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# Distilling the Interplay Between Corporate Environmental Management, Financial, and Emissions Performance: Evidence From U.S. Firms

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***Abstract*—This article investigates the relationship between firms' carbon intensity, carbon management practices, and their financial performance. The extant literature on firms' financial performance and their environmental performance has mostly considered a single dimension of firms' environmental performance leading to restricted, and often, mixed outcomes. With panel data collected on financial statements and climate change related activities from 136 corporate firms in the U.S. between 2011 and 2018, this article integrates a process dimension based on an environmental management score with an outcome dimension represented by firms' carbon emissions intensity. A regression model is employed to investigate the relationships between corporate environmental performance and corporate financial performance. We find evidence of a nonlinear relationship between corporate firms' environmental performance and financial performance across both high and low-carbon intensive sectors. Specifically, we find that for firms in the high-carbon intensive sector, a U-shaped relationship exists between firms' corporate environmental performance outcome dimension and their financial performance while for the low-carbon intensive sector, the converse is the case. The results show that the interaction between the outcome dimension of environmental performance and financial performance is moderated by the process dimension of environmental performance for firms in the low- and high-carbon intensive sectors.**

***Index Terms*—Carbon management, emissions, environmental performance, financial performance, investments.**

## I. Introduction

OVER the past decade, there has been a tremendous growth in corporate investment for environment protection projects. These investment projects aim at limiting the impact of firm operations on their immediate environment. This study provides an in-depth analysis carefully examining the interplay between the effects of firms' corporate investments in making their operations more environmentally sustainable and their financial performance. The increased corporate response to environmental management can be attributed to the constant pressure from stakeholders (investors, shareholders, customers, nongovernment organizations (NGOs) and governments) to reduce their environmental impact and operate with less carbon footprint, along with delivering more environmentally friendly products and services [1]–[3]. In response to these demands, many firms have taken advantage of market opportunities by proactively increasing investments in emissions abatement projects [4], [5]. Likewise, in order to meet the Paris Climate Change Accord's targets, it is imperative to look beyond those policies set at the macroeconomic level and further consider decisions and actions implemented by firms at mitigating emissions on the firm level [6], [7]. Studies also show how corporate firms make substantial contributions towards total greenhouse gas (GHG) emissions. For example, it is estimated that the top 250 corporate emitters are responsible for about one-third of the global annual anthropogenic GHG emissions [8]. Therefore, these reasons have made it crucial for firms to integrate sustainable environmental protection investment projects within their business operations.

Considering investments in emissions abatement usually come at a considerable cost and corporate managers are primarily in the business of maximizing shareholder profits, the value of being green is repeatedly questioned. Under what circumstances does it pay to be green? How much of firm resources should be invested in environmental protection projects and what effects would such investments have on the firm's bottom line? Consequently, these pertinent questions pose a dilemma on the extent of environmental friendliness to be adopted by corporate bodies. While interrelations between corporate environmental performance (CEP) and corporate financial performance (CFP) have been researched, the relationship between the two is vague, as shown in conflicting results from past literature. Moreover, when coupled with the ambiguity surrounding firms' financial performance due to self-reporting on environmental stewardship [9], [10], an additional investigation is necessary to effectively determine the interrelations between CEP and CFP.

It has been postulated that corporate investments in environment projects are direct costs, which draw firms away from their

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core operations and negatively impact competitiveness [11]–[13]. Such conclusion, describes a tradeoff situation between CEP and CFP. On the contrary, it has been found that firms with superior CEP can be rewarded with improved competitiveness [2], [14]. This stream of research explains that improved technology investment in emissions abatement reduces waste and improves resource utilization and firm productivity—ultimately leading to positive effects on CFP [15].

This article aims to resolve such ambiguity by examining the consequences of organizations' environmental activities on their CFP through removing the generalized treatment of firms and further taking into consideration the multidimensional nature of CEP. CEP has previously been measured as either i) the environmental operational performance/outcomes dimension which considers the output of a firm's operational activities as it relates to its natural environment, or ii) the environmental management performance/process dimension, which refers to management principles and activities aimed towards reducing the impact of their operations on the natural environment. However, studies have shown these two to be dissimilar constructs which fail to individually capture or explain a comprehensive measure of CEP [16]–[19].

Supported by prior existing literature, our research exposes how the results in the studies are underlined by the generalized treatment of firms. By introducing a bifurcated treatment of firms along high- and low-carbon intensive sectors, our results differ from previous studies by showing empirical evidence of contrasting nonlinear relations between the outcomes dimensions of CEP and CFP across bifurcated groups. Additionally, we also introduce a new robust measurement construct for the process dimension of CEP. Likewise, by integrating a comprehensive set of environmental management practices developed from the Carbon Disclosure Project (CDP) reporting guidelines into an environmental management score (EMS), we successfully capture the process dimension measure in its entirety. We, then, investigate the combined nonlinear effects of this new metric and the outcome dimension metric on CFP in a curvilinear study using regression analysis. Better yet, our results also show evidence across both industry segment groups of a moderating effect of the process dimension on the relationship between the outcomes dimension measure and both the accounting and stock market measurement metric of CFP. Ultimately, these provide an in-depth analysis into the interplay between CEP and CFP.

The contributions of this research to the existing literature provide theoretical insights that reveal how business performance of firms is not only related to technology investments in environmental mitigation as observed from firm environmental outputs but is also distinguished by industrial sectoral differences. Furthermore, the study sheds some light on how the combined effects of technology investment in emission mitigation and firm-level investments in environmental policies influence the business performance of firms. In doing so, this clarifies to business managers, practical commitment levels in improving overall environmental performance as it relates to the carbon intensity of the business environment.

This study presents several practical implications for corporate managers and decision makers involved in both the planning and implementation of corporate environmental and sustainability projects. For firms in the high-carbon intensive sector, corporate investments in environmental protection have to exceed certain thresholds before marginal economic benefits outweigh marginal costs. Beyond this threshold, firms are rewarded by the market for improved outcomes results. For this group of firms, corporate managers may realize that investing in strategic environmental management processes alongside technology investments in emission abatement is expected to be rewarded by the market with improvements in their future earning potentials. On the contrary, for firms in the low emissions sectors, corporate investments in environmental protection exhibit diminishing returns beyond a certain threshold, which imply negative effects on firm financial performance. For this group of firms, corporate managers may also realize the importance of balancing investments in strategic environmental management processes alongside investments in emissions abatement technologies.

## II. Background

Some steps taken by corporate organizations in limiting their GHG emissions include investments in energy efficient and low-carbon energy technologies, and engagement in several corporate carbon management practices. Carbon management is critical to the success of corporate firms due to several imminent climate change risks and opportunities they face. As a result, corporate organizations are constantly faced with pressure from stakeholders (government, shareholders, potential investors, NGOs, and environmental regulatory organizations) to limit their carbon emissions [20]–[23]; particularly in how technical knowledge informs their technology choices [24]. Governments have introduced various incentives to encourage reduction of GHG emissions at the corporate level. In a similar vein, consumers are increasingly focusing on doing business with environmentally friendly corporations who have provided information on their GHG mitigation actions [25]–[28]. Thus, corporate firms are constantly aiming to improve their environmental performance. In the following sections, a review of the literature highlights underlying distinguishing metrics on the constructs and linkages between CEP and CFP.

### A. *Construct for Corporate Environmental Performance*

Environmental performance metrics are necessary to assist stakeholders in decision making and provide a basis for drawing comparisons across corporate organizations [17]. Over the years, studies have defined and measured the scope of CEP [16]–[19]. Three different perspectives of environmental measurement were identified by [16], which include process improvements, environmental cleanliness, and customer satisfaction, with arguments that none of these measures solely capture the entire concept of environmental measurement. Similarly, Xie and Hayase[18], Trumpp *et al.* [19], and Delmas *et al.* [29] identified two distinctive dimensions of CEP, which include environmental processes and environmental outcomes. Specifically, environmental processes refer to management practices aimed towards reducing the effect of business operations on the natural environment. Environmental outcomes on the hand refer

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to the operational performance indexes or the outputs from firm operational activities such as $CO_2$, $NO_X$, and $SO_X$ emissions. As a result, the outcomes measures are easily conceptualized and can be represented by common operational performance indexes unlike the process measures, which are intangible and pose a measurement challenge. We further argue that the inconsistencies in the extant literature could, therefore, stem from the incomplete conceptualization of the CEP measurement construct. In this study, a firm's outcome based measure is represented by its carbon performance (CP) [6], [29] and its process based measure by an EMS.

### *B. Relationship Between Environmental and Financial Performance*

The effect of CEP on CFP can be explained using various management theories. The traditional economic theory of firms by [30], assert that organizations should be in the business of maximizing shareholder wealth and not engaging in social responsibilities, which as this shifts focus away from firms' primary responsibilities—ultimately implying that environmental protection efforts could negatively impact a firms bottom line. On the other hand, drawing from the stakeholder's theory, a firm's stakeholders respond to accounting and market signals in relation to its environmental responsiveness [31]. Therefore, the level of a firm's commitment to stakeholder demands in relation to its environment also determines both the firm's reputation and consequently its CFP [32], [33]. In a similar vein, the legitimacy theory explains that firms are socially accountable for the environmental implications of their operations [34]. Therefore, firms who fail to comply with these demands may experience a negative impact on their bottom line, thus jeopardizing their sustained existence. Finally, the resource based view (RBV) of a firm explains that firms derive both internal and external benefits by creating tangible and intangible resources—leading to improved competencies and capabilities. In addition, such valuable resources improve an organization's competitiveness within its industry and consequently improve its CFP [35]–[37]. From an external perspective, these intangible resources are either created or diminished by a firm's decision to either engage or not engage in corporate social responsibilities [38], [39]. The natural RBV (N-RBV) by Hart [40] originated from the RBV perspective and details how firms can generate competitive advantage by building capabilities in the areas of pollution prevention, product stewardship, and sustainable development through its environmental interactions. As a result, these lead to improved efficiencies, reduced waste, higher productivity, lower costs, and ultimately improved CFP [40], [41].

While the extant literature has closely examined the influence of environmental performance on a firm's finances, there have been conflicting conclusions. For instance, some studies highlight linear relationships whereas others document nonlinearity between the two performance metrics. On the one hand, a positive linear relationship [42]–[45] is reported based on the win–win hypothesis by [13] and supported with arguments from the N-RBV and the stakeholder theory. For example, King and Lenox[43] found evidence of a positive correlation between lower pollution levels and higher financial performance based a sample consisting of 652 manufacturing firms in the U.S. The research argue how carbon emissions mitigation steps adopted by corporate organizations are associated with competitive advantage—hence improving CFP. On the other hand, numerous studies support the existence of a negative relationship [46]–[48]. This is based on the traditional economic theory [30] that identifies an inverse relationship between a firm's social responsibility actions and its profit due to the transfer of firm resources away from its central focus. For instance, Cordeiro and Sarkis [46] demonstrated the presence of a significant negative relationship between environmental friendliness and earnings-per-share forecasts. This win-lose theory depicts how a firm's superior investments in emissions mitigation technology and practices is expected to have a negative impact on its economic results compared to cost savings such as from less superior investments. In essence, emissions reduction activities and investments are regarded as nonvalue added costs, which negatively affect the firm's bottom line [11], [15].

Recent research examines the nonlinear relationship between CEP and CFP with varying results. Some studies highlight the nonlinear relationship between only the outcomes dimension measures of CEP and CFP across Japanese manufacturing firms [15], [21]. The results show evidence of an inverted U-shaped relationship. Some other similar studies were also done along these lines but argued for a U-shaped relationship [49], [50]. [51] observed an inverted U-shaped relationship between CEP and CFP using both the process dimension and the outcomes dimension across carbon-intensive sectors. However, the process dimension in this case is represented using an environmental, social and government (ESG) indicator scale, which contains elements of both process and outcome dimensions of CEP [51]. Due to the challenges in providing a distinct numerical measure of the process dimension, independent measures of this dimension is less often captured in the extant literature. Also, recent studies advocate for further studies investigating the introduction of distinct measures of the process dimension [19], [51].

To the best of our knowledge, no study has investigated the nonlinear relationship between CEP and CFP considering distinct measures of both the process and outcomes dimensions. We achieved this by developing a distinct comprehensive measure of the process dimension using data on twenty-five implemented corporate management practices across five distinct categories provided in the reporting guidelines of the CDP. These guidelines span several areas that adequately capture the definition of the process dimension measure. Moreover, we also extend these curvilinear investigations on both dimensions of CEP by performing our analysis in two separate groups of industry sectors categorized according to their carbon emission levels.

