FIRMS' PROACTIVE CONTRIBUTION TOWARDS CARBON NEUTRALITY: U.S. CARBON-INTENSIVE INDUSTRIES

By

LEE, Joon-Young

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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ABSTRACT

FIRMS' PROACTIVE CONTRIBUTION TOWARDS

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Proactive contribution towards carbon neutrality by heavy carbon-footprint firms is one of the challenges the global community is facing. Consequently, there has been high scholarly interest in exploring firms' carbon performance and its association with various company aspects. This exploratory research utilizes 'investments in sustainability' as a proxy for carbon performance and empirically examines its relationship with environmental litigation and market share — both subjects of extensive academic inquiry. This paper uses a sample of carbon-intensive firms operating in the United States over the period of 2013 to 2021. The findings indicate a lack of statistical significance for both environmental litigation and market share in their relationship with 'investments in sustainability.'

Keywords**:** *Climate Change, Investments in Sustainability, Environmental Litigation, Market Share*

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On most occasions, I seldom voluntarily express my faith publicly. Yet, in this instance, I feel compelled to express my deepest gratitude towards God as I concede the impossibility of completing this task on my own. I thank God wholeheartedly.

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INTRODUCTION

1.1 Introduction

Do frequent climate change litigations motivate — or force — companies to pursue higher commitment towards carbon neutrality? In this pursuit, do heavy carbon-footprint companies with prominent market presence perceive an increased opportunity to secure their market position?

An unparalleled rise in global temperature in recent years — now rapidly approaching 1.5 degrees above the pre-industrial average — poses one of the most formidable and imminent threats humanity is facing (Volger, 2020; UNFCCC, 2021a; UN, 2022; IPCC, 2022). With the advent of climate change, there has been a burgeoning number of studies analyzing firms to systematically understand the relationship between carbon performance and various company aspects (e.g., de Villiers, 2011; Albertini, 2013; Lee, S. Y. & Klassen, 2016; Alam et al., 2019; Velte et al., 2020). For instance, in his hallmark meta-analysis, Albertini (2013) demonstrates the positive nature of the relationship between carbon performance and financial performance; de Villiers et al. (2011) compellingly posit that various board-related features are positively associated with environmental performance; Velte et al. (2020) provide convincing evidence in support of a positive connection between carbon performance and environmental disclosure.

Whereas the existing literature has significantly broadened our understanding of the relationship between carbon performance and various company aspects, most studies have focused on utilizing 'pollution outputs' such as GHG emissions or emission intensities and placed relatively less emphasis on 'financial outputs' such as 'investments in sustainability' in firm-level empirical studies (but see Chen & Ma, 2021; Atif et al., 2022). This holds true despite the fact that 'investments in sustainability' is a vital strategy to improve the carbon performance

of firms (Atif et al., 2022). Moreover, previous studies have paid little attention to identifying the relationship between carbon performance and firms' market standing such as market share, notwithstanding market share being one of the most academically researched areas in business (Edeling & Himme, 2018). Also, few studies have focused on whether environmental litigation connects to 'investments in sustainability' amidst the global trend of rapidly growing climate change litigations (see Setzer & Higham, 2022 for climate change litigation growth).

This paper, hence, will add to our understanding of how environmental litigation and market share relate to a firm's carbon performance and its contribution towards carbon neutrality. This paper will also contribute to the current literature by utilizing 'investments in sustainability' empirically and by building upon extant literature on firm behavior based on the legitimacy theory. Finally, this paper will expand our understanding of how carbon-intensive firms are responding to climate change.

To this extent, this paper aims to examine whether environmental litigation or market share is associated with 'investments in sustainability' and seeks to identify their possibility of being firm determinants of proactive contribution towards carbon neutrality. This paper employs a quantitative approach utilizing multiple regression with a panel fixed effect, focusing on heavy carbon-footprint firms in the United States. This study tests the following research hypotheses: (H_{a1}) A higher number of environmental litigations is associated with a firm's higher 'investments in sustainability'; (H_{a2}) A firm's higher market share is associated with higher 'investments in sustainability.'

The remaining sections of this paper are organized as follows: the first section introduces the background and context of this research. The subsequent section discusses the research methodology and the third section presents the results of the multiple regression analysis. The fourth section discusses the contributions and implications of this paper, and the

last section concludes the paper.

1.2. Background

1.2.1. Terminology

Prior to discussing the background of this study, it is advantageous — or even vital — to define the related terms. Befittingly, the Intergovernmental Panel on Climate Change (IPCC) — the transnational scientific body formed under the auspices of the UNEP (United Nations Environment Programme) and WMO (World Meteorological Organization) — provides a list of definitions (IPCC, 2018, 2021). Arguably, the IPCC has the most objective and authoritative voice in both technical and scientific matters of climate change (IPCC, 2022). The IPCC's definitions are accepted and endorsed by international organizations such as the International Energy Agency (IEA) and Organisation for Economic Co-operation and Development (OECD) (OECD, 2021).

