statistics for the dependent variables. Overall, the COVID-19 crisis caused a remarkable reduction in stock prices. In the full crisis period, the firms in our sample experienced, on average, an abnormal return equal to − 5.9%, with notably negative returns for firms in the first quartile, which had abnormal returns lower than − 20%. The wide range between the first and last quartiles suggests strong heterogeneity in abnormal returns. In a similar vein, market volatility was significantly high during the pandemic, with an average value of 4.6% (about 73% in annualised terms). This seems to be driven by the market dynamic realised after COVID-19 began to spread in Europe and the United States (fever period).

3.3. ESP index

To measure firm environmental performance, we use the ESG data from Refinitiv Asset4. Based on publicly reported data, Refinitiv Asset4 provides an analytic assessment of firm ESG performance, taking into account more than 450 ESG items. In addition to the overall ESG score, Asset4 provides detailed information about performance in the three different pillars, namely, environmental (E), social (S) and governance (G), as well as the corresponding scores in several sub-components. More specifically, the environmental score takes into account firm ESP over three dimensions: emissions reduction, product innovation and resource use. The environmental score is based on 61 specific binary indicators, which summarise whether a specific policy or action has been undertaken by the firm to enhance the corresponding environmental performance.

To construct our index of environmentally sustainable practices (*ESP index*), we follow the additive approach proposed by Banerjee and Gupta (2017) and Banerjee et al. (2020).[7] Starting from the binary indicators described above, we computed the firm-level aggregated index, which ranges from 0 to 1, by summing all the positive indicators and dividing them by the total number of indicators. A higher index value therefore indicates higher environmental performance. Because some indicators are relevant only for specific industries, we exclude sector-specific indicators from the index calculation if the firm belongs to those industries.

Panel C in Table 2 reports the descriptive statistics for the ESP index and its subcomponents. The average firm in our sample has an ESP index of roughly 0.27, although the high range between the first and the last quartiles, from 0.06 to 0.44, indicates a strong heterogeneity in our sample. At the disaggregated level, the higher environmental performance comes from policies aimed at reducing the use of resources, as suggested by the higher average value equal to 0.33. The scores related to firms' commitment to reductions in polluting emissions from production processes are significantly lower. Interestingly, despite the average score of 0.22, more than 25% of the firms in the sample have not yet implemented specific policies to reduce emissions.

[5] We use country-specific total return MSCI index in local currency as the market proxy.
[6] In Section 4.6, we also test this relationship over the whole of 2020 and in the post-COVID-19 period, i.e. from March 23 to December 31.
[7] As shown in Section 4.5, similar results are obtained by using the environmental score provided by Refinitiv Asset4.

Table 2
Descriptive statistics.

	N	Mean	St. Dev.	25th	Median	75th
Panel A: Market performance						
Abnormal return - Full period	3854	-0.059	0.228	-0.200	-0.060	0.071
Abnormal return - Incubation	3854	-0.005	0.078	-0.045	-0.005	0.032
Abnormal return - Outbreak	3854	-0.027	0.116	-0.093	-0.026	0.039
Abnormal return - Fever	3854	-0.037	0.219	-0.170	-0.039	0.091
Abnormal return - 2020	3765	-0.012	0.527	-0.302	-0.082	0.173
Abnormal return - post-COVID	3765	0.284	0.941	-0.207	0.116	0.563
Raw return - Full period	3854	-0.367	0.205	-0.499	-0.367	-0.232
Abnormal cumulative return - Full period	3853	-0.191	0.361	-0.360	-0.141	0.043
Panel B: Volatility						
Volatility - Full period	3854	0.046	0.021	0.032	0.042	0.056
Volatility - Incubation	3854	0.019	0.014	0.010	0.015	0.022
Volatility - Outbreak	3854	0.023	0.014	0.014	0.019	0.027
Volatility - Fever	3854	0.068	0.032	0.045	0.062	0.082
Volatility - 2020	3765	0.039	0.019	0.027	0.034	0.047
Volatility - post-COVID	3765	0.036	0.018	0.024	0.031	0.043
Panel C: Environmentally sustainable practices						
ESP index	3854	0.268	0.218	0.063	0.220	0.442
Resource use	3854	0.330	0.291	0.053	0.278	0.579
Product innovation	3854	0.244	0.196	0.071	0.222	0.417
Emission reduction	3854	0.217	0.223	0.000	0.176	0.353
Asset4 Environmental score	3854	0.308	0.296	0.020	0.233	0.556
Panel D: Control variables						
Size	3854	14.738	1.682	13.577	14.705	15.837
Long-term debt	3854	0.216	0.191	0.051	0.188	0.328
Short-term debt	3854	0.034	0.053	0.000	0.012	0.048
Cash	3854	0.179	0.214	0.041	0.098	0.219
Profitability	3854	0.052	0.145	0.031	0.068	0.111
Market-to-book	3854	3.212	5.459	1.130	2.000	3.730
Negative MTB	3854	0.037	0.189	0.000	0.000	0.000
Market beta	3854	1.079	0.623	0.662	1.010	1.421
Momentum	3854	0.218	0.433	-0.034	0.191	0.413
Idiosyncratic risk	3854	0.012	0.016	0.004	0.007	0.014
Panel E: Forecasts						
Δ Sales forecasts	3673	-0.026	0.048	-0.044	-0.014	0.002
Δ EBIT forecasts	3264	-0.096	0.221	-0.156	-0.048	0.000
Δ EPS forecasts	3686	-0.134	0.231	-0.175	-0.052	0.000
Δ FCF forecasts	2189	-0.090	0.325	-0.197	-0.038	0.020

Note: Variables as defined in the Table A.2. Full period refers to the period from January 2 to March 20. Incubation refers to the period from January 2 to January 17. Outbreak refers to the period from January 20 to February 21. Fever refers to the period from February 24 to March 20.

3.4. Control variables

We include a set of firm- and country-specific covariates to control for possible heterogeneity among firms and to reduce the omitted variable bias. We mainly refer to the control variables used by Lins et al. (2017).

Our first covariate is the natural logarithm of market capitalisation (*Size*), measured in thousands of U.S. dollars. Although the literature on the size market premium has not yet reached a clear consensus, recent evidence about the stock market reaction to the COVID-19 crisis suggests that large firms performed better (Ramelli and Wagner, 2020). Accordingly, we expect a positive relationship between firm size and returns. Similarly, previous studies highlight that smaller firms have higher volatility (Kumari et al., 2017). In line with this argument, we expect a negative relationship between firm size and volatility.