## III. Theoretical Framework

Low-carbon intensive firms require minimal efforts and investments in emissions abatement technologies. For such firms,

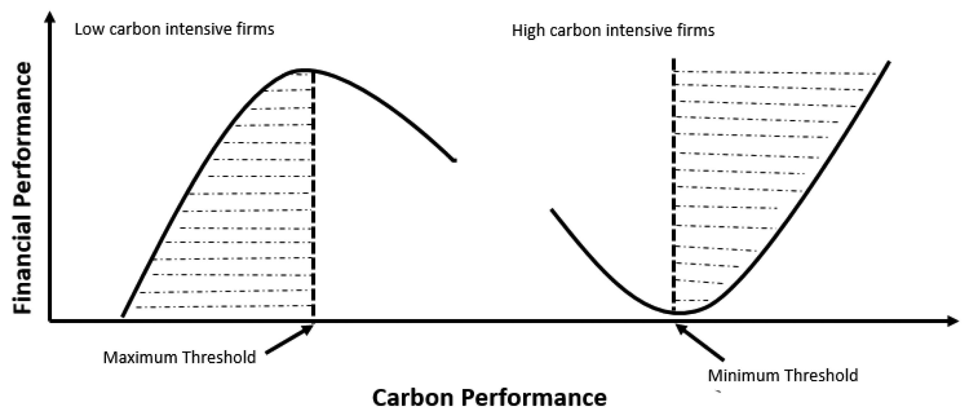


Fig. 1. Financial performance and CP at low- and high-carbon intensive sectors. Source: Authors' synopsis.

utilizing cleaner production processes versus end-of-pipe treatments provides both improved CEP and superior economic benefits [52]–[55]. As these firms also become more environmentally conscious, transaction costs associated with pollution abatement are reduced due to improved efficiencies and reduced waste [56]; further leading to improved economic benefits. Nevertheless, these particular firms can only benefit so much because the emission reduction benefits are lower than the associated costs. Therefore, additional investments to improve CP after certain point will have a negative impact on firms' bottom line. At this stage, firms conceivably meet environment regulation emissions standards due to their improved CP—further reducing any incentives associated with emissions reduction. This creates a turning point in the relationship between CP and CFP resulting to an inverted U-shaped relationship. Such a turning point represents a maximum performance threshold, that if exceeded, results in diminishing returns, as shown in Fig. 1, where associated costs exceed expected benefits of environmental friendliness. Therefore, in unison with both the N-RBV and stakeholder theories, firms on the left of the curve are on the side of increasing CP with improvements in CFP. However, for firms on the right-hand side of the curve, CFP declines as CP improves as a result of marginal abatement costs exceeding its marginal benefits [19], [51]. Therefore, we posit that for firms with a low-carbon intensity, there exists an inverted U-shaped relationship between CP and CFP.

*Hypothesis 1 (H1):* For firms with low-carbon intensity, an inverted U-shaped relationship exists between carbon performance and CFP.

Drawing from the neoclassic economic view, emissions reduction activities are associated with direct costs and could also precisely impact corporate organizations' bottom line. High-carbon intensive firms require substantial investments in emissions abatement. Based on the principle of tradeoffs, a corporate organization's investment in pollution abatement is expected to have a negative effect on its CFP as long as the costs outweigh any potential economic benefits. For instance, these tradeoffs could largely be seen in emissions mitigation by high-carbon intensive firms using end-of-pipe approaches leading to increased operating costs without subsequent economic value added [6], [15]. The immediate environmental improvements could, thus, be associated with a negative impact on CFP.

As these corporate organizations continue to improve CP with more emissions reduction initiatives, the efficient utilization of low-carbon technologies would eventually lead to a superior business position in the market [13]. In line with the N-RBV, introducing proactive environmental improvement mechanisms in areas of product stewardship and sustainability will also eventually improve corporate competitive advantage. In turn, such gains would lead to a reduction in organizations' operational costs due to waste elimination and result to a turning point in the relationship. As shown in Fig. 1, the turning point for these firms represents an expected minimum threshold that is achieved before the emergence of expected benefits associated with environmental friendliness. Improved firm-stakeholder relationships consistent with stakeholder and legitimacy theories strengthen these economic benefits—ultimately attracting environmentally conscious investors and leading to stronger financial results. Therefore, we hypothesize that for firms with high-carbon intensity, a U-shaped relation exists between the CP and CFP.

*Hypothesis 2 (H2):* For firms with high-carbon intensity, a U-shaped relationship exists between carbon performance and CFP.

*Moderating effect of carbon management practices:* In response to addressing climate change related issues, corporate organizations implement carbon management practices to appear more eco-friendly. These practices focus on the strategic internal activities carried out by management. Corporate firms display varying levels of carbon strategies, which determine the strength of their carbon management practices. We refer to the strength of an organization's carbon management practices as the extent and level of implementation of its carbon management practices. This is dependent on the strategic choices and resources available to it and depicts how proactively such carbon management activities are being embraced and integrated into its business operations [20]. Furthermore, these strategic choices are reliant on the stakeholder expectations to be fulfilled by corporate desires. Therefore, firms that meet these stakeholder demands are expected to experience improved CFP [57].

Carbon management practices show a firm's dedication to reducing the impact of its operations on the environment. However, there is not an assurance that such improvements will happen since environmentally friendly corporate bodies may focus more on improving their reputation by reducing the pressure from different stakeholder groups rather than reducing their environmental outputs [29], [58]. In addition, empirical evidence in the extant literature shows that carbon management practices do not solely determine a firm's environmental outputs [18], [59]—thus, it prompts the proposition that carbon management practices have a moderating effect on the relationship between CP and CFP [6]. Therefore, we posit that the relationship between CP and CFP is moderated by the strength of the firm's carbon management practices. Organizations with either low or high CP will, thus, stand to gain more economic benefits with superior carbon management practices compared to less developed carbon management practices. As a result, we hypothesize that the following.

*Hypothesis 3 (H3):* The relationship between a firm's carbon performance and its CFP is moderated by the strength of its carbon management practices: for the same level of carbon performance, higher levels of carbon management practices are associated with improved financial performance while lower levels of carbon management practices are associated with a decline in financial performance.

## IV. Methodology

In the following section, the methodology employed to address the hypotheses is further examined by first describing the data and variables including their sources. Specifically, we highlight our independent, dependent, and control variables. Second, the process involved in defining and creating some of these variables are explored in more detail. Third, the regression model implemented is described with the variables defined.

### *A. Data and Variables*

The dataset consists of climate change related information for corporate organizations participating in the CDP from 2011 to 2017 along with corporate financial data up until 2018. CDP provides voluntary and comprehensive information on corporate climate change related activities to both investors and public users with participating firms representing over 50% of the global market capitalization [60]. A firm's total carbon emissions is denoted by the sum of its scope 1 and scope 2 emissions. The GHG Protocol defines scope 1 emissions as those direct emissions emanating from sources owned and controlled by the corporate body such as the emissions from boilers, vehicles, and process equipment all within the organization's operational boundaries. Scope 2 emissions on the other hand are indirect emissions from the purchase of electricity, heat and steam. Scope 3—also referred to as indirect emissions (excluding those defined in scope 2)—represents emissions along the value chain of corporate firms and also outside their operational boundaries.

Data on firms' financial information was obtained from Refinitiv's (formerly Thomson's Reuters Financial and Risk) Datastream, a global financial and macro-economic data resource with over 65 years of data across 175 countries [61]. The dataset after accounting for outliers and missing data is comprised of 136 U.S. corporate firms who have provided climate change related information to the CDP consistently between the periods of 2011 and 2017. The final unbalanced panel dataset consists of a total of 922 firm-year observations with reporting firms spanning ten industry sectors. For the purpose of this study, the firms have been divided into two categories based on their Global Industry Classification Standards (GICS). The first category represents firms in the low-carbon intensity firms while the second represents firms in the high-carbon intensity firms. Table A1 in the Appendix contains a full list of acronyms.

*1) Independent Variables: Outcome Dimension Measure:* This analysis represents the outcome dimension of CEP by the total carbon emissions of each firm. Previous studies use the emissions of toxic substances [14], [15] and the change in $CO_2$ emissions over a period [50], [62]. The outcome dimension is denoted by the sum of the scope 1 and scope 2 emissions divided by the annual sales figure of each firm [6], [51], where a high emission intensity represents a low CP and a low emission intensity represents a high CP. This denotes the first independent variable of interest CP.

*Process dimension measure:* The second independent variable of interest is the process-based dimension of CEP. The process dimension is defined by developing an EMS for each participating firm within each firm-year. The EMS was developed using climate change information request data provided by firms reporting to the CDP throughout the selected years. The data used consists of twenty-five responses provided by each firm on its own carbon management practices, as shown in Tables A2– A4. These responses are categorized into five broad areas identified in the CDP information request provided to participating firms. The areas include governance, strategy, targets and initiatives, communications, and emissions. Since the responses from the CDP survey are in the form of ordinal data, we attach a score to each level on the ordinal scale. A firm is, therefore, assigned a score based on its response to its level of involvement in each carbon management practice. Furthermore, a score of zero is assigned to represent the nonexistence of any carbon management practice.

Governance refers to the organizational governance structure adopted by firms to address the issue of climate change (Table A2: G1–G3). For instance, a score of zero is assigned to firms who have provided no incentives to managers for climate change management and the firms who do support incentives receive a score of 1. The strategy section (Table A2: S1–S3), refers to firms' processes and strategies developed in structuring their approach towards climate change including specific action plans and principles incorporated into environmentally-conscious business operations [20], [63]. For instance, in measuring a firm's approach towards climate change risk management, scores are coded as 2 (highest score) or 1/0 (lowest score) based on the depth of the firm's approach.

Targets and initiatives refer to those already defined and implemented emissions reduction goals, objectives, and steps (Tables A2 and A3: T1–T5). Firms provide information here on their absolute and intensity emissions targets, and also on the scopes covered by each target. A firm with emissions targets on all three emissions scopes is awarded the highest possible score while a firm with targets on any two scopes is awarded the next lower score in that manner until a score of zero is assigned to firms with no emissions targets during the reporting year. The communications section provides details on the communications provided by firms outside of the CDP report on their GHG emissions and climate change related activities (Table A3: C1–C2). Firms are awarded points based on whether or not such communication has been provided and the status of the communication report at the end of the reporting year.

The emissions category (Tables A3 and A4: E1–E12) show data on the following:

1) type and status of firms' emissions verification or assurance status;
2) the depth of the verification or assurance undertaken;
3) the emissions scopes individually verified (scope 1, scope 2, and scope 3);
4) the proportion of GHG emissions verified within each scope.

For example (see Table A3), firms are assigned scores based on the depth of verification undertaken ranging from a high to reasonable, moderate, limited, and no assurance. Firms are also assigned points based on whether or not they are involved in any emissions trading schemes. The EMS, our second independent variable of interest, is the outcome of standardizing the scored responses for each question and then finding the average value of the standardized scores for each of the firms in each firm year.

*2) Dependent Variables:* The dependent variable in our research is a firm's CFP. For the purpose of this study, we recognize both the accounting and stock market dimensions of CFP. Accounting metrics consider actual costs and revenue in addition to how firm investments in climate change reduction affect profit. Stock market measures on the other hand represent the estimates of a firm's future cash flows relative to the assets invested [43]. Consistent with approaches in the past research, we measure a firm's accounting profitability dimension using the return on assets (ROA) [14], [25] and a firm's stock market profitability measure using Tobin's Q [42], [43]. ROA was calculated by finding the ratio of the net income to the total asset value for each firm within each year while Tobin's Q was calculated by finding the ratio of the total market value to the total asset value of each firm within each year.

*3) Control Variables:* Several control variables are introduced, which also influence CFP. The size of a firm (SIZE) is controlled for because it directly influences a firm's corporate social behavior with larger firms being more responsive to stakeholder demands [64]. However, previous research have shown evidence of both positive and negative effects of firm size on CFP [43], [65]. The size of a firm is represented by the natural logarithm of its total assets within the firm year [48], [65].

We control for a firm's growth (GROWTH) because it is expected that an increase in growth would influence a firm's future earnings. The growth of a firm is represented by the percentage increase in sales from one year to the next year [25], [56]. A firm's leverage (LEVERAGE) is also controlled for and represented as the ratio of its long term debt to its total assets [6], [29] because leverage may impact CFP since it is a measure of firms' corporate risk tolerance.

Also, a firm's total cash flow within the year (CASH_FLOW) is controlled for and defined as a ratio of the sum of its total cash flows to its total sales within the year [66]. We also control for a firm's research and development intensity (R&D_INT). A corporate firm's investment in innovation through R&D can potentially improve shareholder value and enhance CFP through the development of intangible expertise and resources [67], [68]. We denote a firm's R&D intensity by the ratio of its R&D expenses to its sales within the year [14].

A firm's capital intensity (CAPITAL_INT) is also controlled for and defined by the ratio of the firm's capital expenditure to its assets at the start of the year [49]. Evidence from the extant literature has also shown capital intensity to affect CFP both positively and negatively [14], [50].

Furthermore, the renewable portfolio standards (RPS), is the final variable introduced and used as a proxy for the regulatory environment in which these firms operate. The RPS refers to policy mandates across states requiring that a certain percentage of electricity is sourced from renewable energy sources. The variable is the average annual RPS percentage calculated by dividing the sum of nominal RPS requirements in a year by the total annual electricity sales [69]. The RPS data were sourced from the Lawrence Berkeley National Laboratory database of RPS. This proxy for policy reflects in the sum of scope 1 and 2 emissions in each period.