The IPCC (2021) defines 'carbon neutrality' and 'net zero CO_2 emissions' as the "condition in which anthropogenic CO_2 emissions associated with a subject are balanced by anthropogenic CO_2 removals" (p. 2221) and "condition in which anthropogenic CO_2 emissions are balanced by anthropogenic CO_2 removals over a specified period" (p.2240), respectively. It distinguishes them with 'Greenhouse Gas (GHG) neutrality' and 'net zero GHG emissions' which are defined as the "condition in which metric-weighted anthropogenic GHG emissions associated with a subject are balanced by metric-weighted anthropogenic GHG removals" (p.2232) and "condition in which metric-weighted anthropogenic GHG emissions are balanced by metric-weighted anthropogenic GHG removals over a specified period" (p. 2240), respectively.

These definitions of terms, however, may vary depending on which entity is using them; for instance, ‘net zero’ may have several different interpretations or alternative meanings (Fankhauser et al., 2022). This paper, nonetheless, adopts the definitions proposed by the IPCC acknowledging its authority — albeit with minor tailoring for this study. Namely, this paper follows suit of the Climate Neutral Now, UNFCCC (UN Framework Convention on Climate Change), and denotes ‘carbon’ to encompass both carbon dioxide and greenhouse gases; hence, using the terms ‘carbon neutrality,’ ‘GHG neutrality,’ and ‘net zero’ synonymously (UNFCCC, 2021b). Since this paper utilizes ‘carbon neutrality’ to indicate an overarching environmental goal, distinguishing the terms would be deemed unnecessary. The International Organization for Standardization (ISO) also pursues a similar approach, using ‘net zero’ in an equivalent manner to ‘net zero GHG emissions’ (ISO, 2022). Along the same line, this paper uses ‘carbon performance’ and ‘environmental performance’ in an interchangeable manner.

1.2.2. Major Themes in Recent Literature

Table 1 on the following page provides a general review of the trends in recent literature, presenting seven prominent themes that serve as the background to this study. These themes investigate the relationship between various company aspects and carbon performance (CP).

Table 1

Major Themes in Recent Literature

Theme/Approach	Authors	Topic
CP-CFP (Corporate Financial Performance) Relationship		
Positive Association	Michalisin & Stinchfield (2010), S. Y. Lee (2012), Albertini (2013), Dixon-Fowler et al. (2013), Miah et al. (2021), Benkraiem et al. (2022), Laskar et al. (2022), Tsioptsia et al. (2022)	CP positively (or negatively) affects CFP
Negative Association	Walley & Whitehead (1994), Fisher-Venden & Thorburn (2011)	
Corporate Governance-CP Relationship	de Villiers et al. (2011), Galbreath (2012), Aggarwal & Dow (2013), Shrivastava & Addas (2014), Haque (2017), Nadeem et al. (2020), Atif et al. (2021), Goud (2022)	Board gender diversity, etc. positively affect CP
Information Disclosure-CP Relationship		
Positive Association	Giannarakis et al. (2017), Daromes et al. (2020), Velte et al. (2020), S. Kim & J. D. Kim (2021), Siddique et al. (2021)	Information disclosure positively affects CP (or has mixed results)
Mixed Association	Hahn et al. (2015)	
Stakeholder/Investor-CP Relationship	Damert & Baumgartner (2018), S. H. Lee & S. J. Lee (2018), S. Kim et al. (2022)	Stakeholders exert effects on CP; Green loans and CP show no associations
R&D-CP Relationship	K. H. Lee & Min (2015), Alam et al. (2019)	R&D positively affects CP

Operational Efficiency/Lean Manufacturing-CP Relationship	S. Y. Lee & Klassen (2016), Yu et al. (2016)	Efficiency has no effect on CP; Lean production has a positive effect on CP
Litigation-CP Relationship	Preston (2011), Do et al. (2022)	Litigation positively affects CP

The first strand of literature explores the effects of firms' environmental performance on market value or financial performance (Albertini, 2013; see also Walley & Whitehead, 1994; Michalisin & Stinchfield, 2010; Fisher-Venden & Thorburn, 2011; Lee, S. Y., 2012; Albertini, 2013; Miah et al., 2021). In his prominent meta-analysis, Albertini (2013) posits that carbon performance is related to financial performance in a positive way. He asserts that the relationship is stronger when 'environmental management variables,' such as corporate practices in favor of pollution reduction, become the moderator. Similarly, Michalisin and Stinchfield (2010) find similar results in their compelling study, establishing a positive association between firms' environmental strategies and financial performance (see also Lee, S. Y., 2012). However, the topic is not without debate. A vastly influential, earlier study by Walley and Whitehead (1994) reasoned that 'win-win' solutions are exceptional when considering the high cost associated with ambitious environmental aims. Fisher-Vanden and Thorburn (2011) also found that announcement in a membership program designed to reduce GHG was related to negative stock returns. However, more studies (see Albertini, 2013; Dixon-Fowler et al., 2013 for meta-analyses on the topic) and recent studies (Benkraiem et al., 2022; Laskar et al., 2022; Tsioptsia et al., 2022) are in support of a positive correlation. This growing body of literature provides deep insight into how firms' environmental performance affects financial statuses or market values, allowing managers and policymakers to consider real-life implications — firms may base their carbon-friendly decisions upon these results. Nonetheless,

relatively few studies focus on surveying the determinants — related to financial indicators — that could lead companies to act proactively.

