A causal analysis of environmental and financial performance: Differences between brown and green firms

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Abstract

This study investigates the two-way relationship between corporate environmental performance (EP) and corporate financial performance (FP). The relationship between EP and FP remains ambiguous after decades of study. To contribute to the ongoing debate, we estimate a system of dynamic equations simultaneously by deploying structural equation modeling (SEM). The study employs annual data on all constituents of the S&P 500 index from 2011 to 2020 retrieved from Bloomberg and Refinitiv. In contrast to most literature, this study conclusively finds that FP affects EP only for a subset of firms (brown firms) while the effect of EP on FP differs across model specifications, measures of FP, or sectors, rendering the effect inconclusive. Further, the findings reveal that environmental expenditures entirely moderate the effect of FP on EP. The study concludes that FP boosts EP in brown firms only when environmental expenses are incurred.

Keywords: Simultaneous Equation Modeling, Environmental Pillar Score, Return on Assets, Environmental Disclosure Score

JEL: Q56, M14, G32, C33

1. Introduction

The world is starting to realize the environmental consequences of conducting business as usual. Regulators and policy makers are, therefore placing more and more stringent pollution abatement requirements on businesses. In the past few decades, the Environmental Protection Agency (EPA) has regulated more than 174 major industrial sources of air toxics, including chemical plants, oil refineries, aerospace manufacturers, and steel mills. Between 1999 and 2011, a number of these regulations became effective. It is expected that these standards will reduce annual toxic emissions by about 1.7 million tons when they are fully implemented. These policies require businesses to invest in pollution abatement technology to reduce their emissions. This seems to be at odds with the idea of profit-making – the primary reason why businesses exist.

Yet some businesses are going above and beyond the regulatory requirements to improve their environmental performance or reduce toxic emissions. There are several reasons for this. First, investment in pollution abatement enhances operational efficiency leading to improved profits. Pollution can be seen as a waste of resources (such as raw materials and energy). Thus, Porter (1991) suggests that investments made to comply with environmental regulations and policies may lead to a reduction in such wastage and cause an increase in profits so much so that they end up compensating for the compliance costs incurred for waste disposal. Second, when investors have a preference for green products as Pástor et al. (2022) find, firms selling these products will see an increase in their profits, and thereby, an increase in their asset prices. Third, socially responsible investments (such as investment in pollution abatement) can reduce the cost of capital for businesses, as the findings of Heal (2005) indicate. Finally, Feldman et al. (1997) observe that firms that make investments to improve their environmental performance signal that they are better protected against other risks such as regulatory or legislation non-compliance. As a result, compliant firms are more trusted by stakeholders when compared to their non-compliant counterparts. All these reasons support the view that investments in environmental performance (EP) are conducive to enhanced financial performance (FP), defying the traditionalist view of EP where EP is seen as a mere cost that only contributes to deteriorating firm profit margins.

The majority of the literature is devoted to explaining the direction of the impact of EP on FP i.e. the papers either side with Porter's hypothesis and conclude that EP impacts FP positively (Hart and Ahuja, 1996; King and Lenox, 2002; Konar and Cohen, 2001) or they conclude that EP affects FP negatively thereby providing evidence for the traditionalist view (Wagner et al., 2002; Lu and Taylor, 2018). Some researchers also find that there exists no relationship between both (Aras et al., 2010).

Several meta-analytic studies have attempted to reconcile these inconsistencies in the literature. Horváthová (2010) finds that factors such as the empirical method employed, the measure of financial performance or the time covered by the study affect the nexus between EP and FP. Dixon-Fowler et al. (2013) find that small firms gain more from improving EP compared to large firms, that US firms benefit more than their international counterparts from improving EP, and that EP has more influence on market-based measures than on accounting-based measures of FP. Albertini (2013) finds that the EP-FP relationship is stronger when EP is measured by Environmental Management variables (EMVs) that indicate firms' attitude towards environmental responsibility. Employing instead Environmental Performance variables (EPVs) or Environmental Disclosure variables (EDVs), which measure the environmental outcomes, as measures of EP produces weaker EP-FP associations. Albertini (2013) further highlights that the EP-FP relationship appears stronger when FP is measured using accounting-based measures (relative to market-based measures), and in non-longitudinal analyses (when compared to longitudinal ones).

The literature took an interesting turn when Waddock and Graves (1997) found that improving EP can be contingent upon firms' FP. Their results substantiated the slack resource theory according to which firms with slack resources (potentially available because of better financial performance) may be in a better position to invest in EP. While the research investigating the impact of FP on EP is still scant, some studies have made an attempt at exploring the bi-directional relationship between both (Al-Tuwaijri et al., 2004; Lu and Taylor, 2018; Liu, 2020).

A number of studies have delved into exploring the role of moderators in influencing the EP-FP nexus. Some examples of such moderators include competitive advantage, an industry's environmental risk, and the role of corporate brand and financial constraints (López-Gamero et al., 2009; Semenova and Hassel, 2016; Rahman, 2023). The importance of the sector of activity or the industry membership of a firm as a potential moderator in the EP-FP relationship has been highlighted by Dixon-Fowler et al. (2013). Lucas and Noordewier (2016) or Liu (2020) find that there exists inter-industry differences in the impact of EP on FP. However, the possibility that there could also be differences in the impact of FP on EP across industries is left unexplored. This is where the primary contribution of our paper lies. We posit that both the impact of EP on FP and of FP on EP could differ depending on the industry/sector to which the company belongs.

Overall, in the literature to this date, the effect of corporate environmental performance (EP) on the corporate financial performance/profitability (FP) has been studied extensively. Most recent studies find that EP positively affects FP (Temiz, 2022; Chen et al., 2023). However, this relationship may be biased as there also exists evidence pointing out the prevalence of an opposite causal relationship i.e. corporate financial performance affecting corporate environmental performance. It is also intuitively plausible that the financial performance of a firm enables it to have enough slack to have the ability to invest in improving its environmental performance. If this bi-directional nature of the relationship is not taken into account to model the EP-FP relationship, then the results obtained in most of the prior literature in this area may present a biased and an incomplete picture of the actual relationship between EP and FP.

Owing to this rationale, in this paper, we posit that the availability of slack (proxied by FP) affects the capability of companies to invest in their environmental management practices (proxied by EP), and improved EP results in developing capabilities that may lead to higher efficiency and therefore, better FP. Considering this mechanism of two-way effects, the EP-FP relationship is postulated to be bi-directional and must be estimated as such in order to give a complete and unbiased picture of the EP-FP relationship.

Additionally, we model this relationship separately for brown (heavily polluting) and green (relatively less polluting) sectors. This is done because heavy-emitters differ from light-emitters in their characteristics such as nature of operations and emissions intensity. Gull et al. (2022) and Van Hoang et al. (2023) point out that the sector to which a company belongs significantly affects its commitment towards sustainability development goals. Carbon control policy (which varies greatly across industries) is also found to negatively affect the ESG performance of firms (Shu and Tan, 2023). Companies operating in sectors that pollute more are also more likely to be subject to more stringent regulations corresponding to higher environmental compliance costs. Qian et al. (2023) find that government inspection (which are more likely to be carried out in polluting industries) has a pronounced influence on the environmental investments of a firm. These differences between brown and green companies may result in different levels of proactiveness in investing in environmental practices (FP $\rightarrow$ EP). These differences also affect the response of FP to changes in EP. Hence, how FP affects EP may be different for brown companies compared to their green counterparts (EP $\rightarrow$ FP). Finally, we include the lagged values of both FP and EP in the model specification (to control for the strong persistence in the dynamics of FP and EP).

This bi-directional relationship is modeled with the novel structural equation modeling (SEM) approach. SEM estimates the equations in a system of equations simultaneously. SEM enables modeling the EP-FP relationship while taking care of the endogeneity resulting from simultaneity. We establish a causal relationship by controlling for the endogeneity using instrumental variables for both the endogenous variables (EP and FP) in the system of equations that we estimate.

To the best of our knowledge, this is the first dynamic longitudinal study of the EP-FP bi-directional relationship that distinguishes between clean (green) and dirty (brown) sectors. For the effective formulation of policies, it is important to allow for differences in the EP-FP relationship between green and brown firms, because the decisions to (i) adopt pro-environmental measures to become greener (captured by the impact of financial performance on environmental performance) and (ii) reap the economic benefits of becoming greener (captured by the impact of environmental performance on financial performance) are intertwined. Therefore, the separate analysis of the two-way EP-FP relationship enables a better understanding of inter-industry differences than imposing a one-way impact of EP on FP across industries (Iwata and Okada, 2011; Liu, 2020), allowing regulators to design sector-specific incentive policies, which depend not only on the financial benefits accruing from improvements in environmental performance but also on the environmental efforts in response to improvements in financial performance.

By exploiting the outlined methodology to estimate the bi-directional relationship between EP and FP for green and brown sectors separately, we find that only firms in brown sectors improve their EP upon experiencing an improvement in FP. This result is robust across different model specifications, estimation methods, and alternate measures of FP and EP. Therefore, we find conclusively that FP affects EP only for a subset of firms (brown firms) while the effect of EP on FP depends on the model specifications, measure of FP, and sector. Our results attest to the slack resource theory originally proposed by Waddock and Graves (1997) but only for a subset of firms (brown firms). The results also substantiate the theory put forward by Palmer et al. (1995). They argue that generalizing a positive impact of EP on FP is not appropriate. They assert that the positive impact of EP on FP may only exist for some firms depending upon their internal capabilities. Given this, a more directed approach to regulation is advisable as it would be better aligned with achieving win-win results for businesses and the environment.

The rest of the paper is organized as follows: Section 2 reviews the relevant literature; Section 3 provides a description of the data used and variables constructed; Section 4 specifies the research methodology adopted; Section 5 reports and discusses empirical findings; Section 6 reports robustness checks results, and Section 7 concludes, highlighting the main contribution and discussing future avenues for research.

2. Literature review

2.1. Theoretical foundations

As per the traditional economic rationale, EP bears a negative impact on FP. Friedman (1970) argued that investments in corporate social responsibility (CSR) activities are wasteful expenditures that reduce the returns to the business stakeholders. Porter (1991) and Porter and Linde (1995) were amongst the first to challenge this negative view of environmental performance. They argue that carefully crafted environmental regulation can provide a boost to a country's competitiveness by promoting innovation that leads to lower costs. They discuss several cases where such 'innovation offsets' end up exceeding the cost of compliance. This has been termed in the literature as 'Porter's hypothesis'. A large body of literature and multiple theories discuss how enhancing environmental performance can be a win-win situation where environmental harm is curbed and firms benefit in the form of better financial performance (Porter and Van der Linde, 1995; King and Lenox, 2002; Hart and Ahuja, 1996).

Wernerfelt (1984) puts forward the resource-based view according to which a firm can uphold its competitive advantage only if the capabilities creating that advantage are backed by resources that cannot be easily imitated by its competitors. This view is taken one step forward by Hart (1995) who explores the interconnectedness of pollution prevention, product stewardship, and sustainable development. As per the natural resource-based view proposed by Hart (1995), a firm's capability to cope with the complexities posed by the natural environment enables the development of costly-to-copy resources and capabilities. Such capabilities and resources lead to an improved competitive advantage and a better reputation. The resulting improvements from better environmental management strategies can enhance financial performance (Hart and Dowell, 2011).

Instrumental stakeholder theory also provides a rationale for the win-win argument behind the positive association between EP and FP. The instrumental stakeholder theory states that firms employ various strategies to establish a good relationship with their stakeholders which in turn helps firms improve financial performance (Jones, 1995). Slack resource theory, as discussed earlier, suggests that firms with better financial performance may possess the required 'slack' to invest in socially responsible actions (Waddock and Graves, 1997). While most of the literature explores how EP affects FP, a subset of the literature has also investigated whether more profitable firms invest more in environmental performance (Al-Tuwaijri et al., 2004; Semenova and Hassel, 2016; Liu, 2020). Combining the evidence for the existence of a bi-directional relationship between EP and FP as suggested by the aforementioned theories and literature, we model the EP-FP nexus using a system of equations where both EP and FP are endogenous.

2.2. Factors affecting the EP-FP nexus

The heterogeneous results pertaining to the EP-FP nexus reported in the literature can be attributed to moderators (Dixon-Fowler et al., 2013). Bissoondoyal-Bheenick et al. (2023) highlight the importance of size and media channels as moderators in the relationship between ESG and firm performance measured by Tobin's Q ratio. Alexopoulos et al. (2018)'s findings indicate that firm-specific and market-related characteristics such as societal, cultural and institutional settings impact the linkage between EP and FP. These factors lead to a negative impact of EP on FP, suggesting that there are no economic benefits for firms that actively engage in reducing their energy consumption. Dal Maso et al. (2018) demonstrate that stakeholder prioritization and engagement jointly strengthen the EP-FP relationship. López-Gamero et al. (2009) show that firms recognized as earlier environmental performers adopt more proactive environmental management practices, which in turn translate into better financial performance i.e. becoming a relatively more environmentally proactive firm earlier leads to better financial outcomes. They also show that the impact of environmental protection on environmental performance is positive and that it depends on the sector under consideration.