### *B. Model*

An ordinary least square (OLS) multiple regression technique is employed in investigating the relationship between the process based and outcome based measures of CEP and CFP. We also test for the presence of nonlinear relationship by introducing the quadratic term of CP. Due to the effects of maturity on the impact of carbon mitigation investments on firm economic returns, a time lag is introduced to capture any expected benefits. Also, in order to alleviate any issues of endogeneity that may arise as a result of correlations between our error term and independent variables, we use CFP measures at years $t+1$ and $t+2$ [14], [47]. Our final model is shown as follows:

$$\begin{aligned}\mathrm{CFP}_{it+n} = {} & \beta_0 + \beta_1 \mathrm{CP}_{it} + \beta_2 \mathrm{CP}_{it}^2 + \beta_3 \mathrm{EMS}_{it} \\ & + \beta_4 (\mathrm{EMS}_{it}\mathrm{CP}_{it}) + \beta_5 (\mathrm{EMS}_{it}\mathrm{CP}_{it}^2) + \beta_6 \mathrm{SIZE}_{it} \\ & + \beta_7 \mathrm{GROWTH}_{it} + \beta_8 \mathrm{CASH\_FlOW}_{\mathrm{it}} \\ & + \beta_9 \mathrm{LEVERAGE}_{it} + \beta_{10} \mathrm{CAPITAL\_INT}_{\mathrm{it}} \\ & + \beta_{11} \mathrm{R\&D\_INT}_{\mathrm{it}} + \beta_{12} \mathrm{RPS}_{\mathrm{t}} + \epsilon \end{aligned} \tag{1}$$

where $i$ represents each firm, $t$ each year and $n \in (1, 2)$ indicating the time lags for the dependent variables. CP and EMS represent the key independent variables of carbon performance and EMS while SIZE, GROWTH, CASH_FLOW, LEVERAGE, CAPITAL_INT, R&D_INT, and RPS represent control variables and $\epsilon$ the error term.

## V. Results

This section describes the distribution of firm industry sectors across bifurcated groups and displays the descriptive statistics

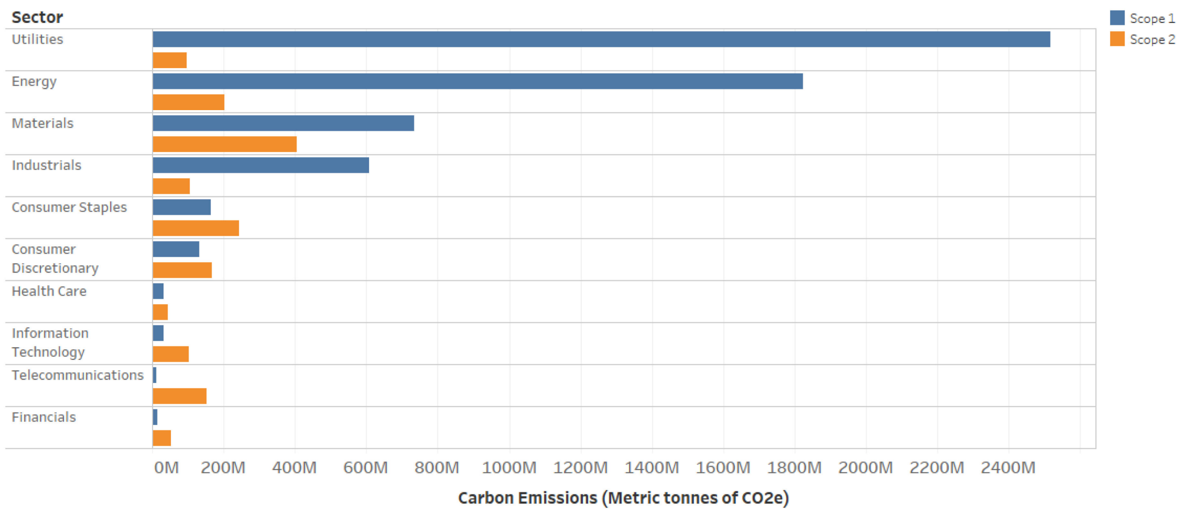


Fig. 2. Scope 1 and Scope 2 emissions by sector. Source: Authors' analysis.

of variables employed. It further discusses the regression results across both groups, some implications of these results and model validations carried out.

### A. *Firm Industry Sector Distribution and Descriptive Statistics*

Fig. 2 shows the total scope 1 and scope 2 emissions of firms in the dataset while Table I shows the distribution of the firms based on their GICS. A detailed list of firms in the dataset per GICS group is provided in the Appendix (Tables A5–A10).

Table II shows the entire dataset summary statistics for all firms alongside those in the low and high-carbon intensive industry sectors separately. A comparison of the low and high-carbon intensive sectors indicates the mean CP in the high-carbon intensive sectors is over 29 times that in the low-carbon intensive sectors. The correlation matrix of the dataset with all firms as well as the low and high-carbon intensive sector is also shown in Table III. All correlations between the independent variables are below $\pm 0.7$.

### B. *Regression Results*

In order to investigate the relationships between the dependent and independent variables, a multiple OLS regression analysis is performed on the two sections of the data set which include firms in the low and high-carbon intensive sectors. Using two separate measurement metrics of CFP as the dependent variable, the regression model includes: 1) linear and quadratic terms of CP; 2) EMS; 3) the interaction components of both the linear and quadratic components of CP and EMS; and 4) control variables. Tables IV and V show the regression results for the low-carbon intensive sectors while Tables VI and VII show that for the high-carbon intensive sectors. For each of the groups,the results are shown for CFP at year $t + 1$ and year $t + 2$.

*1) Low-Carbon Intensive Sector Analysis:* Models A1 and B1 (Tables IV and V, respectively) indicate the effect of introducing all the control variables into the model. The results indicate most of the variables showing the expected coefficient signs and significance for both Tobin's Q and ROA. Models A2 and B2 include the main independent variables of interest: the linear and quadratic terms of CP and EMS. The results show that with Tobin's Q at time $t + 1$ (model A2), R-squared value improved by 0.027 and F-tests suggest that the additions into the model better predict the variation in the dependent variable. Model B2 also shows statistically significant increase in the R-squared value by 0.019 with statistical significance coefficients indicating an inverted U-shape for CP and CP$^2$. Model A6 demonstrate similar findings as A2 and B6 and also shows similar improvements in R-squared by 0.103 though not statistically significant.

Models A3 and B3 include the linear interaction term between CP and EMS. Results show an improvement in the R-squared value by 0.019 and 0.013, respectively, and also that the inclusion of the interaction term better specify the models. The final set of models (A4 and B4) include the quadratic interaction terms for CP and EMS. Results show the coefficient of the linear and quadratic terms for both models ($\beta_1$ and $\beta_2$) to be positive and negative, respectively, and both statistically significant. The inclusion of this component indicates a statistical significant increase in the R-squared value at the $1\%$ level indicating an improvement over and beyond the previous model. Similar results are seen in models A8 and B8 for CFP at year $t + 2$.

*2) High-Carbon Intensive Sector Analysis:* For the high-carbon intensive sectors, the results are shown in Tables VI and VII. Models C1 and D1 (Tables VI and VII, respectively) show the effects of including only the control variables for both Tobin's Q and ROA, respectively. The next block (models C2 and D2) includes the linear and quadratic terms of CP and EMS. Both models present a statistically significant increase in R-squared of 0.089 and 0.11, respectively, both at the $1\%$ level. At time $t + 2$, models C6 and D6 also demonstrate statistically significant similar findings.

Models C3 and D3 include the first interaction term of the linear component of CP and EMS. C3 shows an increase in

TABLE I
CLASSIFICATION OF FIRMS BY GICS SECTORS AND INDUSTRY GROUPS

| Low Carbon Intensive Sectors | | High Carbon Intensive Sectors | |
|---|---|---|---|
| ***Financials (26)*** | | ***Energy (10)*** | |
| Banks, Diverse Financials, Insurance | 23 | Oil & Gas | 10 |
| Real Estate | 3 | ***Industrials (20)*** | |
| ***Health Care (13)*** | | Aerospace & Defense | 7 |
| Healthcare Providers & Services, and Healthcare Technology | 6 | Air Freight transportation and Logistics | 1 |
| Pharmaceuticals, Biotechnology & Life Sciences | 7 | Air Transportation - Airlines | 1 |
| ***Information Technology (16)*** | | Electrical Equipment and Machinery | 6 |
| Software & Services | 8 | Ground Transportation - Railroads Transportation | 2 |
| Technology Hardware & Equipment | 8 | Ground Transportation - Trucking Transportation | 1 |
| ***Telecommunication Services (2)*** | | Trading Companies & Distributors and Commercial Services & Supplies | 2 |
| Telecommunication Services | 2 | ***Consumer Staples (14)*** | |
| ***Consumer Discretionary (11)*** | | Household and Personal Products | 1 |
| Consumer Durables | 2 | Food & Beverage Processing | 10 |
| Hotels, Restaurants & Leisure, and Tourism Services | 2 | Food & Staples Retailing | 3 |
| Media | 2 | ***Utilities (11)*** | |
| Retailing | 5 | Electric Utilities & Independent Power Producers & Energy Traders (including fossil, alternative and nuclear energy) | 11 |
| | | ***Materials (13)*** | |
| | | Chemicals | 5 |
| | | Containers & Packaging | 4 |
| | | Forest and Paper Products - Forestry, Timber, Pulp and Paper, Rubber | 1 |
| | | Mining - Iron, Aluminum, Other Metals | 2 |
| | | Mining - Other (Precious Metals and Gems) | 1 |

Source: Authors' analysis.

R-squared of 0.014 while D3 shows an increase of 0.001. Comparable findings are also seen in models C7 and D7. The final block includes the interaction term of the quadratic component of CP and EMS. Models C4 and D4 show R-squared improvements of 0.004 and 0.027, respectively. Similar results are also seen in models C8 and D8 at time $t + 2$.

*3) Moderation Analysis:* The analysis of the interaction components between CP and EMS shows that the interactions are significant for both the low carbon and high carbon intensive sectors. We also see this being consistent for CFP measured as Tobin's Q and ROA at both years $t + 1$ and $t + 2$.

Generally, for quadratic nonlinear relationship with interacting components on the linear and squared term, we can determine whether the strength of the relationship between an independent variable and the dependent variable is influenced by a moderating variable by testing for a joint significance of the coefficients of the interaction terms [70]. A partial F-test performed by restricting the two interactions $\mathrm{CP} \cdot \mathrm{EMS}$ and $\mathrm{CP}^2 \cdot \mathrm{EMS}$ confirms their joint significance at $p < 0.001$ for CFP measured by ROA and Tobin's Q in both the low- and high-carbon intensive sectors. This provides evidence that the strength of the moderating variable (EMS) influences the relationship between CP and CFP—thus supporting **H3**.

To further investigate the moderating relationship, the graph of Tobin's Q and ROA were plotted against CP at different levels of the moderator variable (EMS) using the fitted regression values, as shown in Fig. 3, for the low-carbon intensive sectors and Fig. 4 for the high-carbon intensive sectors. A high EMS value (EMS_$H$) is represented to be one standard deviation above the mean, a moderate EMS value (EMS_$M$) to be the mean EMS and a low EMS value (EMS_$L$) to be the EMS at one standard deviation below the mean [70], [71]. To encompass the horizontal axis spread, values of CP are taken in steps of 0.5 of the standard deviation above and below the mean.

*4) Model Validation:* Several model validation tests were carried to validate and confirm the accuracy of the regression model. Tests for multicollinearity showed the absence of multicollinearity among the independent variables. Table VIII shows that the variance inflation factors ranged from a minimum of 1.2 to a maximum of 2.2—these are within the acceptable threshold of values less than 10 [72]. Also, a residual normality test was performed to determine the goodness of fit of the regression models. For a null hypothesis indicating the residuals are normal, results show $p > 0.77$ and $p > 0.85$ for the low- and high-carbon intensive sectors, respectively.

TABLE II
SUMMARY STATISTICS BY INDUSTRY SECTOR

| **All sectors, N=922** | | | | |
|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Min | Max |
| ROA | 0.049 | 0.054 | -0.413 | 0.409 |
| Tobin's Q | 1.709 | 0.646 | 0.752 | 4.420 |
| Size | 17.407 | 1.410 | 13.617 | 21.553 |
| Cash Flow | 0.336 | 0.620 | -3.296 | 4.983 |
| Growth | 0.035 | 0.245 | -0.747 | 6.359 |
| Leverage | 0.241 | 0.141 | 0.000 | 0.937 |
| R&D Intensity | 0.059 | 0.111 | 0.000 | 0.955 |
| Capital Intensity | 0.045 | 0.058 | 0.000 | 0.821 |
| RPS (%) | 7.639 | 1.217 | 5.753 | 9.785 |
| Carbon Performance | 0.400 | 1.350 | 0.001 | 28.041 |
| Environmental Management Score | 0.023 | 0.408 | -1.460 | 0.852 |
| **Low Carbon Intensity Sectors, N=468** | | | | |
| Variable | Mean | Std. Dev. | Min | Max |
| ROA | 0.050 | 0.051 | -0.112 | 0.409 |
| Tobin's Q | 1.690 | 0.703 | 0.752 | 4.420 |
| Size | 17.716 | 1.630 | 13.617 | 21.553 |
| Cash Flow | 0.390 | 0.797 | -3.296 | 4.983 |
| Growth | 0.037 | 0.115 | -0.521 | 0.700 |
| Leverage | 0.199 | 0.141 | 0.000 | 0.937 |
| R&D Intensity | 0.080 | 0.132 | 0.000 | 0.955 |
| Capital Intensity | 0.032 | 0.066 | 0.000 | 0.821 |
| RPS (%) | 7.667 | 1.231 | 5.753 | 9.785 |
| Carbon Performance | 0.027 | 0.037 | 0.001 | 0.418 |
| Environmental Management Score | -0.026 | 0.408 | -1.460 | 0.775 |
| **High Carbon Intensity Sectors, N=454** | | | | |
| Variable | Mean | Std. Dev. | Min | Max |
| ROA | 0.047 | 0.056 | -0.413 | 0.203 |
| Tobin's Q | 1.728 | 0.581 | 0.753 | 4.356 |
| Size | 17.088 | 1.050 | 14.774 | 20.391 |
| Cash Flow | 0.282 | 0.349 | -1.158 | 2.145 |
| Growth | 0.033 | 0.330 | -0.747 | 6.359 |
| Leverage | 0.284 | 0.127 | 0.000 | 0.752 |
| R&D Intensity | 0.038 | 0.080 | 0.000 | 0.783 |
| Capital Intensity | 0.059 | 0.045 | 0.000 | 0.280 |
| RPS (%) | 7.611 | 1.203 | 5.753 | 9.785 |
| Carbon Performance | 0.783 | 1.847 | 0.008 | 28.041 |
| Environmental Management Score | 0.073 | 0.402 | -0.908 | 0.852 |

Source: Authors' analysis.