The second corpus of studies examines the relationship between firms' corporate governance and carbon performance (de Villiers et al., 2011; see also Galbreath, 2012; Aggarwal & Dow, 2013; Shrivastava & Addas, 2014; Haque, 2017; Nadeem et al., 2020; Atif et al., 2021; Goud, 2022). A significant study by de Villiers et al. (2011) convincingly shows that board-related features, such as board independence or board size, are associated positively with firms' environmental performance. Similarly, Haque (2017) demonstrates how the nature of boards, such as board gender diversity (BGD) or board independence, positively affects carbon reduction policies. A more recent study by Nadeem et al. (2020) also confirms that BGD is linked positively to environmental innovation. These important findings are statistically robust and hold high implications for both executive members of firms and policymakers. On a contrary note, existing studies have not extensively explored the various output measures, such as 'financial outputs,' which will be further discussed in the next section: Research Method.

Having discussed a firm's financial and governance aspects, a vital ethics-related question arises: Do transparent companies have better environmental performance? The third body of literature attempts to answer this question by investigating how environmental information disclosure affects environmental performance (Hahn et al., 2015; Velte et al., 2020; Siddique et al., 2021). Hahn et al. (2015), in their influential paper reviewing existing literature, concluded that the effect of carbon disclosure on environmental performance was mixed. However, later research such as studies by Velte et al. (2020) and Siddique et al. (2021) are in support of a positive association. Overall, the current literature appears to weigh on the positive side (Ginnarakis et al., 2017; Daromes et al., 2020; Kim, S. & Kim, J. D., 2021). This thread of studies extends our understanding of the dynamics involving information disclosure and

provides governments or regulatory bodies a rationale to continue their observance of carbon disclosures.

The fourth group of scholarship focuses on how stakeholder/investor relationships correlate with environmental performance (Lee, S. H. & Lee, S. Y., 2018; see also Damert & Baumgartner, 2018; Chen & Ma, 2021; Kim, S. et al., 2022). S. H. Lee and S. Y. Lee (2018) make a convincing argument that 'demands' from financial investors and media increase carbon efficiency. On the other hand, when surveying the effect of sustainable loans on environmental performance, S. Kim et al. (2022) find that there is no connection. S. Kim et al.'s study shows that there may be 'greenwashing practices' by firms with poor disclosure qualities. In addition, Damert and Baumgartner (2018) suggest that end-consumer interactions influence carbon performance. These studies significantly add to the existing literature via providing new perspectives and novel evidence.

The fifth and sixth bodies of literature consist of two significant themes — R&D and 'operational efficiency/lean manufacturing.' These studies indicate that R&D and lean manufacturing have a positive relationship with carbon performance, whereas operational efficiency has no significant correlation (see Lee, K. H. & Min, 2015; Alam et al., 2019 for R&D, see Lee, S. Y. & Klassen, 2016 for lean manufacturing, see Yu et al. for operational efficiency). The aforementioned studies offer valuable insight into the discussion using strong statistical models.

Finally, the last strand of studies investigates the connection between environmental litigations and carbon performance (Preston, 2011; Do et al., 2022). Preston (2011) introduces a significant case where an unsuccessful lawsuit still instigated a voluntary redesign of a project, leading to a reduction in future GHG emissions. Do et al. (2022) confirm this approach with substantial empirical evidence that shows declined litigation rights' association with toxic

chemical releases by firms. These significant findings contribute to the vibrant discussions on the relationship between carbon performance and various company aspects. Nevertheless, few studies have focused on examining the impact of environmental litigation on firms' financial decisions, such as investments in improving environmental sustainability.

Overall, the existing literature has significantly expanded our insight into how carbon performance is related to a number of company aspects; however, relatively few studies have focused on: (1) utilizing 'financial outputs' such as 'investments in sustainability' in firm-level empirical studies, (2) investigating the relationship between carbon performance and firms' environmental litigation, and (3) examining the linkage between market share and 'investments in sustainability.' This paper, hence, intends to fill these gaps by developing hypotheses addressing these topics.