Nakao et al. (2007) argue that since there are many dimensions of environmental and financial performance of firms, concluding on a positive two-way relationship between environmental and financial performance is not appropriate (mostly due to potential omitted variable bias). So, they compare various dimensions of top-scoring firms (from an environmental management survey) before drawing conclusions regarding the direction of the EP-FP relationship. Iwata and Okada (2011) study the effect of improving environmental performance on the financial performance of Japanese clean and dirty manufacturing industries. They find that the financial impact of improving environmental performance is different for clean and dirty industries. Bissoondoyal-Bheenick et al. (2023) also find that the impact of ESG on FP varies across different industry sectors. Semenova and Hassel (2016) include the industry's environmental risk and environmental policy as a variable in their model that determines the relationship between FP and EP. Qi et al. (2014) show that industry-level environmental performance positively impacts a firm's financial performance. Lucas and Noordewier (2016) explore industry pollution-related factors as moderators in the relationship between FP and EP. These authors find that relatively dirty and non-proactive industries benefit more (in terms of improved financial performance) from engaging in environmental management practices.

Most of the literature that addresses the bi-directional relationship between EP and FP has predominantly relied on cross-sectional data sets (Al-Tuwaijri et al., 2004; Lucas and Noordewier, 2016; Lu and Taylor, 2018). Albertini (2013) highlights that the EP-FP relationship appears stronger in non-longitudinal studies. Liu (2020) exploits longitudinal data and addresses the issue of reverse causality by employing a cross-lagged model. There, it is acknowledged that the relationship between EP and FP can be different for firms operating in 'dirty' industries relative to firms operating in 'clean' ones. The rationale behind this hypothesis is that as industries vary in their industrial configurations and structures, their performance response to better environmental management strategies may differ. The reported findings support a heterogeneous impact across industries of EP on FP, but that FP has a positive mean effect on EP.

Lucas and Noordewier (2016) state that the 'technical environment' of a particular industry will bear an impact on the amount of pollution created in an industry. Industries that pollute more are also more likely to be subject to more stringent regulation. Environmental compliance costs are more likely to be higher for firms in relatively more polluting sectors. This implies that the cost savings from adopting better environmental management strategies may be greater for firms operating in relatively more polluting sectors (Klassen and McLaughlin, 1996). We therefore examine separately the EP-FP nexus, distinguishing between high (referred to as brown firms) and relatively low emitters (or green firms).

2.3. Measures of FP and EP in the literature

The literature studying the relationship between corporate financial performance (FP) and environmental performance (EP) mostly examines competing measures of FP to gauge how this variable responds to changes in EP, or EP→FP. The most popular accounting-based measure to establish the EP→FP relationship is the return on assets (ROA), e.g. Choi et al. (2010), Qureshi and Ahsan (2022) and Lahouel et al. (2022). Return on equity (ROE) has also been employed (instead) in many studies, e.g. Wagner et al. (2002). Other measures of FP employed in the literature include return on sales, return on capital employed, stock returns, price to book value, return on invested capital, earnings before interest and tax (EBIT) to total sales, and earnings before interest, tax, depreciation, and amortization (EBITDA) to total sales (Qiu et al., 2016; Wagner et al., 2002; Naimy et al., 2021; Iwata and Okada, 2011; Laguir et al., 2018; Gull et al., 2022). Alareeni and Hamdan (2020) use market-based measures of FP, such as Tobin's Q, in conjunction with accounting-based measures. The importance of using both these market-based and accounting-based measures is discussed in Endrikat et al. (2014) meta-analysis, where it is acknowledged that the accounting-based measures of FP, such as ROA, better capture the efficiency with which a firm makes use of its assets to generate value in the short-run. Instead, market-based measures, such as Tobin's Q, gauge the perceptions regarding the future performance of firms and hence, better proxy for their long-term performance. However, Albertini (2013) argues that market-based measures of financial performance are economic indicators that are mostly beyond management control, while accounting-based measures of financial performance are under management's control, reflecting management's voluntary choices regarding firm resource allocation. Thus, we employ Return on Assets (ROA) as the primary measure of FP. Return on equity (ROE), return on invested capital (ROIC), return on capital employed (ROCE), profit margin (PM), EBITDA to revenue ratio (EBITDA/REV), and EBIT to sales ratio (EBIT/SALES) are used as alternative measures of FP to gauge the robustness of the results obtained.

Just as for FP, the literature has considered different ways to measure/quantify EP, such as greenhouse gas emissions (Hassan and Romilly, 2018; Bolton and Kacperczyk, 2020), waste emissions and water use (Hoang et al., 2020), toxic release inventory (Clarkson et al., 2011), environmental scores published by various databases (Liu, 2020), environmental management initiatives (Klassen and McLaughlin, 1996) or carbon intensity (Pedersen et al., 2021), amongst others. Here, we use the environmental pillar score (EScore) or the 'E' of the ESG score provided by Refinitiv. Refinitiv's 'E' scores are a combination of scores assigned under three main categories - 1) emissions 2), resource use, and 3) innovation. The E scores can be thought of as a proxy for a firm's environmental management practices. Environmental management variables (as opposed to environmental performance and environmental disclosure variables) depend on processes, systems, or productivity (Albertini, 2013). This author finds that EP measured using environmental management variables has a significantly stronger relationship with FP.

As discussed previously, the natural resource-based view theory states that a firm develops dynamic capabilities (such as better environmental management practices) to cope with the challenges posed by the natural environment (Hart, 1995). These capabilities may lead to competitive advantage and hence, improve financial performance (Hart and Dowell, 2011). Therefore, EP as a proxy for environmental management practices may be the source of the development of a firm's dynamic capabilities which in turn leads to improved financial performance.

The debate is not only limited to the sign and direction of the EP-FP relationship but also extends to its horizon, i.e. does EP affect the FP of a firm contemporaneously or with a lag? The meta-analysis by Hang et al. (2019) provides evidence in support of the Porter Hypothesis (revisionist view), with the economic returns (FP) to improvements in EP materializing only with a delay of around 2 years. Most researchers find that EP in the previous year affects FP in the current year (Lucas and Noordewier, 2016; Liu, 2020). Some researchers also find evidence in support of a contemporaneous relationship between EP and FP (Al-Tuwaijri et al., 2004; Iwata and Okada, 2011). The meta-analysis conducted by Endrikat et al. (2014) also supports the existence of a relationship between EP and concurrent FP as well as between EP and subsequent FP. Thus, we seek to gauge the impact of prior and concurrent EP on FP and vice versa. We also account for lagged values of both FP and EP in the model specification to control for the strong persistence in the dynamics of financial and environmental performance. As shown below, these additional features of the model allow us to correct for the potential presence of a spurious relationship between EP and FP –that could be explained by a strong time-series persistence in the variables (Granger and Newbold, 1974), and to reduce potential biases in such relationship, due to the effect of unobserved heterogeneity not captured by the set of observable factors used as controls.

3. Data and sample selection

The dataset used for this analysis considers the constituents of the S&P 500 index over the period 2011 to 2020, obtained from Bloomberg and Refinitiv Datastream. The reason for the choice of time period is that the ESG ratings have become more complete and accurate only recently. Therefore, we use data starting from 2011 to ensure the reliability of the results. The enactment of legislative efforts requiring substantial investments in decarbonization - the Infrastructure Investment and Jobs Act (2021) and the Inflation Reduction Act (2022) mark a strategic shift away from traditional environmental regulations towards technological innovation and infrastructure renewal (Farber, 2024). These changes may result in a huge impact on how environmental performance is perceived by companies 2021 onwards, so we do not include these years in our analysis. All available data from 2011 to 2020 on the constituents of S&P 500 index are used in the analysis. The sample employed is unbalanced. In particular, Refinitiv provides data on the Environmental, Social, and Governance (ESG) scores, and their sub-components 'E','S', and 'G' respectively. This study uses a broader and all-encompassing modern definition of environmental management practices by considering the Environmental Pillar Score, i.e. the 'E' of the ESG index, rather than traditional indicators of environmental performance such as greenhouse gas (GHG) or toxic waste emissions, that have been previously used by studies for gauging the nature of the EP-FP relationship (Hassan and Romilly, 2018; Al-Tuwaijri et al., 2004; Iwata and Okada, 2011). EScore has been adopted as a measure of environmental performance at the firm level in the recent literature (Lahouel et al., 2022; Dal Maso et al., 2018; Liu, 2020). This information is merged with data on the Global Industry Classification Standard's (GICS) sector classification for the S&P 500 constituent firms.

There are 11 sectors as per the GICS – Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Communication Services, Utilities, and Real Estate. Six Sectors are classified as brown and five as green[2], according to the MSCI ESG Research on Carbon Footprinting (2015) and the MSCI Net-Zero Tracker (October 2021).[3] The estimations of the carbon footprint in the MSCI ESG Research report have been done as per scope 1 plus scope 2 emissions.[4] In the MSCI Net-Zero Tracker report, the estimations of the implied temperature increase resulting from activities of each of the GICS sectors have been computed using Scope 1, 2 and 3 emissions.[5] Since only Scope 1 and Scope 2 emissions are the emissions that companies can (mostly) directly control, they form the primary basis for the classification of firms into green and brown sectors for the purpose of this study, noting that the inclusion of Scope 3 emissions doesn't alter the classification obtained.[6] The number of green and brown firms in each sector is reported in Table 1.

[2]The sectors are ranked from most to least polluting based on their emissions and the top 6 sectors are classified as brown, with the remaining as green.

[3]A report that gauges the world's listed companies' progress towards reducing climate risk

[4]Scope 1 emissions: all direct GHG emissions from sources owned or controlled by the company, out of total emissions of the MSCI ACWI Index. Some examples include emissions from fossil fuels burned on site, or emissions from entity-owned and/or leased vehicles. Scope 2 emissions: Indirect GHG emissions from consumption of purchased electricity, heat, or steam, and the transmission and distribution (T&D) losses associated with some purchased utilities.

[5]Scope 3 emissions comprise emissions that companies are indirectly responsible for - such as emissions that result from purchasing, using, and disposing of products from suppliers. Since Scope 3 emissions are not produced by the companies themselves i.e these emissions are not the by-product of the activities carried out by companies' owned or controlled assets, and therefore, cannot be controlled by the companies themselves.

[6]As a check to determine if the classification is accurate in light of the time period selected, we rank sectors according to the average emissions' intensity ratio (calculated by dividing Scope 1 and Scope 2 emissions by Total Assets) and then classify firms into green and brown sectors. The classification remains unchanged.

Table 1: Classification of Sectors in the dataset

Brown Sectors		Green Sectors	
Sector	Number of Firms	Sector	Number of Firms
Utilities	29	Real Estate	29
Materials	28	Information Technology	75
Industrials	71	Health Care	64
Energy	21	Financials	67
Consumer Discretionary	60	Communication Services	26
Consumer Staples	32		
Total	241	Total	261

Notes: This table displays the number of firms in each sector. The sectoral classification is done based on the GICS classification criteria. Sectors are then divided into 2 broader categories namely, brown and green. Brown sectors are sectors with higher scope 1 and 2 emissions compared to green sectors. The overall (full) sample comprises all firms listed on the S&P 500 index. The data used is retrieved from Refinitiv and Bloomberg.

Table 2: Summary Statistics of variables employed in this analysis. Table of variable definitions is available in Appendix A.

	Brown Firms			Green Firms		
Variable	Obs	Mean	S.D.	Obs	Mean	S.D.
EScore	2,236	48.96	28.34	2,403	44.51	28.37
ROA	2,296	6.98	7.37	2,477	6.13	8.18
CFO/Sales	2,335	16.43	13.65	2,571	24.81	24.36
TD/TA	2,334	33.89	26.47	2,560	24.77	20.25
SalesGrowth	2,326	5.57	20.87	2,564	11.48	37.80
ln(TA)	2,335	9.66	1.19	2,564	9.85	1.77
EnvDisclScore	2,199	30.97	20.56	2,234	23.56	19.83
CapitalIntensity	2,300	1.88	1.52	2,494	5.28	6.73
ROIC	2,295	12.04	13.35	2,469	10.27	23.98
ROE	2,283	27.75	66.16	2,441	18.20	34.19
EBITDA/REV	2,319	19.64	18.30	2,132	28.42	28.65
ROCE	2,245	34.04	82.09	1,464	44.85	53.89
PM	2,312	7.34	18.41	2,507	14.26	25.69
EBIT/SALES	2,312	12.46	19.40	2,017	17.68	28.43
ER	1,989	0.50	0.50	1,734	0.22	0.41
lnEnvInn	1,590	3.83	0.67	1,257	3.75	0.69
lnEScore	2,040	3.78	0.79	2,176	3.64	0.90

Notes: This table reports the summary statistics for brown and green firms separately. The overall (full) sample comprises all firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg.

The data on the rest of the variables[7] in the analysis is retrieved from Bloomberg. These variables include return on assets (to gauge FP - the second endogenous variable), cash flow from operations to sales (a performance/efficiency ratio used to measure a firm's ability to generate cash flow in proportion to its sales), the environmental disclosure score

[7]The Table containing variable definitions and acronyms used in the study is reported in Appendix A.