We use the ratios of long-term (*Long-term debt*) and short-term debt (*Short-term debt*) to total assets as control variables. In crisis periods, especially when also characterised by high uncertainty, higher leverage can make firms more exposed to market downturns. Indeed, highly leveraged firms can face more difficulties in the reimbursement of outstanding debt because of the higher volatility of future cash flows, thus jeopardising their profitability, investments and probability of survival. This effect can be particularly severe for firms with higher short-term debt because the shock to global demand can significantly undermine their ability to invest (Almeida et al., 2009).

Conversely, cash reserves can be a protective cushion against an overall market crash. Higher cash holdings can indeed ensure a greater ability to absorb economic shocks in terms of both avoiding liquidity shortages for incumbent payments and reducing the dependency of new investment opportunities on future cash flows (Duchin et al., 2010). For this reason, we control a firms' liquidity by using the ratio of cash holdings to total assets (*Cash*). Similarly, we control a firms' profitability by considering the ratio of operating income to total assets (*Profitability*). More profitable firms can be less affected by the cut in corporate investments caused by COVID-19 uncertainty, thus maintaining higher forecasts in terms of future performance. This suggests that more profitable firms can have better returns and lower volatility during the pandemic.

We also use the market-to-book value ratio (*Market-to-book*) as a control variable. In their three-factor model, Fama and French (1992) highlight the key role of the market-to-book value ratio in explaining cross-sectional variations in stock returns. Consistent with previous empirical studies that find a value premium in stock returns (i.e. better performance for low market-to-book ratio firms; (Davis et al., 2000; Fama and French, 1992; Fama and French, 1993), and a lower crash risk for firms with a lower market-to-book ratio (Kim et al., 2014), we expect market-to-book value to be negatively related with market returns and positively associated with realised volatility. Moreover, as suggested by Lins et al. (2017), we add a dummy variable equal to one, whether the firm has a negative market-to-book value ratio, and 0 otherwise (*Negative market-to-book value)*.

We also control for the market beta (*Beta*) as a proxy for firm-specific market risk. We estimate the market beta through a CAPM model based on the previous 60 monthly returns, starting from December 2019, in local currencies.[8] Because firms with a higher beta tend to exacerbate market movements and lose more value in market crashes (Wang et al., 2009), the extreme negative returns and the jump in volatility associated with the COVID-19 crisis may be larger for firms with a higher beta.

Finally, we include in our model firms' momentum (*Momentum*), computed as the raw return from January to December 2019, and idiosyncratic volatility (*Idiosyncratic risk*), calculated as the residual variance of the CAPM model described above. These two control variables allow us to take into account both the persistency of returns (Carhart, 1997) and the average lower performance which characterised stocks with a high past idiosyncratic volatility (Ang et al., 2009).

3.5. Empirical strategy

To analyse the relationship between firm ESP, market performance and volatility during the COVID-19, we estimated the following OLS regression:

$$Y_i = \alpha + \beta ESP_i + \gamma' Controls_i + \Lambda_i + \varepsilon_i \quad (1)$$

where Y_i is the abnormal return or volatility for the firm *i*. Our main independent variable, ESP_i, is the index of environmentally sustainable practices, as detailed in Section 3.2. To account for factors that can affect market returns and volatility associated with the COVID-19 spread, Equation [1] specifies a vector, *Controls*, of firm-specific control variables. More specifically, we include the following in the empirical model as covariates: size, long-term debt, short-term debt, cash holdings, profitability, market-to-book value, negative market-to-book value, market beta, momentum and idiosyncratic volatility. We also include industry- and country-fixed effects (Λ). The use of the latter is crucial for absorbing country-specific features that could otherwise bias our estimations, such as mandatory country-specific environmental disclosure.

4. Results

4.1. Baseline results

Table 3 reports our baseline results. Column 1 shows the effect of the ESP index on market returns during the full period considered (i.e. from January 2 to March 20). We find that firms with high environmental scores performed significantly worse than low ESP firms. Our main coefficient of interest, ESP *index*, is negative and statistically significant at the 1% level. *Ceteris paribus*, a one standard deviation increase in the ESP index is associated with a one percentage point decrease in abnormal returns. In columns 2 − 4, we split the full period into three sub-periods according to the timing and the degree of the COVID-19 spread. Overall, our findings show a stronger market reaction when COVID-19 began to spread globally, in line with Ramelli and Wagner (2020). Indeed, the baseline results obtained over the full period are mainly driven by the stock returns observed during the fever period. In the first period of incubation, when COVID-19 was still in its infancy, investors were neutral to differences in firm environmental performance. Only from the onset of the outbreak did market participants begin to negatively evaluate firms with a high ESP index, although the magnitude of the effect in economic terms is negligible. In the fever period – that is, when the markets collapsed and their volatility reached extremely high peaks – firms with a higher ESP index realised significantly lower returns. Thus, while in the incubation and outbreak phases lower uncertainty did not lead to a significantly different market reaction for high ESP firms, the jump in uncertainty caused by the global pandemic drove the feverish market reaction, which, in turn, was more pronounced for firms with high environmental scores.

Columns 5–8 show the estimates for realised volatility. Contrary to market performance, the ESP coefficient for the entire COVID-19 period is small in magnitude and not significant at conventional levels (Column 5), suggesting that firm environmental performance does not affect firm volatility. On the contrary, regressions in Columns 6 and 7 show a positive and significant relationship between firm ESP and risk. A one standard derivation increase in the ESP index is associated with an increase of about 0.06% in realised volatility. Interestingly, despite the significant negative relationship between abnormal returns and the ESP index in the fever period, we find that the firm environmental performance did not affect firm volatility during the fever period (Column 8).

In summary, our findings suggest that firm environmental performance did not immunise against market turmoil during the

[8] Following Gębka et al. (2017), we use the local three month interbank interest rate as a proxy for the free-risk interest rate in each country and the three month Euribor for the Euro Area. We use total return MSCI indexes as proxies to the stock market portfolio performance in each country. We exclude firms with fewer than 12 monthly observations available.

Table 3
The effect of the ESP index.