RESEARCH METHOD

2.1. Hypotheses Development

2.1.1. Theoretical Framework

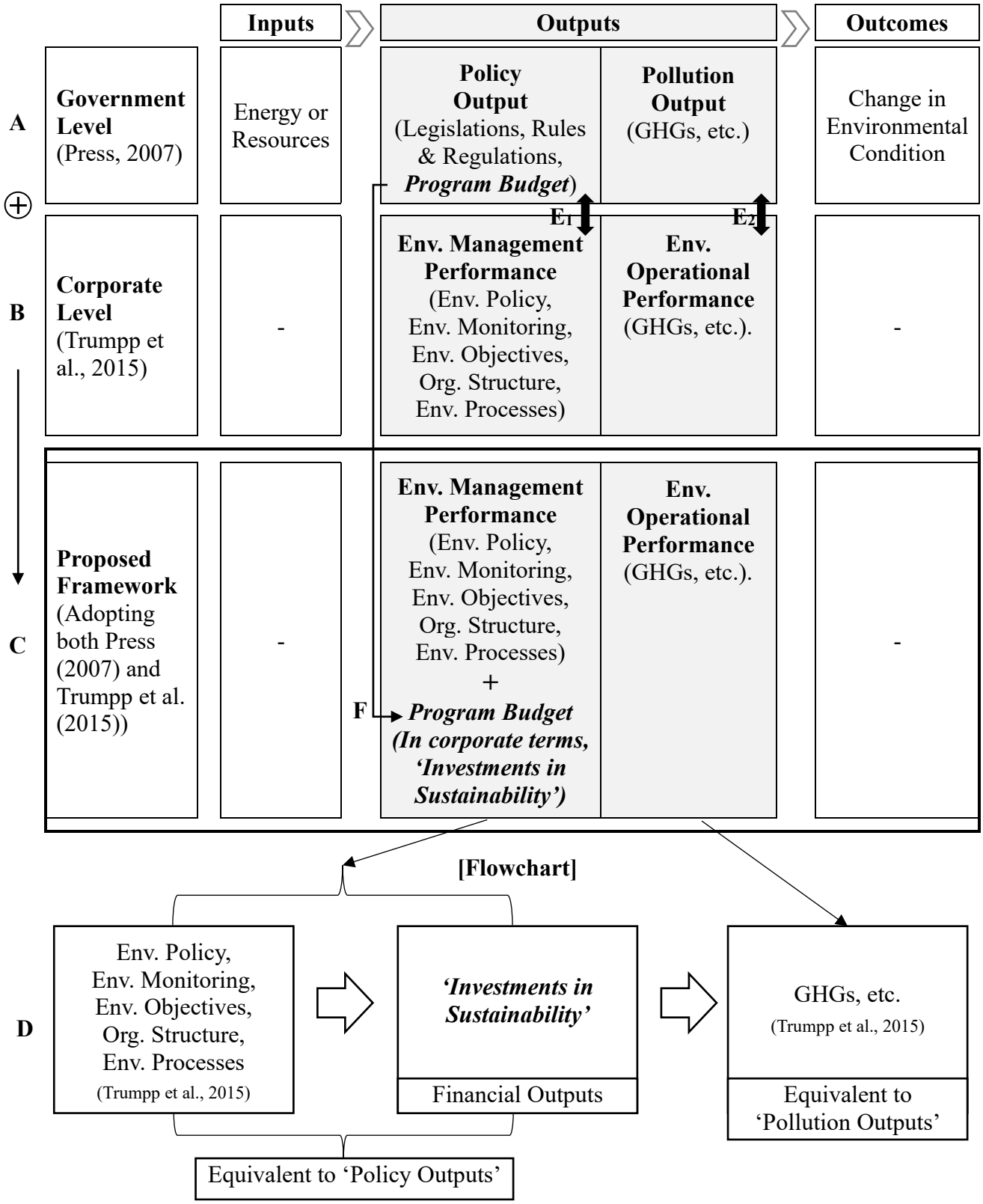
Legitimacy Theory According to Dowling and Pfeffer (1975), the legitimacy theory consists of two value systems — one associated with the company's actions and one deemed acceptable by the larger society. When these two are congruent, organizational legitimacy arises, yet when they are not, organizations feel threatened and seek to harmonize this discrepancy (Dowling & Pfeffer, 1975). Also, there are a number of benefits for organizations to be legitimate; for instance, it enhances firms' "continuity and credibility" — although the two are distinct and separate dimensions (Suchman, 1995, pp. 547-575). In recent years, firms have also faced increasing environmental expectations from society (O'donovan, 2002). They are encountering pressures for improved carbon performance from various angles (Mousa & Hassan, 2015). Current literature, hence, continues to survey firms' legitimization efforts to meet society's environmental expectations (Giannarakis et al., 2017; Marselita et al., 2021; Siddique, 2021; Ajeigbe & Ganda, 2022; Goud, 2022; Manurung et al., 2022).

2.1.2. Research Framework

Figure 1 on the subsequent page presents the overall research framework of this paper, which adopts the concepts and structure from Press (2007) and Trumpp et al. (2015).

Figure 1

Overall Research Framework



Note. The above framework and flowchart are adapted from the concepts and framework present in Press (2007) and Trumpp et al. (2015).