Table 3: Correlation Coefficients

Panel A: Correlation coefficient matrix for Brown firms' sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Time	1											
2	EScore	0.1125*	1										
3	CFO/Sales	0.0178	0.0272	1									
4	TD/TA	0.1588*	0.0319	0.0095	1								
5	SalesGrowth	-0.1496*	-0.1038*	0.0902*	-0.0614*	1							
6	ln(TA)	0.1608*	0.2553*	0.1155*	-0.0375	-0.1896*	1						
7	EnvDisclScore	0.3283*	0.3199*	0.1185*	0.112*	-0.1764*	0.4203*	1					
8	CapitalIntensity	0.1445*	0.0253	0.3251*	0.08*	-0.1148*	0.3618*	0.2402*	1				
9	ROA	-0.0617*	-0.0421*	0.0624*	0.0481*	0.1354*	-0.3586*	-0.1686*	-0.4737*	1			
10	ER -0.0106	0.2531*	0.0973*	-0.0094	-0.1268*	0.3442*	0.3973*	0.2386*	-0.1446*	1			
11	lnEScore	0.0859*	0.9011*	0.0025	0.0309	-0.099*	0.2095*	0.2679*	-0.007	-0.0061	0.2201*	1	
12	lnEnvInn	0.1145*	0.2478*	-0.0133	-0.0033	-0.0175	0.2265*	0.1395*	-0.0201	0.014	0.0647*	0.2321*	1

Panel B: Correlation coefficient matrix for Green firms' sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Time	1											
2	EScore	0.1718*	1										
3	CFO/Sales	0.0287	-0.0162	1									
4	TD/TA	0.0998*	-0.0871*	0.0846*	1								
5	SalesGrowth	-0.0537*	-0.0284	0.1216*	-0.0342	1							
6	ln(TA)	0.1511*	0.2478*	0.0922*	-0.0511*	-0.1373*	1						
7	EnvDisclScore	0.2206*	0.3468*	0.0467*	0.1308*	-0.0993*	0.33*	1					
8	CapitalIntensity	0.0173	0.1017*	0.1246*	-0.1438*	-0.055*	0.5415*	-0.016	1				
9	ROA	0.054*	0.0128	0.2493*	-0.095*	-0.0394	-0.2017*	0.1009*	-0.315	1			
10	ER	0.0259	0.1954*	0.0119	0.029	-0.112*	0.2573*	0.4705*	0.0198	0.0092	1		
11	lnEScore	0.1219*	0.8879*	0	-0.0604*	-0.0267	0.16*	0.2463*	0.0613*	0.0279	0.1206*	1	
12	lnEnvInn	0.0628*	0.1381*	0.0587*	0.0754*	-0.0483	0.1523*	0.2849*	0.1424*	-0.0192	0.2017*	0.1362*	1

Notes: This table reports the correlation coefficients between variables in the main analysis. The correlation coefficients are reported for brown and green firms separately. The time variable ranges from 1 to 10, with 1 denoting the year 2011 and 10 denoting the year 2020. The overall (full) sample comprises all firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. * denotes significance at 5%.

Table 4: Correlation Coefficients between Profitability Measures

Panel A: Correlation coefficient matrix between profitability measures: Brown firms' sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	ROA	1						
2	ROIC	0.8198*	1					
3	ROE	0.3512*	0.382*	1				
4	EBITDA/REV	0.3938*	0.2515*	0.1349*	1			
5	ROCE	0.1277*	0.1092*	0.0962*	0.0531*	1		
6	PM	0.6392*	0.4286*	0.2251*	0.7903*	0.0958*	1	
7	EBIT/SALES	0.5759*	0.4104*	0.2114*	0.9145*	0.0818*	0.9167*	1

Panel B: Correlation coefficient matrix between profitability measures: Green firms' sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	ROA	1						
2	ROIC	0.5749*	1					
3	ROE	0.5792*	0.6012*	1				
4	EBITDA/REV	0.3361*	0.1794*	0.1865*	1			
5	ROCE	0.2015*	0.2461*	0.3002*	0.1594*	1		
6	PM	0.4713*	0.2299*	0.2654*	0.8651*	0.2807*	1	
7	EBIT/SALES	0.46*	0.2439*	0.2693*	0.9463*	0.2146*	0.911*	1

Notes: This table reports the correlation coefficients between profitability measures used for robustness checks. The correlation coefficients are reported for brown and green firms separately. The overall (full) sample comprises all firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. * denotes significance at 5%.

- this score ranges from 0 to 100, the more the environmental information disclosed the higher the score, total assets (firm size), total debt to total assets (firm level of leverage) and capital intensity measured as the ratio of total assets to revenue (another indicator of firm efficiency). Other variables employed in this study include the alternate profitability measures namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. The summary statistics (number of observations, mean, and standard deviation) for brown firms (firms in all brown sectors combined) and green firms (firms in all green sectors combined) for all variables employed in this study are presented in Table 2.

The summary statistics show that environmental pillar scores are higher for brown firms than for green firms. This can be attributed to the fact that brown firms are generally under higher regulatory and stakeholder pressure when it comes to environmental performance as opposed to green firms which compels them to improve their environmental performance. This is also reflected in the environmental disclosure score, which is substantially higher for brown firms compared to green firms. De Villiers and Van Staden (2011) argue that firms with a bad environmental reputation and firms faced with environmental crises are more likely to disclose environmental information. It is plausible that such firms are more likely to be firms belonging to brown sectors and hence, these firms disclose more as well as pursue more environmental initiatives to become 'greener'.

Next, the correlation matrix containing correlation coefficients between all variables employed in the main analysis is reported in Table 3. The correlation matrices for both brown and green firms' samples have been reported in Panel A and Panel B respectively. It can be observed that the pair-wise unconditional correlation between EP and FP is negative for brown firms and positive for green firms. This relationship is explored in detail in Section 5 below. 'Time' denotes the time trend and is also reported in the correlation matrices to understand how variables in the model are associated with time. It can be noted that ROA is negatively associated with time for brown firms but positively so for green firms. But EScore is positively associated with time for both brown and green firms. The correlation matrix between various operational profitability measures is reported in Table 4, Panels A and B for brown and green firms respectively. It can be observed that for brown firms, ROIC & PM are highly correlated to ROA, that EBIT/SALES is moderately correlated to ROA, and that ROE, EBITDA/REV & ROCE are weakly correlated to ROA. Instead, for green firms, ROIC & ROE are moderately related to ROA, while EBITDA/REV, ROCE, PM, & EBIT/SALES are weakly correlated to ROA.

4. Methodology

4.1. Empirical Specification

Structural equation modelling (SEM) is adopted to flexibly study the bi-directional EP-FP relationship, building on the aforementioned literature. The proposed empirical specification considers nonrecursive structural equation models for parameter estimation in the presence of reverse causality. This choice allows us to address the potential reverse causality between EP and FP and accommodate the presence of mutual correlation between the errors of the different equations in the SEM, see Wang and Wang (2019).

The dependent variables in the system of equations are ROA_{it} and the $\text{EScore}_{\text{it}}$, as measures of a firm's FP and EP respectively. In the text, we use EP and FP interchangeably with EScore and ROA (and other measures of ROA), respectively. The model specification includes a set of observable factors acting as controls: $\mathrm{TD/TA_{it}}$ (leverage), $\mathrm{Salesgrowth_{it}}$ (firm growth), $\mathrm{ln(TA)_{it}}$ (firm size), and $\mathrm{CapitalIntensity_{it}}$ and $\mathrm{CFO/Sales_{it}}$ (measures of efficiency level), see equations (1) and (2). Leverage is found in most of the related literature to have a negative impact on $\mathrm{ROA_{it}}$ (Iwata and Okada, 2011; Semenova and Hassel, 2016; Zahid et al., 2020). Firm growth (measured by sales growth) is expected to have a positive impact on its $\mathrm{ROA_{it}}$ (Lahouel et al., 2022; Wang and Chen, 2022). $\mathrm{ln(TA)_{it}}$ negatively influences a firm's $\mathrm{ROA_{it}}$, because smaller firms are more profitable (Semenova and Hassel, 2016; Hassan and Romilly, 2018; Wang and Chen, 2022). Similarly, the efficiency level is expected to positively affect operational performance. In our empirical specification, two measures of efficiency are employed, namely, the capital intensity ratio ($\mathrm{CapitalIntensity_{it}}$) and the cash flow from operations to sales ratio ($\mathrm{CFO/Sales_{it}}$). A lower $\mathrm{CapitalIntensity_{it}}$ and a higher $\mathrm{CFO/Sales_{it}}$ imply higher efficiency. Therefore, it is expected that the $\mathrm{CapitalIntensity_{it}}$ has a negative impact while $\mathrm{CFO/Sales_{it}}$ has a positive impact on a firm's $\mathrm{ROA_{it}}$. Finally, we expect that $\mathrm{ROA_{i(t-1)}}$ has a significant and positive impact on $\mathrm{ROA_{it}}$. On the other hand, Clarkson et al. (2011) find that the E score is determined by $\mathrm{TD/TA_{it}}$, $\mathrm{SalesGrowth_{it}}$, and $\mathrm{ln(TA)_{it}}$. These variables are therefore included as controls in equation (2). $\mathrm{TD/TA_{it}}$ is expected to negatively impact the decision to pursue an environmentally proactive strategy, while $\mathrm{SalesGrowth_{it}}$ and $\mathrm{ln(TA)_{it}}$ should both have a positive effect on the take-up of pro-environmental strategies. Last, the $\mathrm{EnvDisclScore_{i(t-1))}}$ is also included, since Lu and Taylor (2018) find that it positively affects environmental performance, albeit with a lag (Al-Tuwaijri et al., 2004). Indeed, past years' levels of environmental disclosure may inform investors' expectations in the current year. $\mathrm{EScore_{i(t-1)}}$ and $\mathrm{ROA_{i(t-1)}}$ are included in both equations to remove the presence of strong time series persistence in both dependent variables. Omitting this effect can lead to spurious results on the EP-FP relationship driven by the dynamic persistence of these variables - see Granger and Newbold (1974) for a detailed discussion of this effect in non-stationary time series. Additionally, firm and time fixed effects are included, to control for the presence of unobserved heterogeneity across firms and over time. Thus, the proposed empirical specification is as follows:

$$\begin{aligned}\mathrm{ROA_{it}} &= \beta_0 + \beta_1\mathrm{EScore_{it}} + \beta_2\mathrm{TD/TA_{it}} + \beta_3\mathrm{CapitalIntensity_{it}} + \beta_4\mathrm{ln(TA)_{it}} \\ &+\beta_5\mathrm{CFO/Sales_{it}} + \beta_6\mathrm{SalesGrowth_{it}} + \beta_7\mathrm{ROA_{i(t-1)}} + \beta_8\mathrm{EScore_{i(t-1)}} + \alpha_\mathrm{i} + \mu_\mathrm{t} + \epsilon_\mathrm{it}\end{aligned} \tag{1}$$

$$\begin{aligned}\mathrm{EScore_{it}} &= \delta_0 + \delta_1\mathrm{ROA_{it}} + \delta_2\mathrm{TD/TA_{it}} + \delta_3\mathrm{SalesGrowth_{it}} + \delta_4\mathrm{ln(TA)_{it}} \\ &+\delta_5\mathrm{EnvDisclScore_{i(t-1)}} + \beta_7\mathrm{ROA_{i(t-1)}} + \beta_8\mathrm{EScore_{i(t-1)}} + \alpha_\mathrm{i} + \mu_\mathrm{t} + \mathrm{u_{it}}\end{aligned} \tag{2}$$

where subindices 'i' and 't' refer to the company and time period respectively. α_i and μ_t are shorthand for firm and year/time fixed effects, and ϵ_it and $\mathrm{u_{it}}$ are the corresponding equation error terms.

We impose the exogeneity of the regressors given by the conditions $\mathrm{cov}(\mathrm{u_{it}}, \mathrm{z_{it}}) = 0$ and $\mathrm{cov}(\epsilon_\mathrm{it}, \mathrm{z_{it}}) = 0$ (where $\mathrm{z_{it}}$ is shorthand for all covariates in the model). The nonrecursive SEM approach allows for non-zero correlation between the errors of each equation ϵ_it and $\mathrm{u_{it}}$ i.e. $\mathrm{cov}(\epsilon_\mathrm{it}, \mathrm{u_{it}}) \neq 0$. It is also assumed that errors are serially uncorrelated i.e. $\mathrm{cov}(\mathrm{u_{it}}, \mathrm{u_{i(t-j)}}) = 0$ and $\mathrm{cov}(\epsilon_\mathrm{it}, \epsilon_{i(t-j)} = 0)$, for $j = 1, \ldots$. Additionally, for estimation purposes, the error terms ϵ_it and $\mathrm{u_{it}}$ are assumed to be normally distributed. This is a standard assumption in SEM.