## VI. DISCUSSION

The analysis of the low-carbon intensive group reveal that the coefficient of the linear component of CP ($\beta_1$) is positive and significant while that of the quadratic component ($\beta_2$) is negative and significant. These results are also consistent for CFP measured using ROA and Tobin's Q and depict evidence of an inverted U-shaped relationship between CP and CFP. The results provide evidence in support of **H1** that an inverted U-shaped relationship exists between CP and CFP for firms in the low-carbon intensive sectors. Similarly, the results are also consistent for CFP at year $t+1$ (models A1–A4 and B1–B4) and year $t+2$ (models A5–A8 and B5–B8).

In contrast to the low-carbon intensive sector results, the results of the high-carbon intensive sectors show evidence of a statistically significant U-shaped relationship between CP and CFP. The results reveal the coefficient of the linear component of CP ($\beta_1$) is statistically significant and negative while that of the quadratic term ($\beta_2$) is significant and positive. These results are consistent for CFP represented by ROA and Tobin's Q and are also consistent for CP lagged by one year(models C1–C4 and D1–D4) and two years(models C5–C8 and D5–D8). These provide evidence of a U-shaped relationship between CP and CFP supporting **H2**.

From Fig. 3, the graph of Tobin's Q against CP shows that at the high value of our moderator variable, there is evidence of a U-shaped relationship while at the low value, an inverted

TABLE III
CORRELATION MATRIX OF THE VARIABLES

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **All Sectors** | | | | | | | | | | | | |
| 1 | Tobin's Q | 1.000 | | | | | | | | | | |
| 2 | ROA | 0.533 | 1.000 | | | | | | | | | |
| 3 | Size | -0.369 | -0.199 | 1.000 | | | | | | | | |
| 4 | Cash Flow | -0.214 | -0.160 | 0.240 | 1.000 | | | | | | | |
| 5 | Growth | 0.004 | 0.086 | -0.051 | 0.081 | 1.000 | | | | | | |
| 6 | Leverage | 0.065 | -0.081 | -0.288 | 0.009 | 0.068 | 1.000 | | | | | |
| 7 | R&D Intensity | 0.251 | 0.100 | -0.282 | -0.076 | -0.024 | 0.066 | 1.000 | | | | |
| 8 | Capital Intensity | 0.021 | 0.057 | -0.186 | 0.021 | 0.009 | 0.156 | 0.424 | 1.000 | | | |
| 9 | RPS (%) | 0.093 | -0.018 | 0.071 | -0.053 | 0.078 | 0.085 | -0.113 | -0.084 | 1.000 | | |
| 10 | Carbon Performance | -0.150 | -0.146 | -0.115 | 0.047 | 0.554 | 0.189 | 0.002 | 0.110 | 0.000 | 1.000 | |
| 11 | Environmental Management Score | -0.030 | -0.106 | 0.273 | 0.054 | 0.044 | 0.151 | -0.151 | -0.010 | 0.276 | 0.059 | 1.000 |
| **Low Carbon Intensity Sectors** | | | | | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1 | Tobin's Q | 1.000 | | | | | | | | | | |
| 2 | ROA | 0.567 | 1.000 | | | | | | | | | |
| 3 | Size | -0.440 | -0.289 | 1.000 | | | | | | | | |
| 4 | Cash Flow | -0.179 | -0.174 | 0.304 | 1.000 | | | | | | | |
| 5 | Growth | 0.103 | 0.027 | -0.083 | 0.133 | 1.000 | | | | | | |
| 6 | Leverage | 0.175 | 0.023 | -0.238 | -0.014 | 0.159 | 1.000 | | | | | |
| 7 | R&D Intensity | 0.425 | 0.224 | -0.376 | -0.150 | -0.042 | 0.115 | 1.000 | | | | |
| 8 | Capital Intensity | 0.215 | 0.227 | -0.254 | -0.085 | 0.005 | 0.125 | 0.644 | 1.000 | | | |
| 9 | RPS (%) | 0.045 | -0.044 | 0.068 | -0.070 | 0.082 | 0.076 | -0.124 | -0.055 | 1.000 | | |
| 10 | Carbon Performance | 0.118 | 0.117 | -0.120 | -0.042 | -0.024 | 0.327 | 0.177 | 0.168 | -0.036 | 1.000 | |
| 11 | Environmental Management Score | 0.053 | -0.107 | 0.277 | 0.101 | 0.029 | 0.183 | -0.125 | -0.047 | 0.310 | 0.111 | 1.000 |
| **High Carbon Intensity Sectors** | | | | | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1 | Tobin's Q | 1.000 | | | | | | | | | | |
| 2 | ROA | 0.508 | 1.000 | | | | | | | | | |
| 3 | Size | -0.247 | -0.116 | 1.000 | | | | | | | | |
| 4 | Cash Flow | -0.339 | -0.190 | -0.040 | 1.000 | | | | | | | |
| 5 | Growth | -0.038 | 0.115 | -0.062 | 0.107 | 1.000 | | | | | | |
| 6 | Leverage | -0.101 | -0.178 | -0.246 | 0.175 | 0.054 | 1.000 | | | | | |
| 7 | R&D Intensity | -0.067 | -0.091 | -0.240 | 0.119 | -0.028 | 0.165 | 1.000 | | | | |
| 8 | Capital Intensity | -0.353 | -0.153 | 0.125 | 0.489 | 0.018 | 0.041 | 0.103 | 1.000 | | | |
| 9 | RPS (%) | 0.157 | 0.005 | 0.070 | -0.035 | 0.089 | 0.120 | -0.122 | -0.125 | 1.000 | | |
| 10 | Carbon Performance | -0.264 | -0.198 | -0.101 | 0.190 | 0.615 | 0.165 | 0.105 | 0.081 | 0.011 | 1.000 | |
| 11 | Environmental Management Score | -0.143 | -0.101 | 0.382 | -0.005 | 0.058 | 0.049 | -0.152 | -0.031 | 0.248 | 0.035 | 1.000 |

Source: Authors' analysis.

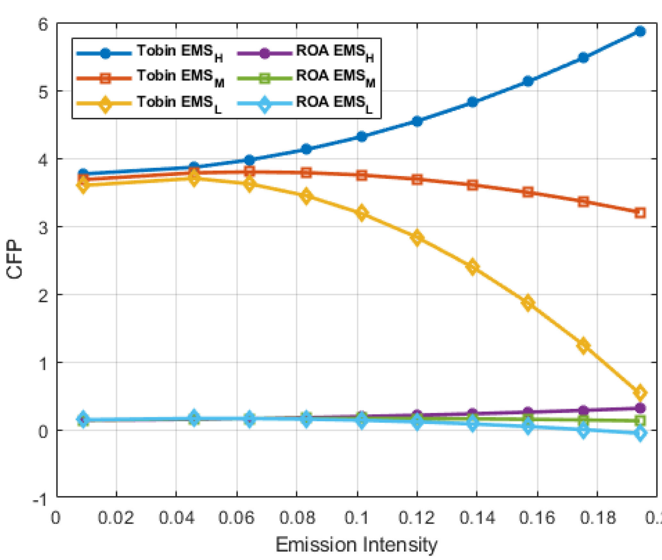


Fig. 3. Corporate financial performance as a function of carbon performance at high, medium, and low values of EMS for the low carbon intensive sectors. Source: Authors' analysis.

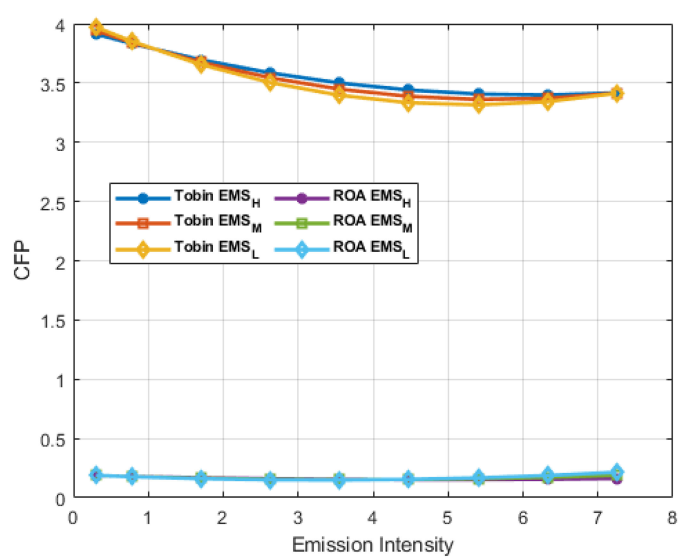


Fig. 4. Corporate financial performance as a function of carbon performance at high, medium, and low values of EMS for the high carbon intensive sectors. Source: Authors' analysis.

U-shaped relationship. For this category, higher levels of EMS are associated with higher levels of CFP for the same level of CP. However, for each of the EMS plots, it is observed that higher levels of EMS are associated with declining CFP as CP

TABLE IV
HIERARCHICAL REGRESSION RESULTS FOR LOW-CARBON INTENSIVE SECTORS WITH TOBIN'S Q AS DEPENDENT VARIABLE AND LAGGED BY 1 AND 2 YEARS

| | Tobin's Q (t+1) | | | | Tobin's Q (t+2) | | | |
|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 |
| cons | 3.359† | 3.985† | 3.863† | 3.651† | 3.287† | 4.049† | 3.902† | 3.763† |
| | (0.387) | (0.421) | (0.417) | (0.414) | (0.489) | (0.529) | (0.521) | (0.51) |
| Size | -0.128† | -0.149† | -0.146† | -0.137† | -0.11† | -0.134† | -0.129† | -0.12† |
| | (0.019) | (0.02) | (0.02) | (0.02) | (0.022) | (0.022) | (0.022) | (0.021) |
| Cash Flow | -0.039 | -0.045 | -0.037 | -0.047 | -0.069* | -0.067* | -0.056 | -0.068* |
| | (0.037) | (0.036) | (0.036) | (0.035) | (0.04) | (0.04) | (0.039) | (0.038) |
| Growth | 0.521** | 0.546** | 0.553** | 0.584** | 0.577** | 0.618** | 0.639** | 0.635** |
| | (0.247) | (0.244) | (0.241) | (0.237) | (0.281) | (0.275) | (0.27) | (0.264) |
| Leverage | 0.266 | 0.013* | 0.064* | 0.022 | 0.396* | 0.13 | 0.195 | 0.192† |
| | (0.204) | (0.219) | (0.217) | (0.213) | (0.228) | (0.245) | (0.241) | (0.235) |
| R&D_Int | 2.097† | 2.092† | 2.396† | 2.538† | 2.326† | 2.33† | 2.696† | 2.851† |
| | (0.286) | (0.283) | (0.292) | (0.289) | (0.31) | (0.308) | (0.316) | (0.312) |
| Capital_Int | -1.270** | -1.338** | -1.787*** | -1.9† | -1.346** | -1.37*** | -1.839† | -1.972† |
| | (0.546) | (0.538) | (0.545) | (0.537) | (0.529) | (0.519) | (0.523) | (0.513) |
| RPS | 0.0531** | 0.027 | 0.03 | 0.033 | 0.02 | -0.018 | -0.017 | -0.023 |
| | (0.023) | (0.024) | (0.023) | (0.023) | (0.042) | (0.043) | (0.042) | (0.041) |
| CP | | 1.258 | 1.324 | 4.358*** | | 1.563 | 1.687 | 4.522*** |
| | | (1.476) | (1.457) | (1.624) | | (1.591) | (1.562) | (1.662) |
| $CP^2$ | | -4.986 | -6.85 | -29.85† | | -5.974 | -8.543 | -33.624† |
| | | (5.412) | (5.366) | (7.837) | | (5.677) | (5.61) | (7.977) |
| EMS | | 0.301† | 0.073 | 0.305*** | | 0.32† | 0.058 | 0.341*** |
| | | (0.076) | (0.098) | (0.112) | | (0.081) | (0.103) | (0.12) |
| CP.EMS | | | 9.828† | -12.994† | | | 11.173† | -15.414† |
| | | | (2.708) | (6.333) | | | (2.81) | (6.725) |
| $CP^2$.EMS | | | | 232.799† | | | | 262.9† |
| | | | | (58.608) | | | | (60.688) |
| F | 28.433† | 22.395† | 22.099† | 22.229† | 25.854† | 20.733† | 20.995† | 21.682† |
| N | 468 | 468 | 468 | 468 | 404 | 404 | 404 | 404 |
| $R^2$ | 0.302 | 0.329 | 0.348 | 0.37 | 0.314 | 0.345 | 0.371 | 0.4 |
| $\Delta R^2$ | | 0.027† | 0.019† | 0.022† | | 0.032† | 0.025† | 0.029† |

Values in bracket represent the robust heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

improves and lower levels of EMS are associated with better CFP as CP improves. For the average and lower EMS case, there is a significantly inverted U-shape in response for CFP to increase with increasing CP. Therefore, the relationship between Tobin's Q and CP is influenced by the strength of EMS. However, while a similar relationship is seen with CFP measured using Tobin's Q and ROA, ROA is less sensitive to changes in the moderator variable, EMS, when compared to Tobin's Q. This is illustrated in the small changes observed in ROA in comparison to Tobin's Q at different levels of the moderator variable.