Government Level: Row A

The formation of the research framework for this paper begins with the discussion of a long-studied subject in the literature: 'inputs, outputs, outcomes' (Behn, 2003; Hatry, 2006; Press, 2007; Dal Mas et al., 2019). According to a highly cited work by Hatry (2006), these concepts are connected in the following order: (1) inputs, (2) outputs, and (3) outcomes. In an environmental context (government level), this concept can be expressed as: (1) energy or resource inputs; (2) environmental policy outputs (legislations, rules and regulations, budgets, etc.) or pollution outputs (GHGs, etc.); (3) environmental outcomes (actual change in environmental conditions) (Press, 2007) — refer to 'Row A' in Figure 1.

Corporate Level: Row B

When assessing the carbon performance at the corporate level, the area of most scholarly interest appears to be in the 'outputs,' where 'outputs' are mostly divided into two categories: management and operational — refer to 'Row B' in Figure 1 (see Xie & Hayase, 2007; Trumpp et al., 2015; Bhattacharya, 2019; ISO, 2021). This is well-illustrated by a prominent study by Trumpp et al. (2015) where they construct firms' environmental performance as comprising 'environmental management performance' (environmental policy, monitoring, objective, etc.) and 'environmental operational performance' (GHGs, etc.). Likewise, ISO (2021) follows a similar approach by having measurement indicators for management and operational performance.

Here, the two corporate-level categories of 'outputs' (management and operational) highly correspond to the two government-level categories of 'outputs' (policy and pollution output) — refer to 'E_1' and 'E_2' in Figure 1.

Proposed Framework: Row C

It is worth noting that both government and corporate-level studies frequently utilize output measures that use GHG emissions — refer to 'E_2'in Figure 1. For example, 'pollution outputs' have received extensive attention due to their high availability and significance in government-level studies (Press, 2007). Likewise, 'operational performance' — equivalent to 'pollution outputs'— has been widely employed by papers studying 'carbon performance-company aspect' relationships (Haque, 2017; Velte et al., 2020; Yan et al., 2020; Atif et al., 2022).

Few corporate-level studies, however, utilize another important 'output' measure discussed in the government-level studies by Press (2007), namely, the 'program budget' — or in corporate terms, 'investments in sustainability.'

In recent studies, 'investments in sustainability' are increasingly gaining attention. Atif et al. (2022) argue that such investment is a crucial strategy for improving environmental performance. They empirically confirm the positive effect it has on firms' carbon performance. Chen and Ma (2021) also stress the importance of green investment in their recent study. Thus, this paper includes 'investments in sustainability' in its proposed framework — refer to 'F' in Figure 1.

Notice that this paper also refers to the 'investments in sustainability' as 'financial outputs,' following the definition of Dooren et al. (2006): "financial output measures … are derived from an analysis of expenditures on a particular output class or functional area" (p. 9).

Flowchart: Row D

The flow chart of Figure 1 builds upon the flow Trumpp et al. (2015) posit in their paper. Trumpp et al. suggest that 'environmental management aspects' deliver the capacity to improve 'environmental operational performance;' hence, this paper assumes a right-direction flow. The middle box, indicating 'investments in sustainability' in the flow, adds an important step. It shows how other components are related to 'investments in sustainability;' for example, how 'environmental management performance' impacts 'investments in sustainability' or how 'investments in sustainability' affects 'environmental operational performance.' The latter relationship has recently been examined by a pioneering study by Atif et al. (2022).

This paper, henceforth, uses the above research framework and utilizes 'investments in sustainability' as a proxy for carbon performance and contribution towards carbon neutrality. The development of the hypotheses under this framework is discussed in the following two subsections.

2.1.3. Environmental Litigation

Concerning environmental litigation, both the significance and the number of climate change cases have been increasing over the years (Setzer & Higham, 2022; UNEP, 2021). According to a report by UNEP (2021), there were approximately double the number of climate change cases in 2021 compared to 2017 — an increase from 884 to 1,550. In their recent work, Setzer and Highham (2022) emphasize the significance of litigations in combating climate change which can pressure both governments and private entities. Individuals, NGOs, and other members of the global community now consider climate change litigation as a tool to raise their voices (Peel & Osofsky, 2015; UNEP, 2021).

There are also a number of studies directly examining the impact of environmental litigation on firms and their behaviors (Erion, 2009; Preston, 2011; Nikolaou et al., 2015; Do et al., 2022; Weller & Tran, 2022). According to a recent paper by Weller and Tran (2022), there are mounting pressures on oil and gas producers due to environmental litigations. Weller and Tran's paper introduces the highly controversial Shell case, where The Hague ruling has led Shell to reduce GHG emissions significantly. Preston (2011) also adds to the literature by analyzing the Drake Brockman v. Minister for Planning, where an unsuccessful lawsuit still caused the firm to reduce future GHG emissions. Likewise, Erion (2009) concludes in his published work that litigation threats have the potential to produce positive changes.