4.2. Model Identification

The model is identified if there is at least one solution to the system of equations. Three conditions are required for model identification:

1) Since this is a non-recursive model where $\mathrm{ROA_{it}}$ and $\mathrm{EScore_{it}}$ are determined endogenously, $\mathrm{ROA_{it}}$ and $\mathrm{EScore_{it}}$ are assumed to be connected to each other by two unidirectional paths (one originating from $\mathrm{ROA_{it}}$ and terminating at $\mathrm{EScore_{it}}$ and the other originating from $\mathrm{EScore_{it}}$ and terminating at $\mathrm{ROA_{it}}$). Model estimation requires then the use of variables that act as 'instruments' to achieve model identification (Finch and French, 2015; Wang and Wang, 2019) i.e. of variables (instruments) that have a direct

path to just one of the endogenous variables in the feedback loop, and not to the other (Martens and Haase, 2006). For example, for equation (1) to be identified, at least one instrument must bear a direct impact on ROA_{it} but not on $EScore_{it}$, and similarly for equation (2), i.e. at least one instrument must have a direct impact on $EScore_{it}$ but not on ROA_{it}.

2) The order condition[8] is satisfied i.e. the degrees of freedom (difference between the number of observed values and the number of parameters estimated in the model) should be either zero (just-identified) or greater than zero (over-identified) to have a unique or more than one solution to the system of equations (1)-(2), respectively.

3) The rank condition[9] is satisfied. The rank condition states that any particular equation within a system of G equations is identified if and only if it is possible to construct at least one non-zero determinant of order (G-1) from the coefficients of variables that were excluded from that equation but that were contained in the other equations included in the model.

For the first condition to be satisfied, $CFO/Sales_{it}$ and $CapitalIntensity_{it}$ have been employed as instruments for ROA_{it}[10]. Both $CFO/Sales_{it}$ and $CapitalIntensity_{it}$ are measures of efficiency. $CFO/Sales_{it}$ measures a company's ability to generate cash from its sales and it is expected to have a direct effect on ROA_{it} while it doesn't necessarily have an impact on the $EScore_{it}$ of a company. Similarly, $CapitalIntensity_{it}$, measured as the ratio of assets to revenue, also reflects the efficiency level of a company by gauging its ability to generate revenue using its assets. While $CapitalIntensity_{it}$ is widely used as a determinant of the ROA_{it} of a company (Russo and Fouts, 1997; Rokhmawati et al., 2015), it doesn't necessarily have a direct impact on $EScore_{it}$ of a firm[11]. de Burgos Jimenez and Céspedes Lorente (2001) state that pollution control, zero waste, or environmental program designs reinforce operational management techniques such as statistical process

[8]The order condition is necessary but not sufficient for identification.

[9]The rank condition is a necessary and sufficient condition for identification.

[10]The first stage results are reported in Appendix B.

[11]Capital Intensity has been measured as the inverse of the assets turnover ratio, which excludes the capital expenditures of a company to build fixed assets. Therefore, it is assumed here not to influence environmental performance.

control, total quality control, total quality management, or design for manufacture. And, uptake of these techniques results in enhanced production efficiency (Luan et al., 2016). Therefore, it is conceivable that better environmental performance may result in better efficiency, while the direct causal relationship in the opposite direction (from efficiency to environmental performance) doesn't appear plausible.

Freedman and Jaggi (1982) also show that there is no association between accounting-based measures of financial performance (such as ROA) and environmental information disclosure. Second, there may be an association between environmental disclosure and ROA, but there is no direct causal relationship between environmental disclosure and ROA. For example, a firm might improve its environmental performance thereby improving its operational efficiency in a given year and hence, disclose more in the same year. In this case, environmental performance may affect environmental disclosure as well as financial performance, but this does not amount to environmental disclosure impacting ROA. And if anything, these are contemporaneous associations, not lagged ones as assumed here. The joint validity of the $\text{EnvDisclScore}_{i(t-1)}$, CFO/Sales_{it}, and $\text{CapitalIntensity}_{it}$ is confirmed by the overidentification tests conducted.[12]

For the second condition to be satisfied, the number of excluded exogenous variables (from an equation) must equal or exceed the number of endogenous variables in that equation minus one (Paxton et al., 2011). By this rule, both equations in the system of equations are identified.

For the third condition to be satisfied, we obtain at least one non-zero determinant of order G-1 (i.e. 2-1 = 1 in this case) for each equation and find that the rank condition is satisfied for both the equations in the system.

4.3. Model Estimation

Model estimation has been performed deploying generalized structural equation modeling (GSEM). This method uses maximum likelihood procedures to estimate the model parameters and permits the inclusion of unobservable factors in the model specification.

[12]The overidentification conditions i.e the Hansen J test statistics and their corresponding P-values for the green sample and brown sample are reported in Appendix B.

This possibility to account for the presence of fixed effects (FEs) has been leveraged here, in a panel data setting. This is done by including dummies as factor variables. Fixed effects in this setting are interpreted as capturing unobserved sources of heterogeneity at the firm level that do not change over time. Year fixed effects have also been accounted for in the model specification. While GSEM enables the inclusion of fixed effects via factor variables (firm and year dummies), it does not allow computation of goodness of fit statistics (such as the chi-squared value, root mean square error of approximation, Tucker-Lewis index, and Comparative Fit Index) that help evaluate the fit of the model to the data.

Another full-information technique[13] that is widely used to solve simultaneous equations to address the problem of endogeneity and correlated errors is three stage least squares (3SLS). The 3SLS procedure extends the 2SLS procedure as follows. First, 3SLS estimates the equation disturbances' variance/covariance matrix using residuals from two stage least squares (2SLS). Second, this matrix is used as the sandwich matrix in GLS estimation performed on the set of equations in the system (Paxton et al., 2011). The 3SLS approach has been adopted to gauge the consistency of results across different estimation techniques.

The estimation is carried out using both the aforementioned techniques.[14] The model is estimated for all brown firms and all green firms separately, pooling across different sectors, which is why fixed effects in this setting are crucial. The estimations are thus conducted in four different settings, for four different model specifications. The goal is to determine whether there are meaningful discrepancies in results across different settings and specifications. This exercise will also provide insight into why results pertaining to

[13]Full-information techniques make use of all information from all equations in a model of simultaneous equations and, therefore, take into account the correlation between residuals of these equations.

[14]A third commonly explored possibility to estimate dynamic longitudinal models is system GMM. Since we take into account the dynamic component ($\mathrm{EScore}_{\mathrm{i(t-1)}}$ and $\mathrm{ROA}_{\mathrm{i(t-1)}}$) in our model, our fixed effects estimator might be biased (i.e. 'Nickell's bias'). The importance of this effect depends on the ratio N/T, with N the number of firms and T the sample period. It is customary in dynamic panel data settings to correct this effect by resorting to system GMM estimation methods. However, to the best of our knowledge, the latter approach has not been extended to a simultaneous equation framework. We therefore rely on instrumental variable identification and maximum likelihood methods to overcome such concerns, while allowing for contemporaneous and dynamic relationships between environmental and financial performance.

the EP-FP nexus are non-robust in the literature.

We test the EP-FP relationship under these four model specifications to gauge the impact of the exclusion of lags of EP and FP and, the exclusion of time FEs from the model. The four model specifications can be broadly classified into two parts - one containing lagged FP ($ROA_{i(t-1)}$) & lagged EP ($EScore_{i(t-1)}$) as controls, and the other without. Within these two broad parts, there are two main settings - 1) with firm & time FEs and 2) with firm FEs only. Finally, the standard errors have been clustered at the firm level (in all four settings) to address the possibility of serial correlation among observations of a firm.

5. Empirical Results

5.1. Main Results

The results from this analysis reveal that the effect of environmental performance on financial performance is not statistically significant for either green or brown firms, so, for simplicity, we only report the results presenting the impact of financial performance on environmental performance[15]. The results for brown firms are reported in Table 5. The results for green firms are reported in Table 6. This paper focuses on the sign and significance of the independent variable (variable of interest) under various model specifications. While comments are made on the results under different model specifications, the final conclusion about the impact of EP on FP (and vice versa) is based on the most comprehensive/robust model specification - one that includes the lags of EP & FP and firm and time FEs.

The results in Table 5 indicate that the impact of ROA_{it} on $EScore_{it}$ for brown firms is consistently positive and statistically significant across model specifications and for both estimation approaches. This is the most important result of this study since it does not depend on 1) the methodology deployed (GSEM or 3SLS) nor on 2) the model specification adopted (i.e. whether lags are included or excluded, and whether time-fixed effects

[15]The results presenting the impact of environmental performance on financial performance are presented in Appendix C.

are taken into account or not). In its most complete specification, column (1) reports that a one percent increase in $\mathrm{ROA_{it}}$ leads to a 0.315 point increase in $\mathrm{EScore_{it}}$, meaning that brown firms that perform better financially also perform better environmentally, irrespective of their size or of disclosing, measured by $\mathrm{ln(TA)_{it}}$ and $\mathrm{EnvDisclScore_{it}}$ respectively.

Brown firms that grow more (have a high $\mathrm{SalesGrowth_{it}}$) or that are less leveraged (have a low $\mathrm{TD/TA_{it}}$) appear to perform worse environmentally. Although these effects are not in line with the findings in the prior literature, the significant leverage-environmental sustainability performance relationship supports the idea that lenders prefer firms that perform better environmentally and that emission reduction efforts may divert resources from more traditional firm expansion strategies (Alsayegh et al., 2020). Ginglinger and Moreau (2023) find that lenders do not prefer firms exposed to high climate risk. This result implies that lenders have a taste for environmental proactiveness and they may prefer to fund activities that improve the environmental performance of firms. Lastly, and as already mentioned, $\mathrm{EScore_{i(t-1)}}$ has a positive and significant impact on $\mathrm{EScore_{it}}$ indicating strong time series persistence of the environmental performance at the firm level over time.

Table 6 reports under cols. (1) and (2) that those that perform worse financially ($\mathrm{ROA_{it}}$) tend to perform environmentally better ($\mathrm{EScore_{it}}$) although the effect is not statistically significant. Furthermore, the opposite sign is obtained once $\mathrm{EScore_{i(t-1)}}$ and $\mathrm{ROA_{it}}$ are excluded, under cols. (3) and (4). Apart from $\mathrm{EScore_{i(t-1)}}$ and $\mathrm{EnvDisclScore_{i(t-1)}}$, all other controls are not significant under col. (1) - the most comprehensive setting. The results are similar across techniques and hence, it can be concluded that green firms that perform better financially do not perform environmentally better, once we control for past emission reduction efforts and past environmental disclosures, as well as for the possibility of environmental performance determining financial performance (reverse causality).

5.2. Mechanism analysis

This subsection discusses the potential mechanism through which FP affects EP. We suggest that the causal effect of FP on EP is moderated by expenditure incurred on environmental practices. Slack resources (proxied by FP) only result in improvement in EP when they are used to invest in the uptake of environmental management practices. This variable is obtained from Refinitiv. We call this variable 'emission reduction' (ER) – a value of 1 signifies that the company has either achieved some reduction in the level of emissions or has incurred some expenditure related to the environment. A value of 0 indicates that the company has neither reduced emissions nor incurred any environmental expenditures.

To show the effect of profitability on environmental performance is moderated by whether a company has reduced emissions or incurred environmental expenditures in a given year or not, we introduce an interaction term between FP and expenditure on environmental practices (the moderator) using seemingly unrelated regression (Sureg). We perform Sureg instead of SEM to explore the role of expenditures incurred on environmental practices as a moderator because estimating the bi-directional EP-FP relationship while also including moderators is not viable in the SEM framework. The use of Sureg enables simultaneous estimation of the system of equations while allowing the use of interaction terms without causing identification issues.

The results of the mechanism analysis are reported in column (9) of Tables 5 and 6. The mechanism results reported in column (9) of Table 5 indicate that an improvement in profitability (representing the availability of slack resources) results in an improvement in the environmental performance of a firm when emission reduction takes place or environmental expenditures are incurred by a firm. The coefficient of the variable ROA (proxy for profitability) becomes insignificant when it interacts with the emission reduction variable indicating that the entire effect of profitability on environmental performance is through companies making efforts to reduce emissions and incurring expenditures to boost their environmental performance. The results reported in column (9) of Table 6 indicate no significant moderating effect for green firms.

5.3. Robustness Tests

5.3.1. Alternate measures of FP

To test the robustness of the main findings to the definition of corporate financial performance, we repeat the estimation procedure by replacing ROA with other comparable measures of operational profitability (financial performance - FP), namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. The simultaneous equations model that includes lags of EP and FP is estimated 1) with firm and time FEs, and 2) with firm FEs only, for comparison purposes. This section reports only the effect of financial performance on environmental performance[16]. The results for brown firms are reported in columns (1) to (12) of Table 7. The results for green firms are reported in columns (1) to (12) of Table 8.

The results in Table 7 are commensurate with the results reported in Table 5. Leaving aside columns (5) and (6) - corresponding to ROCE, the coefficients of all other profitability measures are positive and statistically significant. The robustness of the findings to the choice of profitability measure provides additional support to the conclusion that, conditioning on lagged FP, increases in contemporaneous FP cause improvements in EP for brown firms. Profitability measures with low to moderate correlations with ROA, such as ROE, EBITDA/REV, and EBIT/SALES, still deliver significant and positive coefficients. These results further reinforce the main findings in Table 5.