	Abnormal return				Volatility			
	Full period	Incubation	Outbreak	Fever	Full period	Incubation	Outbreak	Fever
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ESP index	-0.047***	0.002	-0.006	-0.046***	0.000	0.003***	0.003***	-0.002
	(0.017)	(0.007)	(0.011)	(0.015)	(0.001)	(0.001)	(0.001)	(0.002)
Size	0.021***	0.001	0.005***	0.017***	-0.003***	-0.002***	-0.002***	-0.003***
	(0.003)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
Long-term debt	-0.119***	0.004	0.015	-0.138***	0.011***	0.002	-0.000	0.018***
	(0.019)	(0.009)	(0.014)	(0.017)	(0.002)	(0.001)	(0.001)	(0.003)
Short-term debt	0.045	-0.012	0.027	0.040	-0.008*	0.001	0.000	-0.015**
	(0.058)	(0.028)	(0.042)	(0.054)	(0.005)	(0.004)	(0.004)	(0.008)
Cash	0.059***	0.010	-0.001	0.062***	-0.007***	0.003*	-0.002	-0.010***
	(0.021)	(0.010)	(0.014)	(0.017)	(0.002)	(0.001)	(0.001)	(0.003)
Profitability	0.051*	-0.024	-0.021	0.093***	-0.015***	-0.009***	-0.004**	-0.021***
	(0.030)	(0.016)	(0.020)	(0.026)	(0.003)	(0.002)	(0.002)	(0.004)
Market-to-book	0.003***	0.001*	0.001	0.002***	0.000	0.000	0.000***	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Negative MTB	0.081***	0.030**	0.013	0.051**	0.002	0.003	0.004**	0.001
	(0.023)	(0.012)	(0.016)	(0.020)	(0.002)	(0.002)	(0.002)	(0.003)
Market beta	0.229***	-0.025***	-0.030***	0.246***	0.005***	0.002***	0.003***	0.006***
	(0.006)	(0.003)	(0.004)	(0.005)	(0.001)	(0.000)	(0.000)	(0.001)
Momentum	0.034***	0.003	0.040***	0.008	-0.003***	-0.004***	-0.004***	-0.003***
	(0.008)	(0.004)	(0.006)	(0.007)	(0.001)	(0.001)	(0.001)	(0.001)
Idiosyncratic risk	0.096	0.159	0.297	-0.081	0.254***	0.304***	0.274***	0.256***
	(0.308)	(0.180)	(0.221)	(0.256)	(0.029)	(0.028)	(0.025)	(0.043)
Constant	-0.497***	0.007	-0.079***	-0.417***	0.074***	0.041***	0.045***	0.100***
	(0.045)	(0.018)	(0.030)	(0.040)	(0.004)	(0.003)	(0.003)	(0.006)
Observations	3854	3854	3854	3854	3854	3854	3854	3854
Adjusted R^2	0.470	0.101	0.122	0.513	0.541	0.444	0.427	0.495

Note: Variables as defined in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

COVID-19 crisis. Rather, itexacerbated the market crash. These findings are consistent with previous studies, which highlight that sustainability does not protect investors from overall market turmoil (Ashraf et al., 2022; Demers et al., 2021; Döttling and Kim, 2022; Pavlova and de Boyrie, 2022). Our results can be explained by the more severe drop in profitability and cash flow forecasts caused by the extreme uncertainty of the COVID-19 pandemic. While the demand side shock could have equally affected firm sales regardless of their environmental performance – or even to a lower extent high ESP firms, as suggested by the customer channel (Lins et al., 2017) – the development of sustainable environmental practices requires higher investments and structural costs (Yenipazarli et al., 2020), which can hardly be cut during an unexpected crisis. This, in turn, can lead to a greater shrink in profitably and cash flows for firms with higher ESP.[9]

Looking at our control variables for the entire period, we find that larger firms perform better and are less volatile, consistent with Albuquerque et al. (2020). Moreover, according to Ramelli and Wagner (2020), our results show that firms with lower leverage and higher cash holdings achieve significantly higher returns and have lower volatility, although short-term debt is negatively associated with realised volatility. Similarly, more profitable firms have lower volatility and better performance. In line with the main literature, which highlights the contribution of the market-to-book value ratio in explaining cross-sectional variation in stock returns, we find that both market-to-book value and negative market-to-book value are statistically significant in abnormal return regressions.

Our findings show inconclusive evidence on market beta. Firms with higher beta have higher returns, although they are characterised by higher volatility. Momentum is positively related to market performance and negatively related to firm volatility, suggesting that investors rewarded firms with better performance in the pre-COVID-19 period. Finally, our findings show that idiosyncratic risk is positively associated with volatility.

4.2. Constituents of the ESP index, market returns and volatility

In this section, we delve more deeply into the relationship between ESP, market returns and volatility by considering the three sub-components of our ESP index separately – namely, resource use, product innovation and emission reduction. Table 4 shows the results. Columns 1–3 present the models in which abnormal return is the dependent variable. Overall, the difference in the sign and magnitude in the estimated coefficients of the three sub-components suggests that market participants price the kinds of policies undertaken by firms to enhance their environmental performance differently. The negative effect of the ESP index on market performance is mostly driven by policies and actions aimed at reducing the use of natural resources and polluting emissions. In particular, emission reduction policies have a stronger negative impact on stock market returns.

[9] We test this proposition in Section 4.3.

Table 4
The effect of ESP index sub-components on market performance and volatility.

	Abnormal return			Volatility		
	(1)	(2)	(3)	(4)	(5)	(6)
Resource use	-0.033***			0.000		
	(0.012)			(0.001)		
Product innovation		0.008			-0.002	
		(0.016)			(0.001)	
Emission reduction			-0.056***			0.001
			(0.016)			(0.001)
Size	0.021***	0.018***	0.022***	-0.003***	-0.003***	-0.003***
	(0.003)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
Long-term debt	-0.119***	-0.118***	-0.120***	0.011***	0.011***	0.011***
	(0.019)	(0.019)	(0.019)	(0.002)	(0.002)	(0.002)
Short-term debt	0.043	0.038	0.048	-0.008*	-0.008	-0.009*
	(0.058)	(0.058)	(0.058)	(0.005)	(0.005)	(0.005)
Cash	0.058***	0.065***	0.058***	-0.007***	-0.007***	-0.007***
	(0.021)	(0.020)	(0.021)	(0.002)	(0.002)	(0.002)
Profitability	0.052*	0.054*	0.048	-0.015***	-0.015***	-0.015***
	(0.030)	(0.030)	(0.030)	(0.003)	(0.003)	(0.003)
Market-to-book	0.003***	0.003***	0.003***	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Negative MTB	0.082***	0.082***	0.081***	0.002	0.001	0.002
	(0.023)	(0.023)	(0.023)	(0.002)	(0.002)	(0.002)
Market beta	0.229***	0.227***	0.229***	0.005***	0.005***	0.005***
	(0.006)	(0.006)	(0.006)	(0.001)	(0.001)	(0.001)
Momentum	0.034***	0.037***	0.033***	-0.003***	-0.003***	-0.003***
	(0.008)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)
Idiosyncratic risk	0.104	0.104	0.103	0.254***	0.253***	0.254***
	(0.308)	(0.307)	(0.307)	(0.029)	(0.029)	(0.029)
Constant	-0.497***	-0.473***	-0.506***	0.074***	0.074***	0.074***
	(0.045)	(0.043)	(0.045)	(0.004)	(0.003)	(0.004)
Observations	3854	3854	3854	3854	3854	3854
Adjusted R^2	0.470	0.469	0.470	0.541	0.541	0.541

Note: Variables as defined in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

By contrast, product innovation shows positive, albeit not significant, coefficients. Thus, market participants do not negatively perceive policies aimed at enhancing their capacity to reduce the environmental costs and burdens for firms' customers. This evidence can be explained by the fact that improvements in products or production processes can enhance customers' loyalty to the firm (Lins et al., 2017). Customers' loyalty influences consumer behaviours more than policies that are less directly perceived by customers and, consequently, reduces the volatility of firm sales also in times of crisis. Moreover, the stronger and opposite market reactions associated with resource use and emission reduction can also be related to the different impacts on fixed costs and capital structure. Actions aimed at cutting emissions and resource use may require structural investments, which may significantly increase firms' fixed costs, thus making firms more exposed to market downturns and to phases characterised by high economic uncertainty.