Nevertheless, there are also skeptical voices on the role of litigation in combating climate change (Posner, 2006; Peel, 2007; Rogers & Buskirk, 2009; Austin, 2022; Burman, 2022). Peel (2007) states clearly in his paper that litigation most likely will not be "a panacea for delivering effective action" (p. 90). Posner (2006) similarly argues that human rights litigations would have little effect. Austin (2022) also notes the insufficiency of the Clean Air Act. In addition, according to Burman (2022), no court rulings have ordered emitters to compensate for the damages done to date.

With mixed results, the questions arise: Does environmental litigation have an association with a firm's carbon performance? Can environmental litigation be a determinant for proactive contribution towards carbon neutrality?

This paper takes into account Preston (2011)'s work while considering the legitimacy theory. This paper argues that regardless of the litigations' success, the number of litigations changes the perception of firms by society, thereby threatening a firm's legitimacy. Hence, firms will make an effort to minimize the discrepancy by investing in ways to reduce the number of litigations.

The hypothesis formulation is, thus, as follows:

H_{a1}: A higher number of environmental litigations is associated with a firm's higher 'investments in sustainability'

2.1.4. Market Share

Regarding market share, there is a large body of literature on the subject and its impact on various company aspects (Buzzel et al., 1975; Farris et al., 2010; Katsikeas et al., 2016; Edling & Himme, 2018; Hydock et al., 2021). According to a highly influential work by Farris et al. (2010), market share is defined as "the percentage of a market accounted for by a specific entity" (p.33). They state that market share measures firms' performance against competitors and is the basis of strategic actions. It distinguishes itself from other indicators, such as 'sales.' For example, market share is more difficult to increase than sales, and losing market share is more detrimental, which requires strategy changes (Farris et al., 2010). In addition, by the definition provided by Farris et al. (2010), sales can increase while market shares decrease. For this and many other reasons, market share is one of the most extensively used performance indicators in academic empirical studies (Katsikeas et al., 2016; Edling & Himme, 2018). In their highly influential meta-analysis, Edling and Himme (2018) call for marketers to continue monitoring market share because "market share still matters" (p. 18).

Despite such importance, however, studies have paid relatively little attention to studying market share in relation to carbon performance. There have been studies examining the relationship between firm size and carbon performance (Stanwick & Stanwick, 1998; Elsayed, 2006; Younis & Sundarakani, 2019); however, firm size indicators, such as total assets, employee number, or total sales, are different from market share by definition, as partially described above. Firm size also lacks unique attributes of market share such as signaling effects

described by Caminal and Vives (1996) or Bhattacharya et al. (2022). Camina and Vives (1996) argue that market share provides customers with additional quality information. Bhattacharya et al. (2022) confirm this finding by empirically showing that the positive effects of market share are attributed to its features such as quality signaling and market power.

Hence, the questions arise: Does market share have a relationship with a firm's carbon performance? Can market share be a determinant for proactive contribution towards carbon neutrality?

In further formulating the hypotheses, this paper takes three extra steps. First, it establishes a close association between market share and brand image/value via a literature review (Kamakura & Russel, 1993; Kim & Chung, 1997; Zhang, 2015). Second, this paper confirms that environmental performance has become integral to social norms and expectations for private firms (UNFCCC, 2021a; Gromov & Tito, 2022). Finally, via incorporating the legitimacy theory, this paper hypothesizes that companies with a higher market share have a greater incentive to harmonize their high brand image with societal norms; thus, investing more financial resources in sustainability.

H_{a2}: A firm's higher market share is associated with higher 'investments in sustainability'

In addition, by connecting market share and 'investments in sustainability,' the hypothesis also answers the following question: *Do major companies with higher market share contribute more towards carbon neutrality in a tangible way without greenwashing their brands?* Since greenwashing refers to the deceptive actions of firms that results in a 'greener' perception of the firms by the public (de Freitas Netto et al., 2020), measuring the expenditures will inherently be more robust than assessing plans or announcements made by firms intended for better publicity.

Having developed the hypotheses of this research, this paper now turns to the research design and the logic behind the design.

2.2. Research Design

2.2.1. Sample and Data

Significance of Carbon-intensive Industries

Evidently, carbon-intensive firms are highly responsible for CO_2 emissions (Cadez & Czerny, 2016). For instance, major international firms in the oil and gas industry (or sector) are estimated to be responsible for more than seven percent of the total GHG emissions globally (Gromov and Titov, 2022). The IEA (2022) — an authoritative voice in the global energy dialogues (IEA, 2023, para. 1) — estimates that approximately 15% of the energy-associated GHG emissions are attributed to activities involving oil and gas production. Another prominent example is the chemical industry (or sector), which stands out as the third largest contributor of CO_2 (IEA, 2022a). Due to the significance of these impacts, the IEA selects and monitors a number of sectors and assesses their emissions to determine whether they are on track with the Net Zero Scenario (IEA, 2022b). In line with this approach, this paper examines firms operating in the major carbon-intensive sectors identified by the IEA — twenty-five firms have been analyzed in this paper (sampling limitations are addressed in Section 4.2).