Lastly, Table 8 reports that the impact of contemporaneous FP on EP for green firms is negative (in the setting that includes both firm and time FEs) for two out of six measures of profitability namely, ROE, PM, EBITDA/REV, and EBIT/SALES. This result is similar to the findings obtained in Table 6 with the exception that here, in the case of certain profitability measures (such as EBITDA/REV, and EBIT/SALES) the results are also statistically significant. The negative coefficient of contemporaneous FP on EP suggests that there can be a diversion of firms' investment towards endeavours other than the ones that improve environmental performance - endeavours that firms

[16]The results presenting the impact of environmental performance on alternative measures of financial performance are reported in Appendix C.

deem more profitable compared to enhancing their environmental performance (Aigbedo, 2021). Since green firms are faced with lower regulatory attention, they may not prioritize improving their EP like their brown counterparts do. This result is the complete opposite of the corresponding finding for brown firms (reported in Table 6).

5.3.2. Alternate measures of EP

To test the robustness of the main findings to the definition of corporate environmental performance, we repeat the estimation procedure by replacing EScore with other comparable measures of environmental performance, namely, lnEnvInn and lnEScore. The simultaneous equations model that includes lags of EP and FP is estimated with firm and time FEs.

We construct the variable 'lnEnvInn' using the 'environmental innovation score' to measure the environmental performance of a company. We take the natural logarithm of the environmental innovation score as an alternate measure of environmental performance to study the EP-FP relationship. Taking the natural logarithm of the environmental innovation score normalizes the data and alleviates any concerns about the presence of outliers. The environmental pillar score, used as our benchmark measure, is a combination of the emission reduction score, the resource use score, and the environmental innovation score. The environmental innovation score is a measure of a company's ability to lower environmental costs and burdens on its customers. Aastvedt et al. (2021) employs the environmental pillar score and environmental innovation score from Refinitiv to measure green innovation and disentangle the impact of environmental performance on the financial performance of oil and gas companies. The environmental innovation score has been used to measure environmental performance widely in the recent literature (Orazalin and Mahmood, 2021; Rocha et al., 2023; Bazel-Shoham et al., 2024).

Column (14) of Tables 7 and 8 reports the results obtained for equation 2 when the system of equations (equations 1 and 2) are simultaneously estimated after replacing the 'EScore' with the natural logarithm of the Environmental innovation score or 'lnEnvInn'. Table 7 reports the results for the brown firms and Table 8 reports the results for the green firms.

It is clear from the results that FP bears a positive impact on EP for the brown firms (as observed from the main findings of the paper) even for alternate measures of EP. This result provides further evidence that brown firms' profitability (availability of slack) positively affects their environmental performance.

In column (13) of Tables 7 and 8 we also report the results when estimations are performed by replacing the original Environmental pillar score 'EScore' (used in the main analysis) with the natural logarithm of EScore (lnEScore). The estimation results provide further proof that financial performance bears a positive impact on the environmental performance of a company in the case of brown firms only. The effect remains insignificant for the green firms.

Table 5: Impact of Financial Performance on Environmental Performance: Brown Firms

	GSEM				3SLS				Sureg
	Baseline results								Mechanism results
	With lags		Without lags		With lags		Without lags		With lags
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: $EScore_{it}$ (EP)									
$EScore_{it}$ (FP)	0.315**	0.281**	0.368**	0.343*	0.313**	0.281**	0.364**	0.342*	0.0205
	(0.130)	(0.124)	(0.175)	(0.177)	(0.129)	(0.125)	(0.172)	(0.176)	(0.0476)
ER_{it}									-0.494
									(1.093)
ER_{it} * ROA_{it}									0.186***
									(0.0678)
TD/TA_{it}	0.0447	0.0689*	0.0267	0.0850	0.0445	0.0689*	0.0264	0.0849	-0.00188
	(0.0353)	(0.0378)	(0.0506)	(0.0597)	(0.0348)	(0.0375)	(0.0497)	(0.0592)	(0.0236)
$SalesGrowth_{it}$	-0.0237	-0.0384*	-0.0326	-0.0529*	-0.0235	-0.0384*	-0.0323	-0.0528*	-0.0104
	(0.0195)	(0.0212)	(0.0248)	(0.0284)	(0.0199)	(0.0214)	(0.0252)	(0.0287)	(0.0159)
$\ln(TA)_{it}$	1.744	3.100**	4.217**	7.702***	1.739	3.100**	4.209**	7.699***	1.616
	(1.213)	(1.215)	(1.784)	(1.822)	(1.222)	(1.217)	(1.785)	(1.821)	(1.105)
$EnvDisclScore_{i(t-1)}$	0.0637**	0.109***	0.125**	0.251***	0.0637**	0.109***	0.125**	0.251***	0.0635**
	(0.0282)	(0.0277)	(0.0493)	(0.0446)	(0.0281)	(0.0277)	(0.0492)	(0.0445)	(0.0288)
$ROA_{i(t-1)}$	-0.0604	-0.0520			-0.0597	-0.0519			-0.000772
	(0.0560)	(0.0549)			(0.0558)	(0.0550)			(0.0413)
$EScore_{i(t-1)}$	0.622***	0.636***			0.622***	0.636***			0.603***
	(0.0331)	(0.0326)			(0.0330)	(0.0325)			(0.0370)
Constant	9.788	-12.31	24.10	-28.05	6.346	-12.30	15.07	-28.01	10.88
	(13.34)	(12.33)	(20.56)	(19.63)	(12.85)	(12.35)	(19.62)	(19.61)	(11.64)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,841	1,841	1,864	1,864	1,841	1,841	1,841	1,864	1624
R squared					0.931	0.9295	0.8925	0.8874	0.932

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 2 (in the system of equations) when estimation is performed using brown firms' data. Columns (1)-(4) contain estimates of the GSEM estimation technique. Columns (5)-(8) contain estimates of the 3SLS technique. Column 9 contains estimates of Sureg technique. Estimations in columns (1),(3),(5), (7), and (9) include both firm and year fixed effects. Estimations in columns (2),(4),(6), and (8) include only firm fixed effects. Standard errors in all estimations (1)-(9) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistics only for the 3SLS estimates (the goodness of fit statistics cannot be obtained when GSEM is used.). The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table 6: Impact of Financial Performance on Environmental Performance: Green Firms

	GSEM				3SLS				Sureg
	Baseline results								Mechanism results
	With lags		Without lags		With lags		Without lags		With lags
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: $EScore_{it}$ (EP)									
ROA_{it} (FP)	-0.659	-0.153	0.0418	0.486	-0.252	-0.103	0.0401	0.468	-0.136*
	(6.404)	(1.742)	(0.979)	(0.951)	(0.965)	(0.523)	(0.909)	(0.793)	(0.0696)
ER_{it}									0.214
									(1.512)
ER_{it}*ROA_{it}									-0.0339
									(0.0912)
TD/TA_{it}	-0.159	-0.0645	-0.133	-0.0138	-0.109	-0.0591	-0.133	-0.0163	-0.100***
	(0.798)	(0.194)	(0.167)	(0.148)	(0.125)	(0.0647)	(0.158)	(0.130)	(0.0356)
$SalesGrowth_{it}$	0.0187	0.000960	-0.0156	-0.0332	0.00607	-0.000528	-0.0156	-0.0328	0.00552
	(0.202)	(0.0526)	(0.0291)	(0.0262)	(0.0305)	(0.0165)	(0.0278)	(0.0242)	(0.0184)
$\ln(TA)_{it}$	0.280	3.175***	2.364	7.534***	0.733	3.172***	2.363	7.549***	1.895*
	(7.217)	(0.746)	(1.792)	(1.694)	(1.426)	(0.740)	(1.766)	(1.673)	(1.031)
$EnvDisclScore_{i(t-1)}$	0.131**	0.206***	0.347***	0.514***	0.134***	0.204***	0.347***	0.515***	0.153***
	(0.0617)	(0.0678)	(0.0738)	(0.0745)	(0.0418)	(0.0430)	(0.0734)	(0.0724)	(0.0443)
$ROA_{i(t-1)}$	0.168	0.0433			0.0442	0.0279			0.0706
	(1.971)	(0.553)			(0.298)	(0.166)			(0.0459)
$EScore_{i(t-1)}$	0.652***	0.678***			0.657***	0.678***			0.653***
	(0.0859)	(0.0261)			(0.0286)	(0.0260)			(0.0291)
Constant	19.17	-21.01*	7.815	-61.77***	5.881	-21.28***	-4.224	-61.74***	-6.697
	(127.4)	(12.07)	(26.14)	(14.54)	(18.90)	(7.383)	(21.78)	(14.36)	(9.168)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,841	1,841	1,869	1,869	1,841	1,841	1,869	1,869	1,364
R squared					0.9184	0.9169	0.8586	0.8437	0.9129

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 2 (in the system of equations) when estimation is performed using green firms' data. Columns (1)-(4) contain estimates of the GSEM estimation technique. Columns (5)-(8) contain estimates of the 3SLS technique. Column 9 contains estimates of Sureg technique. Estimations in columns (1),(3),(5), (7), and (9) include both firm and year fixed effects. Estimations in columns (2),(4),(6), and (8) include only firm fixed effects. Standard errors in all estimations (1)-(9) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistics only for the 3SLS estimates (the goodness of fit statistics cannot be obtained when GSEM is used.). The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table 7: Impact of financial performance on environmental performance: Brown firms (using alternate measures of financial and environmental performance)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Alternate measures of FP												Alternate measures of EP	
Dependent variable (EP):	$EScore_{it}$												$lnEScore_{it}$	$lnEnvInn_{it}$
ROA_{it}													0.0177***	0.0225*
													(0.00527)	(0.0128)
ROE_{it} (FP)	0.118**	0.103*												
	(0.0555)	(0.0531)												
$ROIC_{it}$ (FP)			0.196**	0.181**										
			(0.0952)	(0.0903)										
$ROCE_{it}$ (FP)					-0.327	-0.343								
					(0.231)	(0.300)								
PM_{it} (FP)							0.0385**	0.0354**						
							(0.0172)	(0.0166)						
$EBITDA/REV_{it}$ (FP)									0.0404*	0.0407*				
									(0.0214)	(0.0214)				
$EBIT/SALES_{it}$ (FP)											0.0378**	0.0362**		
											(0.0178)	(0.0176)		
TD/TA_{it}	0.0189	0.0414	0.0244	0.0502	0.00888	0.0372	0.0289	0.0560**	0.0259	0.0535*	0.0270	0.0552*	0.00138	0.00287
	(0.0263)	(0.0264)	(0.0314)	(0.0344)	(0.0305)	(0.0292)	(0.0248)	(0.0278)	(0.0246)	(0.0278)	(0.0250)	(0.0283)	(0.00134)	(0.00217)
$SalesGrowth_{it}$	-0.0299	-0.0420*	-0.0241	-0.0383*	0.0195	0.0130	-0.0102	-0.0250	-0.00933	-0.0247	-0.0108	-0.0260	-0.00194*	-0.00105
	(0.0230)	(0.0235)	(0.0198)	(0.0206)	(0.0236)	(0.0306)	(0.0161)	(0.0166)	(0.0159)	(0.0163)	(0.0163)	(0.0169)	(0.00101)	(0.000724)
$ln(TA)_{it}$	1.908	3.078**	2.465*	3.764***	-0.372	1.175	1.046	2.543**	0.953	2.395**	0.962	2.475**	0.0929**	0.112**
	(1.261)	(1.196)	(1.483)	(1.434)	(1.728)	(1.697)	(1.130)	(1.126)	(1.124)	(1.113)	(1.129)	(1.125)	(0.0430)	(0.0542)
$EnvDisclScore_{i(t-1)}$	0.0741**	0.110***	0.0652**	0.110***	0.107***	0.168***	0.0634**	0.113***	0.0644**	0.112***	0.0641**	0.114***	0.00107	-0.00118
	(0.0290)	(0.0281)	(0.0289)	(0.0284)	(0.0405)	(0.0506)	(0.0281)	(0.0276)	(0.0280)	(0.0277)	(0.0280)	(0.0276)	(0.00108)	(0.00130)
$FP_{i(t-1)}$	-0.0971**	-0.0855**	-0.0167	-0.0108	0.186	0.197	-0.000445	-0.00275	0.00624	0.00707	0.00938	0.00705	-0.00617**	-0.00587
	(0.0425)	(0.0400)	(0.0288)	(0.0281)	(0.124)	(0.165)	(0.0101)	(0.0103)	(0.00849)	(0.00904)	(0.00896)	(0.00875)	(0.00266)	(0.00397)
$EP_{i(t-1)}$	0.616***	0.629***	0.629***	0.642***	0.618***	0.635***	0.621***	0.636***	0.623***	0.637***	0.622***	0.637***	0.537***	0.562***
	(0.0336)	(0.0327)	(0.0338)	(0.0332)	(0.0415)	(0.0418)	(0.0337)	(0.0332)	(0.0338)	(0.0332)	(0.0337)	(0.0332)	(0.0318)	(0.0358)
Constant	7.289	-9.178	-1.704	-19.71	29.55*	8.605	14.40	-5.716	14.90	-4.610	15.05	-5.246	0.899*	0.294
	(13.36)	(12.27)	(15.72)	(14.80)	(17.50)	(16.41)	(11.72)	(11.23)	(11.67)	(11.10)	(11.71)	(11.21)	(0.468)	(0.574)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,836	1,836	1,841	1,841	1,791	1,791	1,841	1,841	1,841	1,841	1,841	1,841	1,666	1,330
R squared	0.9102	0.9136	0.9288	0.9275	0.8153	0.8011	0.932	0.9304	0.9318	0.9302	0.9319	0.9302	0.8666	0.8138