In line with our baseline results, estimations in Columns 4–6 reveal that none of the three ESP index constituents is significantly related to firm volatility during the COVID-19 crisis. These results confirm the inability of firm ESP to immunise against market shocks.

4.3. ESP index and forecast revisions

Next, we test whether the negative relationship between firm ESP and market returns is driven by changes in earnings and cash flow forecasts. Because market prices should reflect firm growth expectations, we argue that the high uncertainty of the COVID-19 spread leads to larger decreases in earnings forecasts for firms with higher environmental performance. With this aim, we re-estimate our baseline specification, considering the changes in analyst forecasts as dependent variables. We compare the change in the earnings forecasts made at the beginning and at the end of the first quarter of 2020, referring to the end of the next fiscal year, by looking at their percentage changes.[10] In particular, we consider the changes in forecasts of sales (Δ *sales forecasts*), earnings before interests and taxes (Δ *EBIT forecasts*), earnings per share (Δ *EPS forecasts*) and free cash flow per share (Δ *FCF forecast*).

Column 1 of Table 5 reports the results for the specification where the change in sales forecasts is the dependent variable. Contrary to our expectations and to the customer channel (Lins et al., 2017), the main coefficient of interest, *ESP index,* indicates a negligible

[10] To better understand the impact of COVID-19 spread on earnings forecasts, we consider the forecast for the fiscal year 2021 for firms with fiscal year ends between April and August 2020. In this way, the forecasts are based on at least a 6-month period affected by COVID-19 and not biased by the shorter term of the next fiscal year end. We consider the forecasts for the fiscal year 2020 for firms with fiscal year ends starting from September 2020.

Table 5
The effect of ESP index on the percentage change in 1-year forecasts.

	Δ Sales forecasts	Δ EBIT forecasts	Δ EPS forecasts	Δ FCF forecasts
	(1)	(2)	(3)	(4)
ESP index	0.001	-0.045*	-0.045**	-0.082**
	(0.004)	(0.023)	(0.022)	(0.041)
Size	-0.001	0.007**	0.021***	0.009
	(0.001)	(0.004)	(0.003)	(0.006)
Long-term debt	0.006	0.040	0.021	0.016
	(0.005)	(0.029)	(0.026)	(0.047)
Short-term debt	0.018	-0.024	-0.006	-0.127
	(0.014)	(0.085)	(0.074)	(0.188)
Cash	-0.023***	-0.031	0.023	-0.104*
	(0.006)	(0.032)	(0.029)	(0.057)
Profitability	0.035***	0.113***	0.075**	0.184**
	(0.009)	(0.040)	(0.036)	(0.083)
Market-to-book	0.000	-0.001	-0.002**	-0.001
	(0.000)	(0.001)	(0.001)	(0.002)
Negative market MTB	0.002	-0.021	-0.026	-0.029
	(0.006)	(0.031)	(0.031)	(0.050)
Market beta	-0.006***	-0.016*	-0.031***	0.012
	(0.002)	(0.009)	(0.008)	(0.017)
Momentum	0.017***	0.043***	0.057***	0.027
	(0.002)	(0.011)	(0.011)	(0.022)
Idiosyncratic risk	-0.034	0.288	-0.252	-1.980*
	(0.099)	(0.497)	(0.490)	(1.036)
Constant	-0.019	-0.226***	-0.485***	-0.367***
	(0.013)	(0.060)	(0.064)	(0.128)
Observations	3673	3264	3686	2189
Adjusted R^2	0.122	0.062	0.162	0.024

Note: All variables are defined as in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

effect of environmental performance on changes in sales forecasts. This means that revisions to analysts' sales forecasts are not affected by firm environmental performance.

Column 2 shows the results when the percentage change in EBIT forecasts is the dependent variable. We find that better environmental performance is associated with lower growth rates of EBIT forecasts. The stronger negative effect of the ESP index on changes in EBIT forecasts compared to the changes in sales forecasts suggests that firms with better environmental performance face higher costs. In a similar vein, we find a negative and significant relationship between *ESP index* and Δ *EPS forecast*. In fact, all things being equal, a one standard deviation increase in the ESP index is associated with about a one percentage point lower growth rate in EPS forecasts.

Taken together, our results indicate that changes in earnings forecasts are not driven by a significant drop in sales forecasts. Thus, in contrast to the customer channel (Lins et al., 2017), we found that global demand shock does not affect firms differently according to their environmental performance. Rather, our findings corroborate the hypothesis that, in times of crisis, the structure of environmental costs (Letmathe and Wagner, 2018) and the associated capital rental costs (Ee et al., 2018) penalise the forecasts of firms with high environmental performance. The negative relationship between environmental and market performance seems to be channelled through higher costs linked with environmental activities, in line with previous studies that highlighted the lower performance of some ethical business models when facing a sudden economic shock (Ashraf et al., 2022).

The evidence is further confirmed by taking into account the change in free cash flow per share forecasts (Column 4). As for earnings, the sharper reduction in future expected cash flows for firms with high ESP seems to justify their lower market performance during the crisis. Indeed, cash flow shortfalls meaningfully undermine firms' ability to invest and increase costs of accessing external capital (Minton and Schrand, 1999), lowering its overall growth expectations.

4.4. Industry-specific characteristics

In this section, we focus our analysis on the impact of some industry-specific features on the relationship between ESP, market returns and volatility. First, we consider the possible asymmetric effect of environmental performance according to the environmental intensity of the corresponding industry. Because the importance of sustainable criteria in investment processes has grown significantly in the past several years, firms in more polluting industries could have reacted differently to the COVID-19 market crash compared to those in cleaner sectors. Among the different industries, investors could price firm environmental performance differently, giving a higher value to better environmental practices in more polluting industries.

Following Banerjee et al. (2020), we split our sample into high and low environmentally intensive industries, considering industries with average levels of CO2 emissions per firm above the median as having high intensity. Columns 1 and 2 of Table 6 report the results for abnormal returns. The negative relationship between the ESP index and market returns obtained in the baseline results only holds

Table 6
The effect of industry-specific characteristics on market performance and volatility.