Source of Data and Time Period

Data has been mostly extracted from the Bloomberg database with some additional information from annual reports and official company websites. It is worth noting that Bloomberg L.P. provides a wide scope of data in finance and economics to both the

communities of investors and academic institutions (Coe, 2007).

In addition, this paper has been designed to cover a period of ten years for the analysis (Rogers & Bursik, 2009; Chen & Ma, 2021; Ajeigbe & Ganda, 2022); however, due to data constraints, only nine years from 2013 to 2021 have been utilized in this research.

2.2.2. Dependent Variable

The dependent variable, 'investments in sustainability,' is defined by Bloomberg L.P. as "the amount of money spent by the company … on operational environmental and social compliance and other internal environmental and social initiatives, as defined by the company" (Bloomberg L.P., n.d.). According to Bloomberg L.P., some of the examples that are included in the calculation consist of, but are not limited to, investments for "environmental remediation, pollution prevention, recycling, employee training, safety initiatives, etc." (Bloomberg L.P., n.d.).

Although this definition may vary in comparison with other definitions provided by literature (Chen & Ma, 2021; Atif et al., 2022), it suffices in capturing what this study intends to examine.

Also, consistent with the existing literature (Chen & Ma, 2021; Atif et al., 2022), the natural logarithm of the investment amount has been used in this paper.

2.2.3. Independent Variables

This paper uses two independent variables in the research: environmental litigation and market share.

Firstly, the number of environmental litigations is extracted from the Bloomberg database using the criteria: 'subsidiaries included, 'circuit courts excluded,' and 'environmental cases.'

Secondly, for market share, this paper utilizes 'revenue market share,' where a firm's revenue is divided by the total revenue of its respective market (Farris et al., 2010). *Firm revenues* have been extracted with the following criteria from the Bloomberg database: 'revenue adjusted,' 'fiscal year,' and 'USD currency.' *Total market revenues* have also been extracted from the Bloomberg database using the same criteria and the BICS (Bloomberg Industry Classification Standard) classification system:

$$\textit{Market Share} = \frac{\textit{Firm's Revenue}}{\textit{Aggregated Revenue of Firms in the BICS Classification to which the Firm Belongs}}$$

Additionally, lagged independent variables have been incorporated in the study (Alam et al., 2019; Atif et al., 2022; Bhattacharya et al., 2022). In empirical studies, lagged values are used to capture the 'influence' of the independent variables of earlier time frames on the contemporaneous dependent variable. By using lagged variables, this study takes into account the 'delayed responses' of companies.

For both environmental litigation and market share, contemporaneous values as well as one-year lagged values have been included in the study.

2.2.4. Control Variables

The study employs six control variables in two categories: board characteristics and firm characteristics (see Atif et al., 2021, 2022). The use of board or firm characteristics as control variables is well established in extant studies (see Nadeem, 2020; Chen & Ma, 2021; Goud, 2022; Maji & Kalita, 2022). The three board characteristics used in this research are 'percentage of women on the board' representing board gender diversity, 'percentage of independent directors on the board' indicating board independence, and board size. The three firm characteristics used are 'debt to equity ratio' measuring leverage, 'ROE' computing profitability, and 'market to book ratio,' a market valuation-related ratio.

Table 2

Description of Variables

Type	Name	Description	Abbrv.
Dependent Variable	'Investments in Sustainability'	Natural Logarithm of 'Investments in Sustainability'	IS
Independent Variables	Environmental Litigation	Number of Environmental Litigations	NL
	Market Share	Firm Revenue/Total Market Revenue	MS
Control Variables (Board Characteristics)	Board Gender Diversity	Percentage of Women on the Board	pct_wb
	Board Independence	Percentage of Independent Directors	pct_ind
	Board Size	Number of Board Members	b_size
Control Variables (Firm Characteristics)	Leverage	Debt to Equity Ratio	debt_eqy
	Profitability	Return on Equity	roe
	Market Valuation Indicator	Market to Book Ratio	mkt_b

Table 2 summarizes and provides brief descriptions of the variables in this study.

2.2.5. Empirical Model

The regression model this paper employs is as follows:

$$IS_{it} = \alpha_0 + \alpha_1 NL_{it} + \alpha_2 NL_{it-1} + \alpha_3 MS_{it} + \alpha_4 MS_{it-1} + \Sigma Z_{it} + \mu_i + \delta_t + u_{it}$$

Here, IS stands for the natural logarithm of 'investments in sustainability,' which is the contemporaneous dependent variable.

NL and MS denote the number of environmental litigations and market share, respectively. For both independent variables, contemporaneous values (t) and one-year lagged values (t-1) are included.