Fig. 4 also investigates the moderating relationship between CP and EMS in the high-carbon intensive sectors. Evidently, for the same level of CP, higher values of EMS are associated with higher values of CFP, while lower EMS values are associated with lower levels of CFP. However, for the high-carbon intensive sectors, the results for Tobin's Q show that as CP is improved, CFP improves for high, average, and low values of EMS. The results of the moderating relationship for CFP measured as ROA show similar behavior to Tobin's Q. Nonetheless, it is once again seen that ROA is less sensitive to the moderating variable, EMS, as in the case of the low-carbon intensive sectors. These results support **H3** highlighting that the relationship between CP and CFP is moderated by the carbon management practices—for the same level of CP, higher levels of the carbon management

TABLE V
HIERARCHICAL REGRESSION RESULTS FOR LOW-CARBON INTENSIVE SECTORS WITH ROA AS DEPENDENT VARIABLE AND LAGGED BY 1 YEAR AND 2 YEARS.

| | ROA (t+1) | | | | ROA (t+2) | | | |
|---|---|---|---|---|---|---|---|---|
| | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 |
| cons | 0.179† | 0.159† | 0.151† | 0.135† | 0.152† | 0.131† | 0.126† | 0.12† |
| | (0.032) | (0.035) | (0.035) | (0.034) | (0.039) | (0.043) | (0.043) | (0.043) |
| Size | -0.007† | -0.006† | -0.006*** | -0.005*** | -0.006† | -0.006*** | -0.005*** | -0.005*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Cash Flow | -0.006** | -0.006** | -0.006* | -0.007** | -0.008** | -0.008** | -0.007** | -0.008** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Growth | 0.015 | 0.02 | 0.02 | 0.023 | 0.019 | 0.021 | 0.021 | 0.021 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.022) | (0.022) | (0.022) | (0.022) |
| Leverage | -0.021 | -0.036** | -0.033* | -0.037** | -0.009 | -0.023 | -0.021 | -0.021 |
| | (0.017) | (0.018) | (0.018) | (0.018) | (0.018) | (0.02) | (0.02) | (0.02) |
| R&D_Int | 0.016 | 0.008 | 0.026 | 0.037 | 0.045* | 0.034 | 0.047* | 0.054** |
| | (0.023) | (0.023) | (0.024) | (0.024) | (0.025) | (0.025) | (0.026) | (0.026) |
| Capital_Int | 0.111** | 0.106** | 0.079* | 0.07 | 0.05 | 0.053 | 0.036 | 0.031 |
| | (0.045) | (0.044) | (0.045) | (0.045) | (0.042) | (0.042) | (0.043) | (0.043) |
| RPS | -0.001 | 0.0001 | 0.0001 | 0.0004 | 0.001 | 0.002 | 0.002 | 0.002 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| CP | | 0.381*** | 0.385*** | 0.62† | | 0.317** | 0.321** | 0.439*** |
| | | (0.122) | (0.121) | (0.135) | | (0.129) | (0.129) | (0.139) |
| $CP^2$ | | -1.129** | -1.241*** | -3.022† | | -0.893* | -0.984** | -2.03*** |
| | | (0.446) | (0.445) | (0.651) | | (0.46) | (0.462) | (0.669) |
| EMS | | -0.005 | -0.018** | 0.0004 | | -0.005 | -0.014* | -0.002 |
| | | (0.006) | (0.008) | (0.009) | | (0.007) | (0.008) | (0.564) |
| CP.EMS | | | 0.591*** | -1.176*** | | | 0.397* | -0.712** |
| | | | (0.225) | (0.526) | | | (0.232) | (0.564) |
| $CP^2$.EMS | | | | 18.025† | | | | 10.966 |
| | | | | (4.871) | | | | (5.09) |
| F | 9.121† | 7.475† | 7.514† | 8.221† | 8.319† | 6.485† | 6.191† | 6.115† |
| N | 468 | 468 | 468 | 468 | 404 | 404 | 404 | 404 |
| $R^2$ | 0.122 | 0.141 | 0.153 | 0.178 | 0.128 | 0.142 | 0.148 | 0.158 |
| $\Delta R^2$ | | 0.019** | 0.013*** | 0.025† | | 0.103 | 0.006* | 0.01** |

Values in bracket represent the robust heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

practices are associated with improved CFP and lower levels of carbon management practices are associated with reduced CFP.

This article differs from most recent research aimed at understanding the CEP and CFP relationship that only considered environmental outcomes in the operationalization of CEP. By introducing a precise measure of the environmental process dimension compared to how it was captured using environmental indicators containing both elements of the process and outcome dimension, the results from this study make clearer the interplay occurring between both dimensions of CEP as they relate with CFP. In addition, by introducing a treatment of firms across the two industry sector groups the results from this study reveal that ambiguities observed in previous studies may emanate from the generalized treatment of firms, as shown in the outcomes of Sections V.B.1 and V.B.2. Furthermore, as discussed in Section V.B.3, our results show how improvements in environmental outcomes affect the business performance of firms at different levels of the process dimension. The analyses once more reveal how the combined effects of both dimensions of CEP vary across the industry groups.

## VII. ADDITIONAL REGRESSION

Table A11 in the Appendix shows the regression summary results for CFP measured as Tobin's Q and ROA when all firms are grouped together. The results are shown for CFP at year

TABLE VI
HIERARCHICAL REGRESSION RESULTS FOR HIGH CARBON INTENSIVE SECTORS WITH TOBIN'S Q AS DEPENDENT VARIABLE AND LAGGED BY 1 AND 2 YEARS

| | Tobin's Q (t+1) | | | | Tobin's Q (t+2) | | | |
|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 |
| cons | 4.343† | 4.134† | 4.115† | 4.029† | 4.519† | 3.971† | 3.919† | 3.792† |
| | (0.443) | (0.462) | (0.457) | (0.459) | (0.531) | (0.547) | (0.539) | (0.542) |
| Size | -0.163† | -0.153† | -0.153† | -0.149† | -0.167† | -0.147† | -0.148† | -0.144† |
| | (0.024) | (0.025) | (0.025) | (0.025) | (0.027) | (0.027) | (0.027) | (0.027) |
| Cash Flow | -0.376† | -0.283† | -0.257*** | -0.251*** | -0.393† | -0.303† | -0.273*** | -0.266*** |
| | (0.08) | (0.076) | (0.076) | (0.076) | (0.087) | (0.082) | (0.082) | (0.081) |
| Growth | -0.066 | -0.248 | -0.235 | -0.211 | 0.018 | -0.034 | -0.041 | -0.062 |
| | (0.073) | (0.161) | (0.159) | (0.159) | (0.201) | (0.188) | (0.185) | (0.185) |
| Leverage | -0.62*** | -0.325* | -0.372* | -0.355* | -0.434** | -0.251 | -0.325 | -0.32 |
| | (0.199) | (0.192) | (0.191) | (0.19) | (0.217) | (0.204) | (0.202) | (0.202) |
| R&D_Int | -0.377 | -0.16 | 0.044 | 0.129 | -0.409 | -0.202 | -0.013 | 0.099 |
| | (0.312) | (0.296) | (0.3) | (0.303) | (0.297) | (0.28) | (0.281) | (0.286) |
| Capital_Int | -2.27† | -2.32† | -2.623† | -2.418† | -2.614† | -2.676† | -2.995† | -2.731† |
| | (0.626) | (0.591) | (0.593) | (0.603) | (0.706) | (0.659) | (0.656) | (0.669) |
| RPS | 0.078† | 0.084† | 0.089† | 0.092† | 0.065* | 0.094*** | 0.107*** | 0.115*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.037) | (0.035) | (0.035) | (0.035) |
| CP | | -0.169† | -0.167† | -0.252† | | -0.154† | -0.151† | -0.249† |
| | | (0.024) | (0.024) | (0.054) | | (0.023) | (0.023) | (0.057) |
| $CP^2$ | | 0.008† | 0.005** | 0.023** | | 0.005† | 0.002 | 0.022** |
| | | (0.002) | (0.002) | (0.011) | | (0.001) | (0.001) | (0.011) |
| EMS | | -0.125** | -0.225*** | -0.263† | | -0.201*** | -0.319† | -0.361† |
| | | (0.063) | (0.07) | (0.073) | | (0.067) | (0.074) | (0.077) |
| CP.EMS | | | 0.133*** | 0.286*** | | | 0.157† | 0.335*** |
| | | | (0.042) | (0.097) | | | (0.044) | (0.105) |
| $CP^2$.EMS | | | | -0.034* | | | | -0.038* |
| | | | | (0.02) | | | | (0.021) |
| F | 21.805† | 23.22† | 22.424† | 20.906† | 17.718† | 20.325† | 20.189† | 18.91† |
| N | 454 | 454 | 454 | 454 | 396 | 396 | 396 | 396 |
| $R^2$ | 0.225 | 0.344 | 0.358 | 0.363 | 0.242 | 0.346 | 0.366 | 0.372 |
| $\Delta R^2$ | | 0.089† | 0.014*** | 0.004* | | 0.103† | 0.021† | 0.006* |

Values in bracket represent the robust heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

$t + 1$. Models M1 to M4 and M5 to M8 show the regression results with the dependent variable as Tobin's Q and ROA, respectively. The results demonstrate evidence of a significant U-shaped relationship between CP and CFP. These conclusions are in line with recent studies investigating the relationships between CFP and outcome measures of CEP when all industry sectors are combined in the same group [49], [50]. For this group, it is seen that the process dimension variable is only significant for CFP measured as Tobin's Q and not for ROA. In addition, the interaction terms between the outcomes and process dimensions variables are not significant in this case as well.

Furthermore, we performed the analysis across three industry sector groups, which are the high-, intermediate-, and low-carbon intensive sector groups. These results are shown in the Appendix—Tables A12, A13, and A14, respectively. The tables reveal the low- and high-carbon intensive groups show similar results to our original analysis, but with reduced statistical significance. However, the intermediate sector group revealed similar characteristics in direction with the low-carbon intensive group but with the key independent variables of interest seen to be nonsignificant due to the greatly reduced sample size across the group.

TABLE VII
HIERARCHICAL REGRESSION RESULTS FOR HIGH CARBON INTENSIVE SECTORS WITH ROA AS DEPENDENT VARIABLE AND LAGGED BY 1 YEAR AND 2 YEARS

| | ROA (t+1) | | | | ROA (t+2) | | | |
|---|---|---|---|---|---|---|---|---|
| | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| cons | 0.238† | 0.216† | 0.216† | 0.195† | 0.255† | 0.243† | 0.243† | 0.226† |
| | (0.047) | (0.049) | (0.049) | (0.048) | (0.052) | (0.056) | (0.056) | (0.056) |
| Size | -0.009† | -0.008*** | -0.008*** | -0.007*** | -0.01† | -0.01*** | -0.01*** | -0.009*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Cash Flow | -0.024*** | -0.022*** | -0.021* | -0.02** | -0.026*** | -0.02** | -0.02** | -0.019** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.009) | (0.008) | (0.009) | (0.008) |
| Growth | 0.022*** | 0.112† | 0.112† | 0.118† | 0.185† | 0.182† | 0.182† | 0.179† |
| | (0.008) | (0.017) | (0.017) | (0.017) | (0.02) | (0.019) | (0.019) | (0.019) |
| Leverage | -0.083† | -0.072† | -0.073† | -0.069*** | -0.065*** | -0.054* | -0.054 | -0.054 |
| | (0.021) | (0.02) | (0.02) | (0.02) | (0.021) | (0.021) | (0.021) | (0.021) |
| R&D_Int | -0.053 | -0.036 | -0.032 | -0.012 | -0.076* | -0.06** | -0.06** | -0.045 |
| | (0.033) | (0.031) | (0.032) | (0.032) | (0.029) | (0.029) | (0.029) | (0.03) |
| Capital_Int | -0.057 | -0.056 | -0.062 | -0.014 | -0.114 | -0.116* | -0.116* | -0.081 |
| | (0.066) | (0.062) | (0.063) | (0.063) | (0.069) | (0.068) | (0.068) | (0.07) |
| RPS | 0.0004 | 0.0003 | 0.0002 | 0.001 | -0.001 | 0.0004 | 0.0004 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| CP | | -0.005** | -0.005** | -0.025† | | -0.011† | -0.011† | -0.024† |
| | | (0.003) | (0.003) | (0.006) | | (0.002) | (0.002) | (0.006) |
| $CP^2$ | | -0.001† | -0.001*** | 0.004*** | | 0.0004*** | 0.0004 | 0.003*** |
| | | (-0.0002) | (-0.0002) | (0.001) | | (-0.0001) | (-0.0001) | (0.001) |
| EMS | | -0.007 | -0.009 | -0.018** | | -0.006 | -0.006 | -0.012 |
| | | (0.007) | (0.007) | (0.008) | | (0.007) | (0.008) | (0.008) |
| CP.EMS | | | 0.003 | 0.039† | | | 0.0001 | 0.024** |
| | | | (0.005) | (0.01) | | | (0.005) | (0.011) |
| $CP^2$.EMS | | | | -0.008† | | | | -0.005** |
| | | | | (0.002) | | | | (0.002) |
| F | 7.881† | 12.481† | 11.36† | 12.062† | 19.777† | 16.942† | 15.361† | 14.725† |
| N | 454 | 454 | 454 | 454 | 396 | 396 | 396 | 396 |
| $R^2$ | 0.11 | 0.22 | 0.22 | 0.247 | 0.263 | 0.306 | 0.306 | 0.316 |
| $\Delta R^2$ | | 0.11† | 0.001 | 0.027† | | 0.043† | 0.0001 | 0.01** |

Values in bracket represent the robust heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

TABLE VIII
VARIANCE INFLATION FACTORS

| | Low Intensity Sectors | High Intensity Sectors |
|---|---|---|
| Variable | VIF | VIF |
| Carbon Performance | 1.17 | 1.72 |
| Environmental Management Score | 1.29 | 1.28 |
| Size | 1.47 | 1.37 |
| Cash Flow | 1.15 | 1.4 |
| Growth | 1.08 | 1.65 |
| Leverage | 1.27 | 1.17 |
| R&D Intensity | 1.91 | 1.13 |
| Capital Intensity | 1.73 | 1.39 |
| RPS | 1.15 | 1.12 |

Source: Authors' analysis.