	Environment intensive industries				ESP industries			
	High Abnormal return	Low Abnormal return	High Volatility	Low Volatility	High Abnormal return	Low Abnormal return	High Volatility	Low Volatility
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ESP index	0.039	-0.081***	-0.006**	0.003*	-0.003	-0.059***	-0.001	0.001
	(0.034)	(0.019)	(0.003)	(0.002)	(0.036)	(0.019)	(0.003)	(0.002)
Size	0.006	0.027***	-0.002***	-0.003***	0.011*	0.024***	-0.002***	-0.003***
	(0.005)	(0.003)	(0.000)	(0.000)	(0.005)	(0.003)	(0.000)	(0.000)
Long-term debt	-0.101***	-0.131***	0.006*	0.014***	-0.084**	-0.129***	0.002	0.015***
	(0.036)	(0.023)	(0.004)	(0.002)	(0.040)	(0.022)	(0.004)	(0.002)
Short-term debt	0.028	0.007	-0.024**	-0.001	-0.069	0.074	-0.023***	-0.004
	(0.119)	(0.067)	(0.010)	(0.006)	(0.128)	(0.067)	(0.009)	(0.006)
Cash	0.040	0.063***	-0.013***	-0.004**	0.051	0.060***	-0.004	-0.006***
	(0.057)	(0.023)	(0.005)	(0.002)	(0.065)	(0.022)	(0.005)	(0.002)
Profitability	-0.063	0.066**	-0.011	-0.016***	-0.088	0.076**	-0.017*	-0.015***
	(0.071)	(0.033)	(0.008)	(0.003)	(0.083)	(0.033)	(0.009)	(0.003)
Market-to-book	0.004	0.002***	-0.000	0.000	0.001	0.003***	0.000	0.000
	(0.003)	(0.001)	(0.000)	(0.000)	(0.003)	(0.001)	(0.000)	(0.000)
Negative MTB	0.112**	0.075***	-0.005	0.003	0.014	0.100***	0.004	0.001
	(0.057)	(0.025)	(0.005)	(0.002)	(0.060)	(0.026)	(0.004)	(0.002)
Market beta	0.209***	0.242***	0.006***	0.004***	0.234***	0.228***	0.002***	0.005***
	(0.010)	(0.007)	(0.001)	(0.001)	(0.012)	(0.007)	(0.001)	(0.001)
Momentum	0.065***	0.022**	-0.007***	-0.002***	0.038**	0.033***	-0.005***	-0.003***
	(0.017)	(0.009)	(0.001)	(0.001)	(0.019)	(0.009)	(0.001)	(0.001)
Idiosyncratic risk	0.400	-0.307	0.300***	0.246***	-1.508**	0.436	0.402***	0.213***
	(0.480)	(0.402)	(0.053)	(0.034)	(0.604)	(0.362)	(0.058)	(0.033)
Constant	-0.324***	-0.649***	0.070***	0.079***	-0.382***	-0.608***	0.069***	0.079***
	(0.072)	(0.059)	(0.006)	(0.004)	(0.079)	(0.057)	(0.007)	(0.004)
Observations	1143	2711	1143	2711	921	2933	921	2933
Adjusted R^2	0.400	0.504	0.624	0.490	0.397	0.491	0.525	0.532

Note: *High (low)environment intensive industries* refers to the sub-sample of industries with an average firm level of CO2 emission volumes scaled by total assets above (below) the median. *High (low) ESP industries* refers to the sub-sample of industries with an average *ESP index* above (below) the median. All the other variables are defined as in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

for low intensity industries, where a one standard deviation increase in the ESP index is associated with returns that are lower by about 1.75% points. Conversely, in high intensity industries, we find an insignificant effect of firm ESP on market performance.

In Columns 3 and 4, we re-run the analysis using realised volatility as a dependent variable. Interestingly, we find that better environmental performance is associated with lower firm volatility in high intensity industries. Conversely, in line with the results for abnormal returns, estimates for firms in low intensity industries reveal a positive relationship between firm ESP and volatility.

In Columns 5 and 6 of Table 6, we repeat the same exercise, splitting the industries according to their average ESP index. Among firms in high ESP industries, better environmental performance does not have an impact on the market reaction during the crisis period. The difference in returns associated with an increase in the ESP index is negligible. We find a negative relationship between firm ESP and returns, contrary to the hypothesis that in low ESP industries better environmental practices can be positively priced by investors.

Finally, the results reported in Columns 7 and 8 indicate that the effect of the ESP index on firm volatility is similar between industries with high and low average environmental performance. Indeed, firm environmental performance is not significantly related to volatility in either of the sub-samples.

4.5. The country-specific impact of COVID-19

In this section, we test whether the country-specific impact of the COVID-19 outbreak and the corresponding policy responses undertaken by governments could have affected the relationship between firm ESP, market performance and volatility differently. Since the severity of the COVID-19 spread and the range of measures aimed to contain both the health and economic crises were strongly heterogeneous among countries (Hale et al., 2020), in this further analysis, we explicitly take into account the strength of the health crisis and the scale of the economic support to households from a country-level perspective.

We use the cumulative number of COVID-19 related deaths up to March 20 as a proxy for the severity of the health crisis in the countries in our sample.[11] Compared to the number of infections, the confirmed number of deaths is less affected by bias caused by strong cross-country heterogeneity in testing the population. We split the sample into countries with the number of deaths above and below the median. We expect that a deeper health crisis is associated with higher economic uncertainty, strengthening the negative

[11] Source: European Centre for Disease Prevention and Control (ECDC).

relationship between ESP and stock returns. Columns 1 and 2 of Table 7 show the results for firms' abnormal returns. In line with our hypothesis, the coefficient of ESP for the sub-sample of countries strongly affected by the pandemic is negative and statistically significant. Conversely, the coefficient estimated on the sub-sample of less affected countries, although similar in size, is not statistically different from zero. Estimates for realised volatility are reported in Columns 3 and 4. In line with the baseline results, the coefficient of the ESP index is small and not statistically significant for both sub-samples, suggesting that the neutral impact of firm ESP on volatility does not depend on the severity of the health crisis.

Next, we test whether the supportive economic measures undertaken by governments affect the relationship between ESP, market performance and volatility. Stronger responses aimed at supporting the economy are essential in relieving the economic downturn caused by the health crisis and uncertainty about future perspectives.