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 2 (in the system of equations) when SEM estimation is performed using brown firms' data. Columns (1) to (12) report the results for estimations performed by replacing the measure of profitability 'ROA' is replaced by alternate measures of profitability namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. Columns (13) and (14) report the results for estimations performed by replacing the measure of environmental performance 'EScore' by alternate measures of environmental performance namely, lnEScore and lnEnvInn. All estimations reported in the table are performed using 3SLS. Estimation in columns (1),(3),(5),(7),(9),(11),(13), and (14) include both firm and time fixed effects. Estimations in columns (2),(4),(6),(8),(10), and (12) include only firm fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 8: Impact of financial performance on environmental performance: Green firms (using alternate measures of financial and environmental performance)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Alternate measures of FP												Alternate measures of EP	
Dependent variable (EP):	$EScore_{it}$												$lnEScore_{it}$	$lnEnvInn_{it}$
ROA_{it} (FP)													-0.0355 (0.0315)	-0.00972 (0.0198)
ROE_{it} (FP)	-0.212 (0.135)	-0.216* (0.131)												
$ROIC_{it}$ (FP)			0.545 (0.701)	0.505 (0.553)										
$ROCE_{it}$ (FP)					0.0740 (0.0711)	0.0789 (0.0673)								
PM_{it} (FP)							-0.0519 (0.0361)	-0.0547 (0.0394)						
$EBITDA/REV_{it}$ (FP)									-0.0552* (0.0306)	-0.0488 (0.0332)				
$EBIT/SALES_{it}$ (FP)											-0.0453* (0.0243)	-0.0324 (0.0260)		
TD/TA_{it}	-0.0483 (0.0502)	-0.00903 (0.0566)	0.00191 (0.112)	0.0101 (0.0783)	-0.133*** (0.0388)	-0.0969** (0.0393)	-0.0906** (0.0356)	-0.0610* (0.0327)	-0.0986*** (0.0353)	-0.0537* (0.0307)	-0.115*** (0.0362)	-0.0635** (0.0304)	-0.00636 (0.00448)	-0.00175 (0.00305)
$SalesGrowth_{it}$	0.0520 (0.0410)	0.0492 (0.0413)	-0.0272 (0.0406)	-0.0266 (0.0346)	-0.0351 (0.0276)	-0.0368 (0.0274)	0.0217 (0.0176)	0.0238 (0.0186)	0.0162 (0.0174)	0.0169 (0.0182)	0.0183 (0.0165)	0.0150 (0.0168)	0.000846 (0.000845)	0.000345 (0.00181)
$ln(TA)_{it}$	-0.288 (1.424)	2.801*** (1.014)	2.668 (2.157)	3.684*** (1.218)	1.476 (1.660)	3.619*** (1.234)	0.963 (0.844)	3.249*** (0.775)	0.358 (0.904)	3.137*** (0.814)	-0.106 (0.919)	2.788*** (0.785)	0.0196 (0.0525)	-0.0319 (0.0430)
$EnvDisclScore_{i(t-1)}$	0.123*** (0.0454)	0.219*** (0.0428)	0.146*** (0.0485)	0.176*** (0.0506)	0.132** (0.0578)	0.183*** (0.0551)	0.138*** (0.0418)	0.208*** (0.0385)	0.136*** (0.0453)	0.221*** (0.0420)	0.128*** (0.0478)	0.221*** (0.0439)	0.00508*** (0.00160)	-0.000523 (0.00150)
$FP_{i(t-1)}$	0.0826 (0.0574)	0.0931* (0.0565)	-0.229 (0.257)	-0.202 (0.203)	-0.0285 (0.0353)	-0.0223 (0.0348)	-0.000602 (0.0168)	0.00900 (0.0170)	-0.0257 (0.0210)	-0.00808 (0.0207)	-0.0128 (0.0201)	0.00106 (0.0194)	0.0116 (0.00997)	0.00298 (0.00465)
$EP_{i(t-1)}$	0.658*** (0.0265)	0.685*** (0.0279)	0.669*** (0.0284)	0.675*** (0.0263)	0.687*** (0.0328)	0.710*** (0.0355)	0.658*** (0.0245)	0.678*** (0.0259)	0.650*** (0.0280)	0.684*** (0.0295)	0.654*** (0.0290)	0.690*** (0.0305)	0.516*** (0.0418)	0.552*** (0.0322)
Constant	13.68 (13.10)	-18.89** (8.473)	-18.08 (24.25)	-29.21** (11.48)	-3.181 (15.37)	-25.99** (10.60)	2.522 (7.789)	-22.02*** (6.534)	9.098 (8.240)	-21.47*** (6.726)	12.98 (8.482)	-18.95*** (6.572)	1.643*** (0.607)	2.123*** (0.556)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,834	1,834	1,841	1,841	1,112	1,112	1,841	1,841	1,537	1,537	1,439	1,439	1,669	1,034
R squared	0.8999	0.895	0.8939	0.8954	0.925	0.9226	0.9189	0.9162	0.9223	0.9189	0.9234	0.9201	0.807	0.8895

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 2 (in the system of equations) when SEM estimation is performed using green firms' data. Columns (1) to (12) report the results for estimations performed by replacing the measure of profitability 'ROA' is replaced by alternate measures of profitability namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. Columns (13) and (14) report the results for estimations performed by replacing the measure of environmental performance 'EScore' by alternate measures of environmental performance namely, lnEScore and lnEnvInn. All estimations reported in the table are performed using 3SLS. Estimation in columns (1),(3),(5),(7),(9),(11),(13), and (14) include both firm and time fixed effects. Estimations in columns (2),(4),(6),(8),(10), and (12) include only firm fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

6. Conclusion

This paper re-examines the relationship between the financial performance (FP) and the environmental performance (EP) of firms operating in different (clean/green and dirty/brown) sectors, to rationalize the different findings advanced in the recent literature. Deploying non-recursive structural equation methods (SEMs) in a dynamic panel data setting, we find that only brown firms that perform better financially are able to improve their environmental performance (FP→EP), e.g. by investing more. This result aligns well with the increased scrutiny and pressure (by regulators and stakeholders) that brown firms are subject to, leading them to invest more in improving their environmental performance. This result appears robust to different model specifications, estimation methods, and alternative measures of FP. The insignificant impact of EP on FP for brown firms is in line with the argument put forward by Palmer et al. (1995). They describe why generalizing a positive impact of EP on FP (EP→FP) is not accurate. The positive impact of EP on FP (EP→FP) may only exist for a select few firms depending on their internal capabilities, see Liu (2020). Even brown firms which may experience huge gains in terms of cost savings from investment in environmental management practices (Klassen and McLaughlin, 1996) lose financially in the near term in an attempt to comply with the regulation. Therefore, regulation may not necessarily prove beneficial for firms' financial health.

A more directed approach (based on firms' internal capabilities) to regulation should achieve win-win results for the environment and businesses as desired. Incentive schemes must be designed for businesses that stand to lose from compliance in the short run. Moreover, since brown firms tend to increase EP when they have more slack (proxied by their FP), policymakers and regulators can nudge these firms to increase EP by giving them financial incentives, such as tax breaks and subsidies.

In the case of green firms, the bi-directional EP-FP relationship is not significant across different model specifications. EP and FP appear unrelated for green firms. Only when exploring alternative measures of financial performance, such as, EBITDA/REV, or EBIT/SALES, we find that better financially performing (green) firms actually perform worse environmentally. This suggests that investing in environmental management practices is not high on the agenda for green firms. However, to achieve the net zero goal, green firms also have to be pushed to invest in environmental management practices. If these firms do not stand to gain substantially in terms of cost savings from investment in better EMPs, more innovative incentive schemes must be designed aimed at low-emitters - such as setting mandatory sector-relevant environmental standards and imposing penalties for non-compliance. These measures will ensure that relatively low-emitting companies (green firms) maintain a baseline level of environmental performance.

Overall, the results of the analysis can be useful for regulatory bodies and governments. There are long-term and short-term goals that public policy strives to achieve. Using sector-specific road maps developed in collaboration with industry is one way to bridge the gap between long-term pledges and short-term action plans. The basic conceptual model developed in this study can be useful for policy makers who seek to formulate sector-specific policy actions to incentivize environmentally friendly corporate behaviour and deter environmentally injurious corporate actions. This study points to the need for regulators and governments to create sector-specific benchmarks for environmental performance to help companies set realistic and relevant goals. And, put in place incentives tailored to each sector's unique characteristics and challenges to make it cost-effective for businesses to achieve those goals.

Further work should address some of the limitations of the study. 'E' of ESG may be subject to some degree of effort to 'greenwash to appear greener' than actually 'being greener'. Hence, addressing these limitations to come up with a clearer classification of brown and green firms and, combining some measures of environmental performance to formulate a more comprehensive indicator of environmental efforts would be welcome in future research.

Appendix A. Table of Definitions

Table of Definitions

Variable	Abbreviation	Definition	Measure of
Environmental Pillar Score	EScore	The ESG scores provided by Refinitiv measure a company's ESG performance, based on data reported by the company. This study uses the 'E' component of the ESG score that represents a company's performance on emissions, environmental innovation, and resource use	Environmental performance
Return on assets	ROA	Ratio of net income and average total assets: percentage profit a business generates from its assets	Profitability
Cash flow from operations to sales	CFO/Sales	Ratio of cash flow from operations and sales: the ability of a firm to generate cash in proportion to its sales	Efficiency
Total debt to total assets	TD/TA	Ratio of total debt and total assets: extent to which the company relies on debt to finance its assets	Leverage
Sales growth	SalesGrowth	Percentage increase/decrease in the sales of a firm from previous year	Firm Growth
Log (total assets)	ln(TA)	Natural logarithm of total assets of a firm	Size
Environmental disclosure score	EnvDisclScore	Score measuring the degree of transparency of a company in disclosing material information regarding the environment.	Transparency
Capital intensity	CapitalIntensity	Ratio of total assets to revenue: the ability of a company to generate sales from its assets	Efficiency
Return on invested capital	ROIC	Ratio of net operating profit after tax and invested capital: gauges how well a company uses its capital to generate profits	Profitability
Return on Equity	ROE	Ratio of net income and shareholders' equity: gauges how well a company manages its shareholders' capital to generate profits	Profitability
EBITDA to revenue ratio	EBITDA/REV	Ratio of EBITDA (Earnings before interest, tax, depreciation, and amortization) and sales	Profitability
Return on capital employed	ROCE	Ratio of operating profit and capital employed: gauges how well a company uses its total capital to generate profits	Profitability
Profit margin	PM	Ratio of net income to revenue: gauges the extent to which a business activity is profitable after deducting all expenses	Profitability
EBIT to sales	EBIT/SALES	Ratio of EBIT (Earnings before interest and tax) and sales: represents operating margin of a company	Profitability
Log (Environmental Pillar Score)	lnScore	Natural logarithm of the Environmental Pillar Score	Environmental performance of a company
Log (Environmental Innovation Score)	lnEnvInn	The environmental pillar score, used as our benchmark measure, is a combination of the emission reduction score, the resource use score, and the environmental innovation score. The environmental innovation score is a measure of a company's ability to lower environmental costs and burdens on its customers. We use the natural logarithm of the Environmental Innovation Score.	Environmental performance of a company
Emission Reduction	ER	A dummy variable that takes the value '1' if a company has either achieved some reduction in the level of emissions or has incurred some expenditure related to the environment. A value of 0 indicates that the company has neither reduced emissions nor incurred any environmental expenditures.	Emission reduction or environmental expenditure

Notes: This table contains names of the variables used in the analysis, their acronyms, definitions, and what they measure.