## VIII. CONCLUSION

This article investigated the relationship between CEP and CFP as it focused on the multidimensional construct of CEP by considering both the process and outcome dimensions. The contributions from this study provided theoretical insights for the CEP-CFP relationship by revealing how this relationship is impacted by sectoral differences across firms. The study also provided practical implications in relation to a firm's bottom line relevant to decision makers saddled with the responsibility of balancing investments in strategic environmental management processes and emission reduction technologies across different industry sectors.

The results indicated that for firms in the low-carbon intensive sectors, there is evidence of an inverted U-shaped relationship between the outcome dimension of CEP and the CFP measured using both accounting-based metrics (ROA) and stock market performance-based metrics (Tobin's Q). However, in the high-carbon intensive sectors, there is statistical significance evidence of a U-shaped relationship between the outcome dimension measures of CEP and CFP using both ROA and Tobin's Q. This implies that for either of the two sector groups in the study, some firms on one side of the curvilinear relationship have their CFP metrics decline with improvements in CP and the others have it in the converse. Therefore, within both groups, benefits to be accrued from emissions abatement actually depend on the level of outcome measures of CEP for a representative firm. For the high-carbon intensive sectors, our results implied that these benefits were associated with outcome measures beyond a minimum threshold of CP. Therefore, firms in these sectors need to improve their CP beyond certain expected values to derive the associated benefits of environmental stewardship. In the case of the low-carbon intensive sectors, there are increasing benefits associated with certain thresholds of outcomes measures beyond which diminishing returns set in. Hence, firms within this sector need not improve outcomes dimension measures beyond certain expected values in order to avoid negative impacts on CFP. The results from the low-carbon intensive sectors are consistent with theoretical concepts of "too-much-of-a-good-thing" [49], [50], which is derived from the economic theory of diminishing returns. It explains that firms' increased benefits from emissions abatement could eventually result in negative effects when certain thresholds are exceeded. On the contrary, the evidence from the analysis of the high-carbon intensive sectors aligns with the theory that firms' emissions abatement activities may lead to decreasing outcomes below certain levels and once these levels are exceeded, firms observe improved benefits.

The results also demonstrated that the interaction between both dimensions of CEP highlight statistical significance for the low- and high-carbon intensive sectors alike. These effects were also significant when CFP is measured using both Tobin's Q and ROA. For firms in the low-carbon intensive sectors, the results revealed that at higher levels of process based measures, CFP is expected to decline with improvements in CP while at low process based measures, CFP is expected to improve with improved CP. Therefore, it can be implied that firms in these categories need to achieve a balance between high levels of outcomes and high levels of process-based measures. This may be because firms in this category require minimal barriers to overcome in order to derive the benefits of improved environmental response. On the contrary, the results from the high-carbon intensive sectors, revealed relatively higher levels of CFP associated with higher process based measurements. Also, for all the levels of process-based measures, improvements in CP are associated with improvements in CFP. This implied that these group of firms stand to gain more benefits from improved environmental performance with improvements in both outcome and process-based dimension measures. For this category of firms, this may be because they require higher barriers to overcome in terms of environmental performance in comparison to firms in the low-carbon intensive category.

The interplay described between CP, EMS, and CFP appears to be more pronounced in the stock market measurement metric (Tobin's Q) in comparison to the accounting measurement metric (ROA). Given that Tobin's Q represents the estimates of a firm's future cash flow relative to its assets, the results observed may be due to this metric being more sensitive to investors and stakeholders in comparison to the accounting measure that is primarily concerned with the short term profitability of corporate firms. This also sheds more light on some practical implications of the moderating relationship of EMS. Specifically, process dimension improvements are expected to have a greater impact on future earnings rather than immediate profitability measures.

Although this study enhances our knowledge in the relationships between CEP and CFP across different industry sectors, some limitations need to be considered in generalizing the findings from the study. First, all climate change related information was self-reported data by participating firms in the CDP. However, despite this limitation, the authors believe that the CDP still represents one of the most comprehensive data sources for this sort of information. In addition, the study sample size was limited to corporate firms who voluntarily provided details on their carbon management practices consistently within the selected years. Also, due to the readily available data on corporate carbon emissions across all industry sectors over the years, this measurement metric was selected to represent the outcomes measure of CEP. Future studies could investigate this multidimensional interplay across other outcome dimension measures along with including larger sample sizes as more firms continue to report on their carbon management practices.

## Appendix

### A. Acronyms

TABLE A1
Acronyms and their Meanings

| Acronym | Meaning |
|---|---|
| CDP | Carbon Disclosure Project |
| CEP | Corporate Environmental Performance |
| CFP | Corporate Financial Performance |
| CP | Carbon Performance |
| EMS | Environmental Management Score |
| ESG | Environmental, Social and Governance |
| GHG | Greenhouse Gas |
| GICS | Global Industry Classification Standard |
| NRBV | Natural-Resource Based View |
| OLS | Ordinary Least Squares |
| RBV | Resource Based View |
| ROA | Return on Assets |
| RPS | Renewable Portfolio Standards |

### *B. Scores for firms' Carbon Management Practices*

TABLE A2
FIRMS' CARBON MANAGEMENT PRACTICES AND ASSIGNED SCORES, PART 1

| | Questions | Response-Points |
|---|---|---|
| | *Governance* | |
| G1) | Where is the highest level of direct responsibility for climate change within your organization? | No response - 0<br>other manager/officer - 1<br>senior manager/officer - 2<br>Board or individual/sub-set of the board or other committee by board - 3 |
| G2) | Do you provide incentives for the management of climate change issues, including the attainment of targets? | No/no response - 0<br>Yes - 1 |
| G3) | Please provide further details on the incentives provided for the management of climate change issues | no response - 0<br>other non-monetary reward - 1<br>Recognition(non-monetary) -2<br>Monetary -3 |
| | *Strategy* | |
| S1) | Please select the option that best describes your risk management procedure with regards to climate change risks and opportunities | No response/no documented process for assessing and managing risks and opportunities from climate change - 0<br>Integrated into the multi-disciplinary company-wide risk management process - 1<br>A specific climate change risk management process - 2 |
| S2) | Is climate change integrated into your business strategy? | No - 0<br>Yes - 1 |
| S3) | Do you engage in activities that could either directly or indirectly influence public policy on climate change through any of the following? | No/no response - 0<br>Direct engagement with policy makers/trade associations/funding research organizations/other - 1<br>Direct engagement with policy makers + trade association - 2<br>Direct engagement with policy makers + funding research organizations -2<br>Trade associations + funding research organizations - 2<br>Direct engagement with policy makers + trade, associations + funding research organizations - 3 |
| | *Targets and Initiatives* | |
| T1) | Do you have emission reduction target that was active (ongoing or reached completion) in the reporting year? | No/no response - 0<br>Intensity Target - 1<br>Absolute Target - 2<br>Absolute + intensity target - 3 |
| T2) | Does the use of your goods and/or services directly enable GHG emissions to be avoided? | No/no response - 0<br>Yes - 1 |
| T3) | Did you have emission reduction initiatives that were active during the reporting year? | No/no response - 0<br>Yes - 1 |

Source: Adapted from the CDP.

TABLE A3
FIRMS' CARBON MANAGEMENT PRACTICES AND ASSIGNED SCORES, PART 2

| | Questions | Response-Points |
|---|---|---|
| | *Targets and Initiatives* | |
| T4) | Please provide details of your absolute targets | No Absolute targets/no response - 0<br>scope1/scope2/scope3 - 1<br>scope 1+scope2 - 2<br>scope1+scope2+scope3 -3 |
| T5) | Please provide details of your intensity targets | No Absolute targets/no response - 0<br>scope1/scope2/scope3 - 1<br>scope 1+scope2 - 2<br>scope1+scope2+scope3 -3 |
| | *Communications* | |
| C1 | Have you published information about your organization's response to climate change and GHG emissions performance for this reporting year in places other than CDP? | No/no response - 0<br>In voluntary communications - 1<br>In other regulatory findings - 1<br>In mainstream financial reports but have not used the CDSB framework - 2<br>In mainstream financial reports in accordance with the CDSB framework - 2 |
| C2 | Report status | No response - 0<br>Underway - 1<br>Complete - 2 |
| | *Emissions* | |
| E1) | Do you participate in any emission trading scheme? | No and we do not currently anticipate doing so in the next 2 years/No response – 0<br>No but we anticipate doing so in the next 2 years - 1<br>Yes - 1 |
| E2) | Has your Organization originated any project-based carbon credits or purchased any within the reporting year? | No/no response - 0<br>Yes - 1 |
| E3) | Please indicate the verification/assurance status that applies to your scope 1 emissions | No third party verification or assurance /No response - 0<br>No third party verification or assurance-regulatory CEMS required - 1<br>Biennial process in place but no third party verification or assurance of reported emissions - 1<br>Triennial process in place but no third party verification or assurance of reported emissions - 1<br>Third party verification underway but not yet complete - 2<br>Third party verification or assurance complete - 3 |

Source: Adapted from the CDP.

TABLE A4
FIRMS' CARBON MANAGEMENT PRACTICES AND ASSIGNED SCORES, PART 3

| | Questions | Response -Points |
|---|---|---|
| | **Emissions** | |
| E4) | Please indicate the verification/assurance status that relates to your reported scope 2 emissions | No third party verification or assurance /No response - 0<br>No third party verification or assurance-regulatory CEMS required - 1<br>Biennial process in place but no third party verification or assurance of reported emissions - 1<br>Triennial process in place but no third party verification or assurance of reported emissions - 1<br>Third party verification underway but not yet complete - 2<br>Third party verification or assurance complete - 3 |
| E5) | Please indicate the verification/assurance status that relates to your reported scope 3 emissions | No third party verification or assurance /No response - 0<br>No third party verification or assurance-regulatory CEMS required - 1<br>Biennial process in place but no third party verification or assurance of reported emissions - 1<br>Triennial process in place but no third party verification or assurance of reported emissions - 1<br>Third party verification underway but not yet complete - 2<br>Third party verification or assurance complete - 3 |
| E6) | Level of scope 1 verification assurance | No response - 0<br>Third party verification or assurance underway - not known yet - 1<br>Limited assurance - 2, Moderate assurance – 3, Reasonable assurance – 4, High assurance - 5 |
| E7) | Level of scope 2 verification assurance | No response - 0<br>Third party verification or assurance underway - not known yet - 1<br>Limited assurance - 2, Moderate assurance – 3, Reasonable assurance – 4, High assurance - 5 |
| E8) | Level of scope 3 verification assurance | No response - 0<br>Third party verification or assurance underway - not known yet - 1<br>Limited assurance - 2, Moderate assurance – 3, Reasonable assurance – 4, High assurance - 5 |
| E9) | Proportion of reported scope 1 emission verified | No response – 0, Greater than 0 but less than 20% - 1,Greater than 20% but less than 40% - 2,Greater than 40% but less than 60% - 3, Greater than 60% but less than 80% - 4,Greater than 80% to 100%-5 |
| E10) | Proportion of reported scope 2 emission verified | No response – 0, Greater than 0 but less than 20% - 1,Greater than 20% but less than 40% - 2,Greater than 40% but less than 60% - 3, Greater than 60% but less than 80% - 4,Greater than 80% to 100%-5 |
| E11) | Are carbon dioxide emissions from biologically sequestered CO2 relevant to your organization? | No/no response - 0<br>Yes - 1 |
| E12) | Do you engage with any of the elements in your value chain on GHG emissions and climate change strategies? | No, we do not engage/No response -0,Yes, suppliers + customers-1,<br>Yes, customers + other partners in the value chain -2,<br>Yes, suppliers + customers + other partners in the value chain -3. |

Source: Adapted from the CDP.