We use the *economic support index* provided by Hale et al. (2020) to measure the country-specific economic response to COVID-19.[12] As a component of the Oxford COVID-19 Government Response Tracker (OxCGRT), the *economic support index* provides information about income support policies and financial obligation reliefs for households. The index is calculated by adding all ordinal economic policy indicators together and rescaling by its maximum value. Although it does not encompass the support to firms and the total fiscal value of the economic policies, the index has the advantage of providing an efficient measure that facilitates cross-country comparisons of government interventions. The use of monetary values can indeed be biased due to the kind of measures used, the implementation of which can be conditional on specific circumstances, as in the case of loan guarantees, which can thus be considered differently in different countries. [13]

We split our sample by the *economic support index*, with values above (below) the median, indicating a group of countries with stronger (weaker) economic interventions. The findings for abnormal returns, reported in Columns 5 and 6 of Table 7, corroborate our view that the range of public intervention matters. According to our baseline results, in countries with lower economic intervention, the market crash is significantly more severe for firms with better environmental performance. Conversely, ESP has no significant impact on firm performance in countries with higher economic support. Similarly, we find no difference in the relationship between firm ESP and volatility according to country-specific economic support (Columns 7 and 8).

Taken together, the results for abnormal returns are consistent with our main hypothesis that demand side shock in a crisis is stronger for high ESP firms. The various public interventions aimed at alleviating the economic constraints caused by the COVID-19 crisis are crucial for reducing the drop in aggregate demand, whose effect, due to the structural costs of environmental activities (Henri et al., 2016), is stronger for high ESP firms.

4.6. The medium-term impact of ESP

Starting in mid-March 2020, policymakers worldwide adopted a wide range of measures, which fed investors' confidence (Seven & Yilmaz, 2021). As a result, stock markets gradually recovered losses accumulated during the pandemic outbreak.

Thus far, our analysis has focused on the short-term market reaction to the COVID-19 outbreak. However, the improved economic perspectives, the focus of supporting plans on a transition towards a greener and digitalised economy in many countries (Garel and Petit-Romec, 2021) and the overall market rebound may justify the outperformance of firms, such as those with better environmental performance, most penalised by a wave of strong uncertainty.

To shed light on the medium-term market dynamic around the COVID-19 crisis, we complement our analysis by investigating the relationship between ESP, market performance and volatility for the whole of 2020 and for the post-COVID-19 period (i.e. from March 23 to December 31).

Table 8 reports the results. Column 1 shows the estimates when the abnormal return for 2020 is the dependent variable. In line with our main findings, we find a negative and significant relationship between firm ESP and market performance. This suggests that the underperformance characterising high ESP firms during the pandemic was not compensated for by a stronger rebound in the following bull market phase. According to this view, results using abnormal returns in the post-COVID-19 period confirm that firm ESP did not affect market performance in the recovery period (Column 2).

Column 3 reports the results for the volatility realised in 2020. The estimated ESP index coefficient is not statistically significant, suggesting that high ESP firms were not characterised by lower risk. In Column 4, we repeat the same analysis for the volatility realised in the post-COVID-19 period. We find that firms with better environmental performance had higher volatility.

In summary, the analysis of the medium-term impact of firm ESP corroborates our baseline results. Indeed, our findings show that investors did not reward high ESP firms in the market rebound after the market turmoil caused by the COVID-19 outbreak.

4.7. Robustness checks

To assess the robustness of our results, we perform several additional tests. First, we checked the validity of our results by using the Refinitiv Asset4 environmental score as an alternative measure of firm environmental performance. By construction, the Refinitiv ESP

[12] We consider the country-specific indexes at March 20.

[13] We also test whether this relationship is influenced by country-specific lockdown measures aimed at curbing the health crisis, considering the stringency index provided by Hale et al. (2020). The two sub-samples obtained by splitting the sample into high versus low stringency index countries, and thus the results, are very similar to the ones concerning the economic support. For the sake of space, we only report the results for the *economic support index*.

Table 7
The effect of country-specific COVID-19 crisis on market performance and volatility.

	COVID-19 deaths				Economic support			
	High Abnormal return	Low Abnormal return	High Volatility	Low Volatility	High Abnormal return	Low Abnormal return	High Volatility	Low Volatility
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ESP index	-0.046**	-0.059	0.000	0.002	0.017	-0.060***	0.001	0.000
	(0.018)	(0.043)	(0.002)	(0.003)	(0.039)	(0.019)	(0.004)	(0.001)
Size	0.021***	0.022***	-0.003***	-0.002***	0.017***	0.022***	-0.002***	-0.003***
	(0.003)	(0.006)	(0.000)	(0.000)	(0.006)	(0.003)	(0.000)	(0.000)
Long-term debt	-0.130***	-0.060	0.013***	0.006	-0.075*	-0.137***	0.017***	0.010***
	(0.022)	(0.045)	(0.002)	(0.004)	(0.040)	(0.022)	(0.004)	(0.002)
Short-term debt	0.058	0.023	-0.008	-0.003	0.149	0.016	0.000	-0.011**
	(0.066)	(0.125)	(0.006)	(0.010)	(0.134)	(0.064)	(0.014)	(0.005)
Cash	0.063***	0.026	-0.008***	-0.003	0.029	0.056**	0.002	-0.008***
	(0.023)	(0.048)	(0.002)	(0.004)	(0.051)	(0.023)	(0.005)	(0.002)
Profitability	0.064*	0.021	-0.016***	-0.014**	0.010	0.054*	-0.021**	-0.014***
	(0.034)	(0.058)	(0.003)	(0.006)	(0.092)	(0.032)	(0.010)	(0.003)
Market-to-book	0.003***	0.003	0.000	0.000**	0.003	0.003***	-0.000	0.000**
	(0.001)	(0.003)	(0.000)	(0.000)	(0.002)	(0.001)	(0.000)	(0.000)
Negative MTB	0.077***	0.180**	0.001	0.001	-0.011	0.110***	-0.002	0.003
	(0.025)	(0.075)	(0.002)	(0.008)	(0.039)	(0.027)	(0.004)	(0.002)
Market beta	0.232***	0.227***	0.005***	0.004***	0.218***	0.235***	0.004***	0.005***
	(0.007)	(0.011)	(0.001)	(0.001)	(0.012)	(0.007)	(0.001)	(0.001)
Momentum	0.030***	0.052***	-0.004***	-0.002	0.090***	0.023***	-0.002	-0.004***
	(0.009)	(0.017)	(0.001)	(0.001)	(0.021)	(0.009)	(0.002)	(0.001)
Idiosyncratic risk	0.069	0.116	0.236***	0.250***	0.556	0.016	0.364***	0.227***
	(0.384)	(0.529)	(0.034)	(0.051)	(0.736)	(0.340)	(0.085)	(0.030)
Constant	-0.550***	-0.491***	0.074***	0.066***	-0.458***	-0.619***	0.061***	0.077***
	(0.043)	(0.083)	(0.004)	(0.006)	(0.082)	(0.039)	(0.007)	(0.003)
Observations	3023	831	3023	831	889	2965	889	2965
Adjusted R^2	0.454	0.502	0.561	0.473	0.452	0.472	0.450	0.567

Note: *High (low)COVID-19 deaths* refers to the sub-sample of countries with a cumulative number of deaths related to COVID-19 above (below) the median. *High (low) economic support* refers to the sub-sample of countries with an *economic support index* above (below) the median. For both variables, we take the corresponding values at March 20, 2020. All the variables are defined as in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

index has a range from 0 to 100, where higher values mean a higher environmentally friendly performance.[14] Columns 1 and 2 in Table 9 show the findings. According to our baseline results, firms with higher Asset4 environmental scores are characterised by significantly lower returns. By contrast, estimates for realised volatility confirm the insignificant effect of firm ESP on market risk.