Appendix B. First stage IV results

The first stage results for equation 1 for the brown sample, green sample, and full sample are presented in Table B.9 below:

Table B.9: First stage IV results for equation 1 (EP→FP)

	Brown sample	Green Sample	Full sample
Dependent Variable: ROA_{it}			
TD/TA_{it}	-0.065***	-0.125***	-0.102***
	(0.012)	(0.016)	(0.010)
$SalesGrowth_{it}$	0.062***	0.030***	0.035***
	(0.007)	(0.007)	(0.005)
$\ln(TA)_{it}$	-1.935***	-0.798*	-1.012***
	(0.510)	(0.484)	(0.348)
$EnvDisclScore_{i(t-1)}$	0.007	-0.009	-0.001
	(0.013)	(0.016)	(0.010)
$ROA_{i(t-1)}$	0.238***	0.303***	0.282***
	(0.024)	(0.025)	(0.018)
$EScore_{i(t-1)}$	-0.003	-0.013	-0.006
	(0.011)	(0.010)	(0.008)
$CFO/Sales_{it}$	0.114***	-0.002	0.015**
	(0.014)	(0.009)	(0.007)
$CapitalIntensity_{it}$	-0.335	-0.169	-0.341***
	(0.222)	(0.103)	(0.091)
Constant	62.804***	-24.267***	19.009***
	(6.027)	(7.261)	(5.966)
Year FEs	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes
Instrument F-test	14.89***	12.15***	12.81***
Sargan chi2	1.376	2.05	0.845
p-value	0.2407	0.1522	0.3579
N	1,841	1,841	3,682
R-squared	0.6978	0.6655	0.6635

Notes: This table contains estimates of coefficients and standard errors (in parentheses) for the first stage results of Equation 1 (in the system of equations) when SEM estimation is performed using brown, green, and full sample (brown and green combined) data. All estimations reported in the table are performed using 3SLS. Estimations in all columns include both firm and time fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The full sample comprises all firms listed on the S&P 500 index. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

The first stage results for equation 1 (presented in Table B.9) show that the instruments for ROA_{it} i.e. $CFO/Sales_{it}$ and $CapitalIntensity_{it}$ are jointly significant (indicated by values of F-statistic greater than 10) for brown, green, and the full samples. The overidentification test results also indicate the joint validity of instruments (see p-value>0.05) for brown, green, and full samples.

The first stage results for equation 2 for the brown sample, green sample, and full sample are presented in Table B.10 below:

Table B.10: First stage IV results for equation 2 (FP→EP)

	Brown sample	Green Sample	Full sample
Dependent Variable: $\text{EScore}_{\text{it}}$			
TD/TA_{it}	0.024	-0.078**	-0.021
	(0.021)	(0.031)	(0.018)
$\text{SalesGrowth}_{\text{it}}$	-0.007	0.011	-0.0001
	(0.013)	(0.012)	(0.008)
$\ln(\text{TA})_{\text{it}}$	1.600*	0.991	1.320**
	(0.931)	(0.904)	(0.627)
$\text{EnvDisclScore}_{\text{i(t}-1)}$	0.067***	0.137***	0.093***
	(0.023)	(0.029)	(0.018)
$\text{ROA}_{\text{i(t}-1)}$	0.013	-0.020	0.005
	(0.044)	(0.048)	(0.032)
$\text{EScore}_{\text{i(t}-1)}$	0.620***	0.661***	0.650***
	(0.021)	(0.019)	(0.014)
$\text{CFO/Sales}_{\text{it}}$	0.015	-0.021	-0.007
	(0.026)	(0.016)	(0.012)
$\text{CapitalIntensity}_{\text{it}}$	-0.548	0.043	-0.147
	(0.406)	(0193)	(0.165)
Constant	0.989	4.767	29.446
	(11.006)	(13.566)	(10.763)
Year FEs	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes
Instrument F-test	88.86***	69.87***	80.94***
Sargan chi2	1.376	2.05	0.845
p-value	0.2407	0.1522	0.3579
N	1,841	1,841	3,682
R-squared	0.9323	0.9197	0.9257

Notes: This table contains estimates of coefficients and standard errors (in parentheses) for the first stage results pf Equation 2 (in the system of equations) when SEM estimation is performed using brown, green, and full sample (brown and green combined) data. All estimations reported in the table are performed using 3SLS. Estimations in all columns include both firm and time fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The full sample comprises all firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

The first stage results for equation 2 (presented in Table B.10) show that the instrument for $\text{EScore}_{\text{it}}$ i.e. $\text{EnvDisclScore}_{\text{i(t}-1)}$ is significant (indicated by values of F-statistic greater than 10) for brown, green, and the full samples. The overidentification test results also indicate the validity of the instrument (see p-value>0.05) for brown, green, and full samples.

Appendix C. Results: Impact of Environmental Performance on Financial Performance

The results reported under column (1) in Table C.11 indicate that the impact of $\mathrm{EScore_{it}}$ on $\mathrm{ROA_{it}}$ for brown firms is positive but not statistically significant in the most robust setting, i.e. with $\mathrm{EScore_{i(t-1)}}$ and $\mathrm{ROA_{i(t-1)}}$, and both firm and time FEs. But the impact of $\mathrm{EScore_{it}}$ on $\mathrm{ROA_{it}}$ is positive and statistically significant under column (2), once time FEs are removed from column (1) model specification. This result points out that when variation in $\mathrm{ROA_{it}}$ explained by year shocks is taken into account, the variation in $\mathrm{ROA_{it}}$ explained by $\mathrm{EScore_{it}}$ becomes insignificant. So, it can be concluded that the impact of $\mathrm{EScore_{it}}$ on $\mathrm{ROA_{it}}$ is not statistically significant.
It is also evident that the impact of $\mathrm{EScore_{i(t-1)}}$ on $\mathrm{ROA_{it}}$ is negative and significant in column (2). This negative impact of $\mathrm{EScore_{i(t-1)}}$ on $\mathrm{ROA_{it}}$ is in line with El Khoury et al. (2023). However, our interpretation of the results differs once we control for the presence of time dummies in column (1). In this case, we find the absence of any contemporaneous or lagged statistically significant effect of EScore on $\mathrm{ROA_{it}}$[17].

Looking at other controls, we find that $\mathrm{TD/TA_{it}}$, $\mathrm{ln(TA)_{it}}$ and $\mathrm{CapitalIntensity_{it}}$ negatively influence $\mathrm{ROA_{it}}$ while $\mathrm{SalesGrowth_{it}}$, $\mathrm{CFO/Sales_{it}}$ and $\mathrm{ROA_{i(t-1)}}$ positively influence $\mathrm{ROA_{it}}$, in line with results reported in the literature.

Columns (3) and (4) present the results excluding lags of EScore and ROA while including firm and time FEs, and including only firm FEs, respectively. Here, the coefficients of $\mathrm{EScore_{it}}$ are not statistically significant and are very small in magnitude compared to those under columns (1) and (2), likely due to the presence of suppression effects[18] (Williams and Jorgensen, 2023). The findings are consistent across estimation techniques - the GSEM results reported under columns (1), (2), (3) and (4) are very similar to the corresponding 3SLS specifications, reported under columns (5), (6), (7) and (8).

[17]We conducted a Wald test to confirm the lack of statistical significance of both contemporaneous and lagged effects of EScore on ROA. Results are available upon request.

[18]The suppression effect occurs when adding a predictor increases another variable's predictive ability.

The results reported in Table C.12 under column (1), indicate that the impact of $\text{EScore}_{\text{it}}$ on ROA_{it} is negative but not statistically significant for green firms. When excluding year fixed effects, under column (2), the sign reverses. This sign reversal could result from the fact that time dummies act as potential confounding variables in our analysis. Confounding variables ('confounders') are variables that influence both the dependent (ROA_{it} or FP) and the independent variable ($\text{EScore}_{\text{it}}$ or EP). As both EP and FP increase with time, see Table 3, and both EP & FP are also positively associated (unconditionally), results of models excluding time dummies may suffer from omitted variable bias (Busch et al., 2022). The results under columns (3) and (4) also indicate that the inclusion of time dummies switches the signs of the coefficient of $\text{EScore}_{\text{it}}$. This finding reinforces the possibility that time dummies act as strong 'confounders' in the contemporaneous relationship between EP and FP for green firms. Moreover, $\text{EScore}_{\text{it}}$ is an insignificant predictor of ROA_{it} even in the setting excluding lags of EScore and ROA. As for the controls, under column (1) (the main setting), TD/TA_{it} and $\text{ROA}_{\text{i(t-1)}}$ are the only significant predictors of ROA_{it}, while all other controls do not appear to be statistically significant.

The results under columns (1) and (2) are very similar to the results reported under columns (5) and (6). And similarly for the results reported under columns (3) and (4) and (7) and (8) respectively. Hence, irrespective of the estimation technique and model specification, contemporaneous EP appears not to impact the FP of green firms.

The results in Table C.13 indicate that the impact of contemporaneous EP on FP (for all cases except column (1)) is positive but not statistically significant, corroborating the result reported in Table C.11. For example, the magnitude of the impact of contemporaneous EP on FP becomes larger in most cases when year FEs are taken into account - this points to the possibility (as discussed above) that the year dummies act as suppressors.

Table C.14 reports that controlling for lagged EP, the impact of contemporaneous EP on FP for green firms is negative but statistically non-significant (in the setting that includes both firm and time FEs) for four out of six measures of profitability considered, namely, ROE, ROIC, ROCE, and EBITDA/REV. These results conform with those reported in Table C.12. The sign reversal for the contemporaneous effect of EP on FP upon considering time FEs (in addition to firm FEs) is also much the same as observed in Table C.12. This sign reversal could be stemming from omitted variable bias (which occurs if year dummies are not included in the model specification) that confounds the results in the setting with only firm FEs.

Table C.11: Impact of Environmental Performance on Financial Performance: Brown Firms

	GSEM				3SLS				Sureg
	Baseline results								Mechanism results
	With lags		Without lags		With lags		Without lags		With lags
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable: ROA_{it}									
$EScore_{it}$	0.113	0.178*	-0.00357	0.0529	0.113	0.178*	-0.00368	0.0529	0.0246**
	(0.194)	(0.104)	(0.122)	(0.0568)	(0.189)	(0.103)	(0.120)	(0.0563)	(0.0113)
TD/TA_{it}	-0.0678	-0.0713	-0.0612	-0.0621	-0.0677	-0.0713	-0.0612	-0.0621	-0.0663
	(0.0485)	(0.0506)	(0.0542)	(0.0550)	(0.0484)	(0.0505)	(0.0540)	(0.0548)	(0.0536)
$SalesGrowth_{it}$	0.0627***	0.0734***	0.0573***	0.0669***	0.0627***	0.0734***	0.0573***	0.0669***	0.0572***
	(0.0153)	(0.0167)	(0.0148)	(0.0159)	(0.0153)	(0.0167)	(0.0148)	(0.0159)	(0.0150)
$ln(TA)_{it}$	-2.029**	-2.198**	-1.508	-1.627	-2.031**	-2.198**	-1.508	-1.627	-1.947*
	(0.971)	(0.986)	(1.171)	(1.158)	(0.969)	(0.989)	(1.184)	(1.164)	(1.018)
$CFO/Sales_{it}$	0.108***	0.108***	0.122***	0.118***	0.108***	0.108***	0.122***	0.118***	0.121***
	(0.0258)	(0.0245)	(0.0312)	(0.0296)	(0.0242)	(0.0239)	(0.0297)	(0.0288)	(0.0233)
$CapitalIntensity_{it}$	-0.356	-0.427	-0.500	-0.612	-0.354	-0.427	-0.498	-0.611	-0.154
	(0.391)	(0.387)	(0.421)	(0.408)	(0.397)	(0.388)	(0.424)	(0.409)	(0.401)
$FP_{i(t-1)}$	0.237***	0.232***			0.237***	0.232***			0.222***
	(0.0491)	(0.0500)			(0.0489)	(0.0499)			(0.0425)
$EP_{i(t-1)}$	-0.0738	-0.114*			-0.0737	-0.113*			-0.0299**
	(0.121)	(0.0666)			(0.118)	(0.0662)			(0.0127)
Constant	20.76*	22.23**	22.66	20.90**	20.99**	22.23**	22.63*	20.90**	23.26**
	(11.95)	(9.030)	(13.84)	(10.31)	(10.63)	(9.035)	(12.32)	(10.34)	(10.04)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,841	1,841	1,864	1,864	1,841	1,841	1,864	1,864	1,624
R squared					0.6886	0.6633	0.6742	0.6652	0.695

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 1 (in the system of equations) when estimation is performed using brown firms' data. Columns (1)-(4) contain estimates of the GSEM estimation technique. Columns (5)-(8) contain estimates of the 3SLS technique. Column 9 contains estimates of Sureg technique. Estimations in columns (1),(3),(5), (7), and (9) include both firm and year fixed effects. Estimations in columns (2),(4),(6), and (8) include only firm fixed effects. Standard errors in all estimations (1)-(9) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistics only for the 3SLS estimates (the goodness of fit statistics cannot be obtained when GSEM is used.). The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table C.12: Impact of Environmental Performance on Financial Performance: Green Firms