### *C. Organization List by Industry Sector*

TABLE A5
LOW-CARBON INTENSIVE FIRMS I

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 1 | Carnival Corporation | Consumer Durables, Services, Household and Personal Products | Consumer Discretionary |
| 2 | Herman Miller | Consumer Durables, Services, Household and Personal Products | Consumer Discretionary |
| 3 | Darden Restaurants, Inc. | Hotels, Restaurants & Leisure, and Tourism Services | Consumer Discretionary |
| 4 | MGM Resorts International | Hotels, Restaurants & Leisure, and Tourism Services | Consumer Discretionary |
| 5 | Omnicom Group Inc. | Media | Consumer Discretionary |
| 6 | Walt Disney Company | Media | Consumer Discretionary |
| 7 | Gap Inc. | Retailing | Consumer Discretionary |
| 8 | Kohl's Corporation | Retailing | Consumer Discretionary |
| 9 | Office Depot, Inc. | Retailing | Consumer Discretionary |
| 10 | Target Corporation | Retailing | Consumer Discretionary |
| 11 | Tiffany & Co. | Retailing | Consumer Discretionary |
| 12 | AFLAC Incorporated | Banks, Diverse Financials, Insurance | Financials |
| 13 | Allstate Corporation | Banks, Diverse Financials, Insurance | Financials |
| 14 | American Express | Banks, Diverse Financials, Insurance | Financials |
| 15 | Bank of America | Banks, Diverse Financials, Insurance | Financials |
| 16 | Capital One Financial | Banks, Diverse Financials, Insurance | Financials |
| 17 | Cincinnati Financial Corporation | Banks, Diverse Financials, Insurance | Financials |
| 18 | Citigroup Inc. | Banks, Diverse Financials, Insurance | Financials |
| 19 | Comerica Incorporated | Banks, Diverse Financials, Insurance | Financials |
| 20 | Franklin Resources, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 21 | Genworth Financial, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 22 | Goldman Sachs Group Inc. | Banks, Diverse Financials, Insurance | Financials |
| 23 | Invesco Ltd | Banks, Diverse Financials, Insurance | Financials |

Source: CDP.

TABLE A6
LOW-CARBON INTENSIVE FIRMS II

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 24 | Legg Mason, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 25 | Marsh & McLennan Companies, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 26 | Morgan Stanley | Banks, Diverse Financials, Insurance | Financials |
| 27 | Northern Trust | Banks, Diverse Financials, Insurance | Financials |
| 28 | PNC Financial Services Group, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 29 | Prudential Financial, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 30 | The Hartford Financial Services Group, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 31 | The Travelers Companies, Inc. | Banks, Diverse Financials, Insurance | Financials |
| 32 | U.S. Bancorp | Banks, Diverse Financials, Insurance | Financials |
| 33 | Unum Group | Banks, Diverse Financials, Insurance | Financials |
| 34 | Wells Fargo & Company | Banks, Diverse Financials, Insurance | Financials |
| 35 | CBRE Group, Inc. | Real Estate | Financials |
| 36 | Prologis | Real Estate | Financials |
| 37 | Simon Property Group | Real Estate | Financials |
| 38 | Abbott Laboratories | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 39 | Anthem Inc | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 40 | Baxter International Inc. | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 41 | Becton, Dickinson and Co. | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 42 | Cardinal Health Inc. | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 43 | Humana Inc. | Healthcare Providers & Services, and Healthcare Technology | Health Care |
| 44 | Agilent Technologies Inc. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 45 | Allergan, Inc. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 46 | Eli Lilly & Co. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |

Source: CDP.

TABLE A7
LOW-CARBON INTENSIVE FIRMS III

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 47 | Johnson & Johnson | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 48 | Merck & Co., Inc. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 49 | PerkinElmer, Inc. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 50 | Pfizer Inc. | Pharmaceuticals, Biotechnology & Life Sciences | Health Care |
| 51 | Adobe Systems, Inc. | Software & Services | Information Technology |
| 52 | Akamai Technologies Inc | Software & Services | Information Technology |
| 53 | Autodesk, Inc. | Software & Services | Information Technology |
| 54 | Automatic Data Processing, Inc. | Software & Services | Information Technology |
| 55 | Cognizant Technology Solutions Corp. | Software & Services | Information Technology |
| 56 | eBay Inc. | Software & Services | Information Technology |
| 57 | Microsoft Corporation | Software & Services | Information Technology |
| 58 | Symantec Corporation | Software & Services | Information Technology |
| 59 | International Business Machines (IBM) | Technology Hardware & Equipment | Information Technology |
| 60 | Xerox Corporation | Technology Hardware & Equipment | Information Technology |
| 61 | Intel Corporation | Technology Hardware & Equipment | Information Technology |
| 62 | Cisco Systems, Inc. | Technology Hardware & Equipment | Information Technology |
| 63 | Corning Incorporated | Technology Hardware & Equipment | Information Technology |
| 64 | Jabil Circuit, Inc. | Technology Hardware & Equipment | Information Technology |
| 65 | Juniper Networks, Inc. | Technology Hardware & Equipment | Information Technology |
| 66 | QUALCOMM Inc. | Technology Hardware & Equipment | Information Technology |
| 67 | AT&T Inc. | Telecommunication Services | Telecommunication Services |
| 68 | Verizon Communications Inc. | Telecommunication Services | Telecommunication Services |

Source: CDP.

TABLE A8
HIGH-CARBON INTENSIVE FIRMS I

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 69 | Procter & Gamble Company | Consumer Durables, Household and Personal Products | Consumer Staples |
| 70 | Brown-Forman Corporation | Food & Beverage Processing | Consumer Staples |
| 71 | Campbell Soup Company | Food & Beverage Processing | Consumer Staples |
| 72 | ConAgra Foods, Inc. | Food & Beverage Processing | Consumer Staples |
| 73 | Constellation Brands, Inc. | Food & Beverage Processing | Consumer Staples |
| 74 | General Mills Inc. | Food & Beverage Processing | Consumer Staples |
| 75 | Hormel Foods | Food & Beverage Processing | Consumer Staples |
| 76 | Kellogg Company | Food & Beverage Processing | Consumer Staples |
| 77 | McCormick & Company, Inc | Food & Beverage Processing | Consumer Staples |
| 78 | PepsiCo, Inc. | Food & Beverage Processing | Consumer Staples |
| 79 | The J.M. Smucker Company | Food & Beverage Processing | Consumer Staples |
| 80 | CVS Health | Food & Staples Retailing | Consumer Staples |
| 81 | Kroger | Food & Staples Retailing | Consumer Staples |
| 82 | Wal-Mart Stores, Inc. | Food & Staples Retailing | Consumer Staples |
| 83 | Apache Corporation | Oil & Gas | Energy |
| 84 | Baker Hughes Incorporated | Oil & Gas | Energy |
| 85 | Chevron Corporation | Oil & Gas | Energy |
| 86 | ConocoPhillips | Oil & Gas | Energy |
| 87 | Devon Energy Corporation | Oil & Gas | Energy |
| 88 | Exxon Mobil Corporation | Oil & Gas | Energy |
| 89 | Halliburton Company | Oil & Gas | Energy |
| 90 | Noble Energy, Inc. | Oil & Gas | Energy |
| 91 | Occidental Petroleum Corporation | Oil & Gas | Energy |
| 92 | Schlumberger Limited | Oil & Gas | Energy |
| 93 | Boeing Company | Aerospace & Defense | Industrials |
| 94 | Lockheed Martin Corporation | Aerospace & Defense | Industrials |
| 95 | Northrop Grumman Corp | Aerospace & Defense | Industrials |
| 96 | Raytheon Company | Aerospace & Defense | Industrials |
| 97 | Rockwell Collins, Inc. | Aerospace & Defense | Industrials |
| 98 | Textron Inc. | Aerospace & Defense | Industrials |
| 99 | United Technologies Corporation | Aerospace & Defense | Industrials |
| 100 | FedEx Corporation | Air Freight transportation and Logistics | Industrials |

Source: CDP.

TABLE A9
HIGH-CARBON INTENSIVE FIRMS II

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 101 | Southwest Airlines Co. | Air Transportation - Airlines | Industrials |
| 102 | Cummins Inc. | Electrical Equipment and Machinery | Industrials |
| 103 | Deere & Company | Electrical Equipment and Machinery | Industrials |
| 104 | Eaton Corporation | Electrical Equipment and Machinery | Industrials |
| 105 | General Electric Company | Electrical Equipment and Machinery | Industrials |
| 106 | Parker-Hannifin Corporation | Electrical Equipment and Machinery | Industrials |
| 107 | Stanley Black & Decker, Inc. | Electrical Equipment and Machinery | Industrials |
| 108 | CSX Corporation | Ground Transportation - Railroads Transportation | Industrials |
| 109 | Norfolk Southern Corp. | Ground Transportation - Railroads Transportation | Industrials |
| 110 | Ryder System, Inc. | Ground Transportation - Trucking Transportation | Industrials |
| 111 | Covanta Energy Corporation | Trading Companies & Distributors and Commercial Services & Supplies | Industrials |
| 112 | Waste Management, Inc. | Trading Companies & Distributors and Commercial Services & Supplies | Industrials |
| 113 | Air Products & Chemicals, Inc. | Chemicals | Materials |
| 114 | Ecolab Inc. | Chemicals | Materials |
| 115 | Monsanto Company | Chemicals | Materials |
| 116 | PPG Industries, Inc. | Chemicals | Materials |
| 117 | The Mosaic Company | Chemicals | Materials |
| 118 | Avery Dennison Corporation | Containers & Packaging | Materials |
| 119 | Ball Corporation | Containers & Packaging | Materials |
| 120 | Bemis Company | Containers & Packaging | Materials |
| 121 | Sealed Air Corp. | Containers & Packaging | Materials |
| 122 | International Paper Company | Forest and Paper Products - Forestry, Timber, Pulp and Paper, Rubber | Materials |
| 123 | Freeport-McMoRan Inc. | Mining - Iron, Aluminum, Other Metals | Materials |
| 124 | United States Steel Corporation | Mining - Iron, Aluminum, Other Metals | Materials |

Source: CDP.

TABLE A10
HIGH-CARBON INTENSIVE FIRMS III

| S/N | Organization | Industry Group | GICS Sector |
|---|---|---|---|
| 125 | Newmont Mining Corporation | Mining - Other (Precious Metals and Gems) | Materials |
| 126 | CMS Energy Corporation | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 127 | Consolidated Edison, Inc. | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 128 | Entergy Corporation | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 129 | Eversource Energy | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 130 | Exelon Corporation | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 131 | Idacorp Inc | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 132 | NRG Energy Inc | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 133 | PG&E Corporation | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 134 | Pinnacle West Capital Corporation | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 135 | Sempra Energy | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |
| 136 | Xcel Energy Inc. | Electric Utilities & Independent Power Producers & Energy Traders | Utilities |

Source: CDP.

### D. Additional Regression Summary

TABLE A11
REGRESSION RESULT SUMMARY FOR ALL SECTORS WITH TOBIN'S Q AND ROA AS DEPENDENT VARIABLES

| | Tobin's Q (t+1) | | | | ROA (t+1) | | | |
|---|---|---|---|---|---|---|---|---|
| | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 |
| cons | 3.807† | 4.331† | 4.325† | 4.31† | 0.191† | 0.195† | 0.195† | 0.191† |
| | (0.294) | (0.309) | (0.309) | (0.309) | (0.026) | (0.028) | (0.028) | (0.027) |
| Size | -0.147† | -0.17† | -0.17† | -0.17† | -0.007† | -0.007† | -0.007† | -0.007† |
| | (0.015) | (0.016) | (0.016) | (0.016) | (0.001) | (0.001) | (0.001) | (0.001) |
| Cash Flow | -0.115† | -0.1*** | -0.098*** | -0.096*** | -0.01† | -0.011† | -0.011† | -0.01† |
| | (0.032) | (0.031) | (0.031) | (0.031) | (0.003) | (0.003) | (0.003) | (0.003) |
| Growth | -0.015 | -0.009 | -0.005 | 0.005 | 0.021*** | 0.072† | 0.072† | 0.075† |
| | (0.079) | (0.146) | (0.146) | (0.146) | (0.007) | (0.013) | (0.013) | (0.013) |
| Leverage | -0.157 | -0.025 | -0.024 | -0.001 | -0.057† | -0.044*** | -0.044*** | -0.039*** |
| | (0.144) | (0.146) | (0.146) | (0.147) | (0.013) | (0.013) | (0.013) | (0.013) |
| R&D_Int | 1.249† | 1.195† | 1.232† | 1.218† | 0.017 | 0.01 | 0.011 | 0.007** |
| | (0.195) | (0.19) | (0.191) | (0.191) | (0.017) | (0.017) | (0.017) | (0.017) |
| Capital_Int | -1.239*** | -1.003*** | -1.065*** | -0.967*** | 0.029 | 0.053* | 0.052 | 0.077 |
| | (0.368) | (0.359) | (0.361) | (0.368) | (0.033) | (0.032) | (0.032) | (0.033) |
| RPS | 0.068† | 0.053*** | 0.054*** | 0.055*** | 0.00004 | 0.0005 | 0.0005 | -0.0003 |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.001) | (0.001) | (0.001) | (0.001) |
| CP | | -0.175† | -0.172† | -0.244† | | -0.009† | -0.009† | -0.027† |
| | | (0.025) | (0.025) | (0.057) | | (0.002) | (0.002) | (0.005) |
| $CP^2$ | | 0.006† | 0.004** | 0.02* | | 0.0003 | 0.0003 | 0.004† |
| | | (0.002) | (0.002) | (0.012) | | -0.0002 | -0.0002 | (0.001) |
| EMS | | 0.145*** | 0.118** | 0.104* | | -0.002 | -0.003 | -0.006 |
| | | (0.05) | (0.053) | (0.054) | | (0.005) | (0.005) | (0.005) |
| CP.EMS | | | 0.07 | 0.198* | | | 0.001 | 0.034† |
| | | | (0.045) | (0.101) | | | (0.004) | (0.009) |
| $CP^2$.EMS | | | | -0.03 | | | | -0.008† |
| | | | | (0.021) | | | | (0.002) |
| F | 33.369† | 31.439† | 28.843† | 26.634† | 11.849† | 15.016† | 13.634† | 14.111† |
| N | 922 | 922 | 922 | 922 | 922 | 922 | 922 | 922 |
| $R^2$ | 0.204 | 0.257 | 0.259 | 26 | 0.083 | 0.142 | 0.142 | 0.157 |
| $\Delta R^2$ | | 0.053† | 0.002 | 0.002 | | 0.058† | 0.0001 | 0.015† |