Next, because U.S. firms represent roughly 47% of our sample, in Columns 3 and 4 of Table 9, we re-estimate Equation [1], excluding U.S. firms. Despite their significant weight, this additional test confirms that the negative relationship between ESP and stock market performance is not driven by the U.S. market. Interestingly, the increase in the magnitude of the *ESP index* coefficient suggests that the relationship is even stronger in other developed countries. Similarly, the results for realised volatility confirm the insignificant effect of firm ESP.

During the COVID-19 pandemic spread, the weak demand and frictions among oil producer countries caused a severe drop in oil prices, with the WTI crude price going negative for the first time in history. Because the stock prices of oil and gas firms are the most affected by oil price movements, we re-estimate our baseline specification excluding firms in the fossil fuel industry. This further test allows us to check whether our results are driven by geopolitical factors related to oil production rather than by COVID-19 uncertainty. The results, reported in Columns 5 and 6, confirm our previous evidence for both market performance and volatility. The negative relationship between the ESP index and stock returns is not sensitive to the oil price shock, supporting our overall results regarding the impact of the strong uncertainty related to the COVID-19 spread.

Our results are robust also to different measures of market returns. In Columns 7 and 8 of Table 9, we replace the main dependent variables used in the baseline specification with two different measures: raw buy-and-hold returns and abnormal cumulative returns from a daily market model computed using daily log returns from January to December 2019.

5. Conclusion

Most stock markets around the world experienced unexpected severe downturns and jumps in volatility during the spread of the COVID-19 pandemic. Our paper provides evidence of how investors gauge firm environmental performance. Our findings show a negative relationship between firm ESP and market returns during the period from January 2 to March 20. In particular, we found that firms with higher ESP realised significantly lower returns when COVID-19 started to spread globally (i.e. in the fever period).

[14] For consistency with the measure used in previous sections, we divide the Refinitiv ESP index by 100.

Table 8
The medium-term impact of ESP index.

	Abnormal return 2020	Abnormal return post-COVID	Volatility 2020	Volatility post-COVID
	(1)	(2)	(3)	(4)
ESP index	-0.092*	-0.050	0.002	0.002**
	(0.050)	(0.089)	(0.001)	(0.001)
Size	0.003	-0.068***	-0.003***	-0.003***
	(0.008)	(0.014)	(0.000)	(0.000)
Long-term debt	-0.244***	0.150	0.010***	0.009***
	(0.062)	(0.117)	(0.002)	(0.002)
Short-term debt	0.275	0.229	0.000	0.004
	(0.198)	(0.347)	(0.005)	(0.005)
Cash	0.108	-0.212*	-0.005***	-0.004**
	(0.074)	(0.117)	(0.002)	(0.002)
Profitability	-0.220*	-0.553***	-0.015***	-0.014***
	(0.115)	(0.191)	(0.002)	(0.003)
Market-to-book	0.010***	0.009**	0.000	0.000
	(0.003)	(0.004)	(0.000)	(0.000)
Negative MTB	0.291***	0.283*	0.003	0.003
	(0.077)	(0.147)	(0.002)	(0.002)
Market beta	-0.139***	-0.368***	0.004***	0.004***
	(0.020)	(0.038)	(0.000)	(0.000)
Momentum	0.122***	0.097*	-0.006***	-0.007***
	(0.031)	(0.051)	(0.001)	(0.001)
Idiosyncratic risk	3.258***	5.720***	0.296***	0.304***
	(1.133)	(1.978)	(0.030)	(0.032)
Constant	0.209	1.500***	0.070***	0.067***
	(0.133)	(0.209)	(0.003)	(0.003)
Observations	3765	3765	3765	3765
Adjusted R^2	0.137	0.139	0.566	0.544

Note: All the variables are defined as in the Table A.2. Robust standard errors are in parentheses. All estimates are obtained using industry and country fixed-effects. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

Table 9
Robustness checks.

	Abnormal return	Volatility	Abnormal return	Volatility	Abnormal return	Volatility	Raw return	Abnormal cumulative return
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Environmental score	-0.026**	0.000						
	(0.012)	(0.001)						
ESP index			-0.081 * **	-0.001	-0.065 * **	0.001	-0.039 * *	-0.052 *
			(0.022)	(0.002)	(0.017)	(0.001)	(0.016)	(0.029)
Size	0.021***	-0.003***	0.024 * **	-0.002 * **	0.025 * **	-0.003 * **	0.021 * **	0.050 * **
	(0.003)	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.002)	(0.004)
Long-term debt	-0.120***	0.011***	-0.092 * **	0.009 * **	-0.129 * **	0.011 * **	-0.126 * **	-0.251 * **
	(0.019)	(0.002)	(0.028)	(0.002)	(0.020)	(0.002)	(0.020)	(0.036)
Short-term debt	0.043	-0.008*	0.128	-0.011 *	0.012	-0.006	0.055	0.059
	(0.058)	(0.005)	(0.078)	(0.007)	(0.060)	(0.005)	(0.059)	(0.107)
Cash	0.061***	-0.007***	0.023	0.000	0.056 * **	-0.006 * **	0.065 * **	0.180 * **
	(0.021)	(0.002)	(0.029)	(0.002)	(0.021)	(0.002)	(0.021)	(0.036)
Profitability	0.051*	-0.015***	0.013	-0.012 * *	0.037	-0.015 * **	0.055 *	0.124 * *
	(0.030)	(0.003)	(0.047)	(0.005)	(0.030)	(0.003)	(0.031)	(0.052)
Market-to-book	0.003***	0.000	0.002 *	0.000	0.002 * **	0.000	0.002 * **	0.004 * **
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Negative MTB	0.083***	0.002	0.052	0.000	0.072 * **	0.003 *	0.078 * **	0.125 * **
	(0.023)	(0.002)	(0.036)	(0.003)	(0.023)	(0.002)	(0.024)	(0.045)
Market beta	0.229***	0.005***	0.206 * **	0.004 * **	0.240 * **	0.003 * **	-0.062 * **	0.012
	(0.006)	(0.001)	(0.008)	(0.001)	(0.006)	(0.001)	(0.006)	(0.011)
Momentum	0.035***	-0.003***	0.051 * **	-0.001	0.028 * **	-0.002 * **	0.022 * **	0.028 *
	(0.008)	(0.001)	(0.012)	(0.001)	(0.008)	(0.001)	(0.008)	(0.015)
Idiosyncratic risk	0.114	0.254***	0.052	0.313 * **	-0.461	0.275 * **	0.017	0.724
	(0.310)	(0.029)	(0.452)	(0.045)	(0.327)	(0.029)	(0.298)	(0.561)
Constant	-0.496***	0.074***	-0.502 * **	0.058 * **	-0.530 * **	0.075 * **	-0.588 * **	-0.838 * **
	(0.046)	(0.004)	(0.055)	(0.004)	(0.047)	(0.004)	(0.043)	(0.077)
Observations	3854	3854	2051	2051	3582	3582	3854	3853
Adjusted R^2	0.469	0.540	0.432	0.491	0.482	0.500	0.345	0.286