	GSEM				3SLS				Sureg
	Baseline results								Mechanism results
	With lags		Without lags		With lags		Without lags		With lags
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable: ROA_{it} (FP)									
$EScore_{it}$ (EP)	-0.0631	0.135	-0.0483	0.0475	-0.0633	0.135	-0.0483	0.0474	-0.0320**
	(0.141)	(0.0978)	(0.0669)	(0.0458)	(0.139)	(0.0969)	(0.0668)	(0.0458)	(0.0161)
TD/TA_{it}	-0.130***	-0.105***	-0.158***	-0.135***	-0.130***	-0.105***	-0.158***	-0.135***	-0.103**
	(0.0381)	(0.0366)	(0.0444)	(0.0438)	(0.0378)	(0.0365)	(0.0444)	(0.0438)	(0.0419)
$SalesGrowth_{it}$	0.0278	0.0270	0.0144	0.0134	0.0288*	0.0272	0.0144	0.0134	0.0680***
	(0.0239)	(0.0226)	(0.0184)	(0.0194)	(0.0174)	(0.0178)	(0.0184)	(0.0188)	(0.0259)
$\ln(TA)_{it}$	-0.776	0.102	-0.0811	0.882	-0.742	0.100	-0.0812	0.883	-1.265
	(1.101)	(1.002)	(1.379)	(1.471)	(0.932)	(1.000)	(1.381)	(1.477)	(0.936)
$CFO/Sales_{it}$	0.00138	-0.00172	0.0166	0.0155	-0.000790	-0.00207	0.0166	0.0155	0.0522***
	(0.0470)	(0.0346)	(0.0254)	(0.0260)	(0.0218)	(0.0227)	(0.0250)	(0.0241)	(0.0174)
$CapitalIntensity_{it}$	-0.152	-0.287***	-0.233**	-0.335***	-0.167*	-0.286***	-0.233**	-0.335***	-0.0602
	(0.324)	(0.101)	(0.108)	(0.111)	(0.0888)	(0.0928)	(0.108)	(0.114)	(0.0783)
$FP_{i(t-1)}$	0.299***	0.305***			0.300***	0.305***			0.314***
	(0.0679)	(0.0656)			(0.0677)	(0.0664)			(0.0622)
$EP_{i(t-1)}$	0.0282	-0.0933			0.0284	-0.0934			0.0171
	(0.0926)	(0.0680)			(0.0916)	(0.0674)			(0.0145)
Constant	18.17**	4.902	15.35	0.978	15.01*	4.917	12.11	0.971	16.99**
	(8.931)	(8.166)	(11.66)	(11.85)	(7.991)	(8.095)	(11.32)	(11.87)	(8.257)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,841	1,841	1,869	1,869	1,841	1,841	1,869	1,869	1,384
R squared					0.662	0.6332	0.6252	0.6115	0.683

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 1 (in the system of equations) when estimation is performed using green firms' data. Columns (1)-(4) contain estimates of the GSEM estimation technique. Columns (5)-(8) contain estimates of the 3SLS technique. Column 9 contains estimates of Sureg technique. Estimations in columns (1),(3),(5), (7), and (9) include both firm and year fixed effects. Estimations in columns (2),(4),(6), and (8) include only firm fixed effects. Standard errors in all estimations (1)-(9) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistics only for the 3SLS estimates (the goodness of fit statistics cannot be obtained when GSEM is used.). The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table C.13: Impact of environmental performance on financial performance: Brown firms (using alternate measures of financial and environmental performance)

	Alternate measures of FP												Alternate measures of EP	
Dependendit variable (FP):	ROE_{it}		$ROIC_{it}$		$ROCE_{it}$		PM_{it}		$EBITDA/REV_{it}$		$EBIT/SALES_{it}$		ROA_{it}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$lnEScore_{it}$ (EP)													9.914 (12.88)	
$lnEnvInn_{it}$ (EP)														-14.84 (21.20)
$EScore_{it}$ (EP)	-1.356 (1.896)	0.311 (0.650)	0.0826 (0.417)	0.240 (0.208)	1.456 (1.069)	1.066** (0.531)	0.916 (0.646)	0.435 (0.274)	0.360 (0.474)	0.277 (0.220)	0.581 (0.544)	0.0924 (0.242)		
TD/TA_{it}	0.108 (0.143)	0.114 (0.144)	-0.00920 (0.0739)	-0.0119 (0.0778)	-0.0244 (0.0864)	-0.0501 (0.0964)	-0.140 (0.0893)	-0.154 (0.0938)	-0.0760 (0.0766)	-0.0844 (0.0828)	-0.0991 (0.0916)	-0.112 (0.0978)	-0.0602 (0.0499)	-0.101** (0.0395)
$SalesGrowth_{it}$	0.191*** (0.0534)	0.218*** (0.0505)	0.109*** (0.0194)	0.119*** (0.0210)	0.0994*** (0.0357)	0.122*** (0.0362)	0.152** (0.0687)	0.177** (0.0705)	0.178*** (0.0682)	0.195*** (0.0716)	0.195*** (0.0740)	0.217*** (0.0766)	0.0687*** (0.0213)	0.0320*** (0.0112)
$ln(TA)_{it}$	-2.465 (4.689)	-3.824 (3.913)	-7.310*** (2.455)	-7.555*** (2.492)	-5.270* (2.832)	-5.114* (2.813)	2.234 (3.373)	1.746 (3.292)	-0.935 (2.654)	-1.118 (2.614)	0.681 (3.268)	0.212 (3.264)	-2.334* (1.246)	0.189 (1.802)
$CFO/Sales_{it}$	0.281** (0.141)	0.278** (0.125)	0.173*** (0.0477)	0.176*** (0.0478)	-0.0491 (0.0708)	-0.0676 (0.0646)	0.877*** (0.112)	0.888*** (0.111)	0.863*** (0.0779)	0.863*** (0.0780)	0.913*** (0.0881)	0.923*** (0.0895)	0.109*** (0.0402)	0.190* (0.115)
$CapitalIntensity_{it}$	-3.121* (1.772)	-1.868 (1.371)	-0.0705 (0.576)	-0.105 (0.556)	2.464 (1.735)	1.232 (1.249)	-3.773* (2.037)	-4.023* (2.073)	1.828 (1.583)	1.763 (1.558)	-1.188 (1.922)	-1.369 (1.960)	-0.280 (0.341)	-1.386*** (0.483)
$FP_{i(t-1)}$	0.738*** (0.164)	0.754*** (0.169)	0.196*** (0.0449)	0.189*** (0.0471)	0.581*** (0.0635)	0.577*** (0.0627)	0.0816** (0.0376)	0.0828** (0.0396)	0.00517 (0.0349)	0.00120 (0.0361)	0.0549 (0.0393)	0.0579 (0.0407)	0.240*** (0.0522)	0.212*** (0.0662)
$EP_{i(t-1)}$	0.858 (1.206)	-0.145 (0.465)	-0.0851 (0.264)	-0.183 (0.136)	-0.912 (0.662)	-0.681** (0.347)	-0.583 (0.411)	-0.293 (0.184)	-0.263 (0.301)	-0.212 (0.147)	-0.393 (0.346)	-0.0993 (0.161)	-5.263 (6.895)	8.642 (11.99)
Constant	54.74 (43.20)	20.13 (38.90)	78.58** (31.45)	78.47*** (25.64)	14.13 (34.14)	27.75 (25.57)	-43.35 (35.99)	-22.62 (31.66)	8.477 (27.09)	13.58 (25.05)	-18.09 (34.88)	1.919 (31.65)	7.064 (20.91)	31.56 (23.85)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,836	1,836	1,841	1,841	1,791	1,791	1,841	1,841	1,841	1,841	1,841	1,841	1,666	1,330
R squared	0.7597	0.7725	0.6453	0.6233	0.8183	0.8262	0.4794	0.5626	0.558	0.5613	0.5348	0.572	0.5982	0.1637

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 1 (in the system of equations) when SEM estimation is performed using brown firms' data. Columns (1) to (12) report the results for estimations performed by replacing the measure of profitability 'ROA' is replaced by alternate measures of profitability namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. Columns (13) and (14) report the results for estimations performed by replacing the measure of environmental performance 'EScore' by alternate measures of environmental performance namely, lnEScore and lnEnvInn. All estimations reported in the table are performed using 3SLS. Estimation in columns (1),(3),(5),(7),(9),(11),(13), and (14) include both firm and time fixed effects. Estimations in columns (2),(4),(6),(8),(10), and (12) include only firm fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table C.14: Impact of environmental performance on financial performance: Green firms (using alternate measures of financial and environmental performance)

	Alternate measures of FP												Alternate measures of EP	
Dependent variable (FP):	ROE_{it}		$ROIC_{it}$		$ROCE_{it}$		PM_{it}		$EBITDA/REV_{it}$		$EBIT/SALES_{it}$		ROA_{it}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$lnEScore_{it}$ (EP)													0.814 (3.843)	
$lnEnvInn_{it}$ (EP)														1.291 (37.19)
$EScore_{it}$ (EP)	-0.465 (0.611)	0.370 (0.376)	-0.125 (0.223)	0.242 (0.205)	-0.657 (1.019)	0.999 (0.653)	0.0650 (0.291)	0.509** (0.223)	-0.0794 (0.245)	0.104 (0.119)	0.203 (0.237)	0.147 (0.131)		
TD/TA_{it}	0.0932 (0.181)	0.206 (0.204)	-0.158*** (0.0605)	-0.110* (0.0611)	0.0687 (0.199)	0.432* (0.256)	-0.292*** (0.0876)	-0.224*** (0.0840)	-0.0706 (0.0600)	-0.0369 (0.0448)	-0.0173 (0.0457)	-0.0233 (0.0345)	-0.141*** (0.0408)	-0.150*** (0.0466)
$SalesGrowth_{it}$	0.235** (0.0952)	0.228** (0.0952)	0.0710** (0.0321)	0.0661** (0.0318)	0.271** (0.134)	0.289** (0.127)	0.173*** (0.0428)	0.167*** (0.0426)	0.157*** (0.0385)	0.155*** (0.0383)	0.100*** (0.0250)	0.102*** (0.0241)	0.0130 (0.0135)	0.0675** (0.0285)
$ln(TA)_{it}$	-5.250 (3.275)	-2.191 (3.362)	-2.926 (2.349)	-1.425 (2.325)	-18.17** (7.438)	-8.896 (5.809)	-0.642 (2.232)	0.999 (2.289)	1.411 (1.103)	2.397* (1.413)	-0.606 (1.289)	-0.638 (1.371)	0.0485 (1.014)	-1.624 (1.007)
$CFO/Sales_{it}$	0.138** (0.0669)	0.177*** (0.0681)	-0.0402 (0.0386)	-0.0382 (0.0383)	-0.733 (0.762)	-0.600 (0.667)	0.422*** (0.0778)	0.431*** (0.0759)	0.490*** (0.0696)	0.494*** (0.0679)	0.682*** (0.0383)	0.676*** (0.0359)	0.0118 (0.0166)	0.0325 (0.0226)
$CapitalIntensity_{it}$	-0.405* (0.226)	-0.665*** (0.257)	0.0637 (0.226)	-0.147 (0.173)	-3.614 (3.894)	-4.999 (3.836)	-0.394 (0.317)	-0.513 (0.329)	-1.192*** (0.434)	-1.258*** (0.474)	-2.737*** (0.788)	-2.804*** (0.774)	-0.187** (0.0808)	-0.0738 (0.129)
$FP_{i(t-1)}$	0.415*** (0.0419)	0.422*** (0.0403)	0.389*** (0.106)	0.397*** (0.109)	0.471*** (0.0636)	0.484*** (0.0661)	-0.0803 (0.0805)	-0.0741 (0.0813)	0.0441 (0.0707)	0.0514 (0.0683)	0.105** (0.0446)	0.102** (0.0445)	0.308*** (0.0593)	0.195*** (0.0663)
$EP_{i(t-1)}$	0.297 (0.425)	-0.220 (0.281)	0.0677 (0.149)	-0.158 (0.143)	0.329 (0.670)	-0.703 (0.486)	-0.103 (0.189)	-0.378** (0.159)	0.0123 (0.161)	-0.0973 (0.0861)	-0.192 (0.155)	-0.159* (0.0908)	-0.578 (1.972)	-0.743 (20.62)
Constant	53.56* (27.79)	13.97 (26.56)	36.69** (18.43)	17.72 (17.44)	197.7** (80.47)	87.36* (45.86)	16.93 (19.16)	-3.550 (17.85)	2.962 (9.371)	-8.771 (9.980)	9.596 (10.42)	11.70 (9.974)	5.660 (9.740)	20.05 (70.72)
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,834	1,834	1,841	1,841	1,112	1,112	1,841	1,841	1,537	1,537	1,439	1,439	1,669	1,034
R squared	0.7	0.6963	0.6156	0.5821	0.6763	0.6673	0.8055	0.783	0.9511	0.9501	0.954	0.9548	0.685	0.7224

Notes: This table contains estimates of coefficients and standard errors (in parantheses) for Equation 1 (in the system of equations) when SEM estimation is performed using green firms' data. Columns (1) to (12) report the results for estimations performed by replacing the measure of profitability 'ROA' is replaced by alternate measures of profitability namely, ROE, ROIC, ROCE, PM, EBITDA/REV, and EBIT/SALES. Columns (13) and (14) report the results for estimations performed by replacing the measure of environmental performance 'EScore' by alternate measures of environmental performance namely, lnEScore and lnEnvInn. All estimations reported in the table are performed using 3SLS. Estimation in columns (1),(3),(5),(7),(9),(11),(13), and (14) include both firm and time fixed effects. Estimations in columns (2),(4),(6),(8),(10), and (12) include only firm fixed effects. Standard errors in all estimations i.e. in columns (1)-(12) are clustered at the firm level to take into account the effects of autocorrelation and heteroskedasticity. The second last row contains the number of observations used in the estimation. The last row of the table contains the R-squared statistic. The sample comprises firms listed on the S&P 500 index. The data employed is annual and pertains to the period from 2011 to 2020. The data used is retrieved from Refinitiv and Bloomberg. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

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