Values in bracket represent the robust-heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

TABLE A12
REGRESSION RESULT SUMMARY FOR LOW CARBON INTENSIVE SECTORS WITH TOBIN'S Q AND ROA AS DEPENDENT VARIABLES

| | Tobin's Q (t+1) | | | | ROA (t+1) | | | |
|---|---|---|---|---|---|---|---|---|
| | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 |
| cons | 2.7† | 2.888† | 2.89† | 2.812† | 0.118† | 0.056† | 0.057† | 0.047 |
| | (0.379) | (0.436) | (0.436) | (0.437) | (0.033) | (0.037) | (0.037) | (0.037) |
| Size | -0.098† | -0.105† | -0.106† | -0.103† | -0.004** | -0.002 | -0.002 | -0.002 |
| | (0.019) | (0.02) | (0.02) | (0.02) | (0.002) | (0.002) | (0.002) | (0.002) |
| Cash Flow | -0.02 | -0.026 | -0.025 | -0.029 | -0.005 | -0.004 | -0.004 | -0.005* |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.003) | (0.003) | (0.003) | (0.003) |
| Growth | 0.234 | 0.283 | 0.282 | 0.28 | 0.008 | 0.008 | 0.008 | 0.007 |
| | (0.229) | (0.23) | (0.231) | (0.23) | (0.02) | (0.02) | (0.02) | (0.02) |
| Leverage | 0.52*** | 0.416** | 0.414** | 0.345 | -0.023 | -0.015 | -0.015 | -0.023 |
| | (0.197) | (0.206) | (0.207) | (0.21) | (0.017) | (0.018) | (0.018) | (0.018) |
| R&D_Int | 4.564† | 4.434† | 4.443† | 4.428† | 0.152† | 0.164† | 0.164† | 0.163† |
| | (0.346) | (0.354) | (0.355) | (0.354) | (0.03) | (0.03) | (0.03) | (0.03) |
| Capital_Int | 2.301** | 1.223 | 1.237 | 1.565 | 0.605† | 0.599† | 0.6† | 0.64† |
| | (1.148) | (1.326) | (1.328) | (1.337) | (0.1) | (0.114) | (0.114) | (0.114) |
| RPS | 0.042* | 0.035 | 0.035 | 0.04* | -0.002 | 0.001 | 0.001 | 0.002 |
| | (0.022) | (0.023) | (0.023) | (0.023) | (0.002) | (0.002) | (0.002) | (0.002) |
| CP | | 2.711† | 2.528 | 3.44* | 0.118 | 0.271* | 0.265* | 0.375** |
| | | (1.619) | (1.689) | (1.761) | (0.033) | (0.139) | (0.145) | (0.15) |
| $CP^2$ | | -8.632 | -8.445 | -22.308 | | -0.936** | -0.93** | -2.605*** |
| | | (5.287) | (5.316) | (9.442) | | (0.453) | (0.456) | (0.806) |
| EMS | | 0.07 | 0.047 | 0.144 | | -0.022*** | -0.023*** | -0.011 |
| | | (0.079) | (0.098) | (0.112) | | (0.007) | (0.008) | (0.01) |
| CP.EMS | | | 1.303 | -10.779 | | | 0.04 | -1.42** |
| | | | (3.384) | (7.6) | | | (0.29) | (0.649) |
| $CP^2$.EMS | | | | 157.303* | | | | 19.008** |
| | | | | (88.663) | | | | (7.572) |
| F | 53.355† | 37.87† | 34.365† | 31.939† | 18.656† | 14.81† | 13.432† | 13.007† |
| N | 396 | 396 | 396 | 396 | 396 | 396 | 396 | 396 |
| $R^2$ | 0.49 | 0.496 | 0.496 | 0.5 | 0.252 | 0.278 | 0.278 | 0.29 |
| $\Delta R^2$ | | 0.005 | 0.0001 | 0.004* | | 0.026*** | 0.0001 | 0.012** |

Values in bracket represent the robust-heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

TABLE A13
REGRESSION RESULT SUMMARY FOR INTERMEDIATE CARBON INTENSIVE SECTORS WITH TOBIN'S Q AND ROA AS DEPENDENT VARIABLES

| | Tobin' Q (t+1) | | | | ROA (t+1) | | | |
|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 |
| cons | 4.137† | 3.731† | 3.476† | 3.299† | 0.166† | 0.139*** | 0.13*** | 0.119** |
| | (0.653) | (0.724) | (0.721) | (0.726) | (0.042) | (0.047) | (0.047) | (0.048) |
| Size | -0.124*** | -0.109*** | -0.096** | -0.093** | -0.004** | -0.003 | -0.003 | -0.003 |
| | (0.035) | (0.037) | (0.037) | (0.037) | (0.002) | (0.002) | (0.002) | (0.002) |
| Cash Flow | 0.027 | 0.009 | 0.016 | -0.011 | 0.015 | 0.016 | 0.016 | 0.014 |
| | (0.179) | (0.178) | (0.176) | (0.176) | (0.012) | (0.012) | (0.012) | (0.012) |
| Growth | -0.237 | -0.024 | 0.242 | 0.243 | 0.016 | 0.022 | 0.031 | 0.031 |
| | (0.464) | (0.471) | (0.476) | (0.474) | (0.03) | (0.031) | (0.031) | (0.031) |
| Leverage | -1.034*** | -1.136*** | -1.276*** | -1.158*** | -0.131† | -0.128† | -0.133† | -0.126† |
| | (0.39) | (0.429) | (0.426) | (0.431) | (0.025) | (0.028) | (0.028) | (0.028) |
| R&D_Int | -0.94 | -0.902** | -0.92** | -0.891** | -0.091† | -0.096† | -0.097† | -0.095† |
| | (0.364) | (0.379) | (0.374) | (0.372) | (0.023) | (0.025) | (0.025) | (0.025) |
| Capital_Int | 1.648 | 1.81*** | 1.763*** | 1.65* | 0.157† | 0.169† | 0.167† | 0.16† |
| | (0.637) | (0.645) | (0.635) | (0.636) | (0.041) | (0.042) | (0.042) | (0.042) |
| RPS | 0.024 | 0.033 | 0.028 | 0.029 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.038) | (0.039) | (0.039) | (0.038) | (0.002) | (0.003) | (0.003) | (0.003) |
| CP | | 1.148 | 2.435 | 4.639 | | 0.038 | 0.081 | 0.22 |
| | | (4.394) | (4.357) | (4.564) | | (0.285) | (0.287) | (0.301) |
| $CP^2$ | | 8.641 | 11.267 | -3.156 | | 0.298 | 0.385 | -0.523 |
| | | (24.656) | (24.296) | (25.908) | | (1.601) | (1.6) | (1.707) |
| EMS | | 0.022 | -0.399* | -0.79 | | -0.007 | -0.021 | -0.046** |
| | | (0.135) | (0.218) | (0.332) | | (0.009) | (0.014) | (0.022) |
| CP.EMS | | | 7.129** | 20.982** | | | 0.237 | 1.11* |
| | | | (2.923) | (9.387) | | | (0.193) | (0.619) |
| $CP^2$.EMS | | | | -85.337 | | | | -5.373 |
| | | | | (54.975) | | | | (3.623) |
| F | 4.031† | 3.469† | 3.795† | 3.711† | 7.646† | 5.531† | 5.184† | 4.972† |
| N | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 |
| $R^2$ | 0.152 | 0.183 | 0.213 | 0.225 | 0.253 | 0.263 | 0.27 | 0.281 |
| $\Delta R^2$ | | 0.031 | 0.03** | 0.012 | | 0.01 | 0.007 | 0.01 |

Values in bracket represent the robust-heteroscedasticity standard errors, $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^\dagger p < 0.001$. Source: Authors' analysis.

TABLE A14
REGRESSION RESULT SUMMARY FOR HIGH CARBON INTENSIVE SECTORS WITH TOBIN'S Q AND ROA AS DEPENDENT VARIABLES

| | Tobin's Q (t+1) | | | | ROA (t+1) | | | |
|---|---|---|---|---|---|---|---|---|
| | G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 |
| cons | 4.298† | 4.203† | 4.288† | 4.202† | 0.258† | 0.25† | 0.252† | 0.227† |
| | (0.501) | (0.525) | (0.517) | (0.519) | (0.06) | (0.063) | (0.063) | (0.062) |
| Size | -0.167† | -0.162† | -0.167† | -0.163† | -0.011*** | -0.009*** | -0.01*** | -0.008** |
| | (0.027) | (0.028) | (0.028) | (0.028) | (0.003) | (0.003) | (0.003) | (0.003) |
| Cash Flow | -0.438† | -0.325† | -0.281*** | -0.272*** | -0.033*** | -0.025** | -0.024** | -0.021** |
| | (0.09) | (0.088) | (0.087) | (0.087) | (0.011) | (0.01) | (0.011) | (0.01) |
| Growth | -0.059 | -0.232 | -0.205 | -0.181 | 0.028** | 0.116† | 0.117† | 0.124† |
| | (0.069) | (0.163) | (0.16) | (0.161) | (0.008) | (0.019) | (0.019) | (0.019) |
| Leverage | -0.776† | -0.462** | -0.555*** | -0.533* | -0.096† | -0.085*** | -0.087*** | -0.081*** |
| | (0.213) | (0.208) | (0.207) | (0.207) | (0.026) | (0.025) | (0.025) | (0.025) |
| R&D_Int | -0.055 | 0.048 | 0.268 | 0.334 | -0.038 | -0.028 | -0.023 | -0.004 |
| | (0.3) | (0.287) | (0.289) | (0.292) | (0.036) | (0.034) | (0.035) | (0.035) |
| Capital_Int | -1.194* | -1.604 | -2.025*** | -1.899*** | 0.031 | -0.018 | -0.028 | 0.008 |
| | (0.657) | (0.63) | (0.631) | (0.636) | (0.079) | (0.075) | (0.077) | (0.076) |
| RPS | 0.08† | 0.085† | 0.09† | 0.093† | 0.0004 | -0.001 | -0.001 | 0.0003 |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.003) | (0.003) | (0.003) | (0.002) |
| CP | | -0.139† | -0.137† | -0.205† | | -0.003 | -0.003 | -0.023† |
| | | (0.024) | (0.023) | (0.053) | | (0.003) | (0.003) | (0.006) |
| $CP^2$ | | 0.006*** | 0.003*** | 0.018* | | -0.001† | -0.001† | 0.003*** |
| | | (0.002) | (0.002) | (0.01) | | (-0.0002) | (-0.0002) | (0.001) |
| EMS | | -0.104 | -0.231*** | -0.268 | | -0.006 | -0.009 | -0.019 |
| | | (0.065) | (0.073) | (0.078) | | (0.008) | (0.009) | (0.009) |
| CP.EMS | | | 0.147† | 0.269*** | | | 0.004 | 0.039*** |
| | | | (0.041) | (0.095) | | | (0.005) | (0.011) |
| $CP^2$.EMS | | | | -0.027 | | | | -0.008*** |
| | | | | (0.019) | | | | (0.002) |
| F | 18.409† | 18.257† | 18.229† | 16.996† | 6.133† | 9.145† | 8.347† | 8.894† |
| N | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 |
| $R^2$ | 0.268 | 0.343 | 0.366 | 0.37 | 0.109 | 0.208 | 0.209 | 0.235 |
| $\Delta R^2$ | | 0.075† | 0.023† | 0.004 | | 0.099† | 0.001 | 0.026*** |

Values in bracket represent the robust-heteroscedasticity standard errors, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, and $^{\dagger}p < 0.001$. Source: Authors' analysis.

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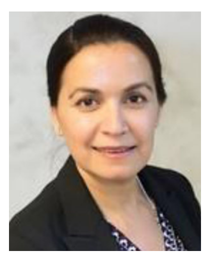

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