Note: All the variables are defined as in the Table A.2. Robust standard errors are in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

Furthermore, firm ESP are not significantly related to volatility in the entire COVID-19 period. We found a positive relationship between firm ESP and volatility during the incubation and outbreak periods only.

The more severe drop in profitability and cash flow forecasts caused by the extreme uncertainty related to the COVID-19 pandemic justifies the negative relationship between firm ESP and returns. While the effect on the change in sales forecasts is negligible, we found a larger decrease in earnings and cash flow forecasts for firms with higher ESP. Taken together, our results favour the hypothesis that the structure of environmental costs and the associated capital rental costs more greatly affect the forecasts of high ESP firms in the short run.

We also find that the spread of COVID-19 produces a heterogeneous impact on the relationship between environmental performance, returns and volatility: the effect is stronger for high ESP firms in environmentally intense and lower environmentally rated industries and in countries where the support to relieve the economic crisis is lower. In addition, our study provides evidence of a positive relationship between firm ESP and volatility in environmentally intensive industries. By contrast, volatility is lower for high ESP firms in less environmentally intensive industries.

The analysis of the medium-term impact of the ESP index confirms the negative relationship between firm environmental performance and returns, even when considering the whole of 2020. Conversely, high ESP firms had higher volatility in the post-COVID-19 period.

Overall, our research suggests that, during the unexpected COVID-19 outbreak, firm environmental performance did not pay off, contrary to crises associated with distrust (e.g. global financial crisis).

This study advances the debate about the effects of firm environmental performance on stock returns and volatility during the COVID-19 crisis (Garel and Petit-Romec, 2021). We provide evidence that the negative relationship between firm ESP and market returns is channelled through higher costs related to environmental initiatives. This is in line with Ashraf et al. (2022), who highlight the lower performance of some ethical business models when facing a sudden economic shock.

This study also provides implications for investors. Environmental performance did not immunise against market meltdown; rather, during downturns, high ESP firms exacerbated market movements. This makes them unsuitable for diversification and protection from general market turmoil.

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Declaration of Competing Interest

None of the authors have a conflict of interest to disclose. The authors have no competing interests to declare that are relevant to the content of this article.

Data availability

The authors do not have permission to share data.

Appendix

Table A.1
Sample description.

Country	N.	Percentage	Cumulative percentage
Australia	266	6.90%	6.90%
Austria	24	0.62%	7.52%
Belgium	36	0.93%	8.46%
Canada	226	5.86%	14.32%
Denmark	35	0.91%	15.23%
Finland	33	0.86%	16.09%
France	131	3.40%	19.49%
Germany	140	3.63%	23.12%
Greece	17	0.44%	23.56%
Ireland	34	0.88%	24.44%
Italy	65	1.69%	26.13%
Japan	376	9.76%	35.88%
Netherland	51	1.32%	37.21%
New Zealand	40	1.04%	38.25%
Norway	37	0.96%	39.21%
Portugal	14	0.36%	39.57%
Spain	52	1.35%	40.92%

(*continued on next page*)

Table A.1 (*continued*)

Country	N.	Percentage	Cumulative percentage
Sweden	105	2.72%	43.64%
Switzerland	103	2.67%	46.32%
United Kingdom	266	6.90%	53.22%
United States	1803	46.78%	100.00%
Total	3854	100.00	

Table A.2
Definitions of variables.

Variable name	Variable definition
Abnormal return	Market model-adjusted return computed over the previous 60 monthly returns, ending in December 2019 and using the country-specific MSCI index as the market proxy.
Raw return	Firm's buy-and-hold return.
Abnormal cumulative return	Sum of the firm's daily abnormal returns, computed as the difference between the daily log return and the corresponding expected return obtained from a daily market model from January to December 2019.
Volatility	Standard deviation of daily returns.
ESP index	Environmentally Sustainable Index computed using the firm-specific 61 environmental specific indicators provided by ASSET4.
Resource use	Firm-specific resource use score calculated as the ESP index.
Product innovation	Firm-specific product innovation score calculated as the ESP index.
Emission reduction	Firm-specific emission reduction score calculated as the ESP index.
Asset4 Environmental score	Asset4 Environmental score.
Size	Logarithm of market capitalization, measure in thousands of US dollars.
Long-term debt	Long-term debt-to-total assets ratio.
Short-term debt	Debt in current liabilities-to- total assets ratio.
Cash	Cash and marketable securities-to- total assets ratio.
Profitability	Operating income-to-total assets.
Market-to-book	Market value of equity-to- book value of equity.
Negative MT	Dummy variable equal to one if market-to-book is negative and 0 otherwise.
Market beta	Firm-specific market beta computed through CAPM model based on the previous 60 monthly returns starting, from December 2019.
Momentum	Raw return from January to December 2019.
Idiosyncratic risk	Residual variance from a market model estimated from the previous 60 monthly returns, ending in December 2019.
Δ Sales forecasts	Percentage change between the sales forecasts for the next fiscal year end at the beginning of the quarter and the forecast at the end of first quarter 2020.
Δ EBIT forecasts	Percentage change between the EBIT forecast before interest and taxes forecasts for the next fiscal year end at the beginning of the quarter and the forecast at the end of first quarter 2020.
Δ EPS forecasts	Percentage change between the earnings per share forecasts for the next fiscal year end at the beginning of the quarter and the forecast at the end of first quarter 2020.
Δ FCF forecasts	Percentage change between the free cash flows forecasts for the next fiscal year end made at the beginning of the quarter and the forecast at the end of first quarter 2020.

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