Z stands for the six control variables employed in this study, namely 'percentage of women on the board,' 'percentage of independent directors,' 'number of board members,' 'debt to equity ratio,' 'return on equity,' and 'market to book ratio.'

μi and δ_t represent company-specific and time-specific fixed effects, respectively. The regression model has been carefully formulated to avoid possible biases. It is noteworthy to mention that in empirical studies like this paper, RCTs (Randomized Controlled Trials) are inapplicable — environmental litigations or market shares cannot be randomly assigned to profit-maximizing free agents in a highly competitive business environment. Hence, to address the biases, this study first uses multiple regression with well-established control variables that are widely accepted in recent empirical studies (see section 2.2.4. for details). Secondly, the study uses a panel fixed effect (FE) approach which is suitable for analyzing panel data.

In addition, the Hausman Test is conducted prior to the regression analysis in order to confirm the most appropriate model for this study — FE model or RE (random effect) model. Also, the study uses statistical techniques to estimate robust standard errors that take into

account company-level clustering. In this manner, the study indirectly controls for the different industries (or sectors) within the data as well.

RESULTS

3.1. Descriptive Statistics

Table 3

Descriptive Statistics

Variables	Obs.	Mean	SD	Min.	Max.
IS(Original)	150	2.95E+08	6.64E+08	0	4.20E+09
IS	150	16.85058	3.751423	0	22.15835
NL (Contemporaneous)	148	2.283784	3.707027	0	27
NL (Lagged 1 Year)	130	2.446154	3.864089	0	27
MS (Contemporaneous)	247	7.483185	8.90819	0.004332	34.89226
MS (Lagged 1 Year)	222	7.549635	9.025336	0.004332	34.89226
pct_wb	240	19.01303	9.866075	0	41.66667
pct_ind	240	84.76983	10.85812	25	93.3333
b_size	240	10.29167	2.022451	5	15
debt_eqy	243	78.58953	81.5208	0	665.7948
roe	238	8.592332	28.89852	-178.655	134.2269
mkt_b	231	4.047376	5.563968	0.177023	67.4534

Note. IS (natural logarithm of 'investments in sustainability'), NL (number of environmental litigations), MS (market share) (see Table 2 for abbreviations)

Table 3 shows the descriptive statistics of the variables, including the original value of 'investments in sustainability,' or *IS(Original)*. The mean of IS(Original) for the firms is approximately 295 million USD. The average natural logarithm of 'investments in

sustainability,' on the other hand, is approximately 16.85.

In addition, the average number of environmental litigations (t, contemporaneous values) a firm faces in a year is about 2.3 cases with a maximum number of 27 cases. Firms vary significantly in terms of their market share. Whereas the average market share (t, contemporaneous values) is approximately 7.48%, the leading firm occupies over 34.89% of the market. The average 'percentage of women on the board,' 'percentage of independent directors,' and 'number of board members' are approximately 19%, 85%, and 10, respectively. Average 'dept to equity ratio,' 'ROE,' and 'market to book ratio' are approximately 79, 9, and 4, respectively.

Table 4

Pairwise Correlation between Variables

	IS	**NL (Contemp-oraneous)**	**NL (Lagged 1 yr.)**	**MS (Contemp-oraneous)**	**MS (Lagged 1 yr.)**	**pct_wb**	**pct_ind**	**b_size**	**debt_eqy**	**roe**	**mkt_b**
IS	1										
NL (Contemporaneous)	0.4049	1									
NL (Lagged 1 Year)	0.4138	0.4601	1								
MS (Contemporaneous)	0.4748	0.2103	0.1751	1							
MS (Lagged 1 Year)	0.4777	0.2060	0.2217	0.9845	1						
pct_wb	0.1454	0.1209	0.1255	0.2506	0.2683	1					
pct_ind	0.0495	-0.1121	-0.0660	0.1121	0.1193	0.5760	1				
b_size	0.3202	0.1913	0.2266	0.1896	0.1988	0.2176	0.4227	1			
debt_eqy	-0.4820	-0.0774	-0.1056	-0.1990	-0.2150	0.0005	0.0711	0.0651	1		
roe	-0.1329	0.0398	0.0346	0.0652	0.0420	-0.0262	-0.0637	0.0579	-0.1216	1	
mkt_b	-0.2677	-0.0959	-0.1514	-0.0576	-0.0644	-0.1393	-0.1484	0.0882	0.3981	0.3357	1

Note. IS (natural logarithm of 'investments in sustainability'), NL (number of environmental litigations), MS (market share) (see Table 2 for abbreviations)

Table 4 shows the pairwise correlations between variables. Both the number of environmental litigations (t, contemporaneous values) and market share (t, contemporaneous values) positively correlate with the natural logarithm of 'investments in sustainability.' The correlation coefficients of the relationships are 0.4049 and 0.4748, respectively, showing moderate levels of correlation.

The correlation coefficients between the independent variables and control variables are less than 0.6 (see Atif et al., 2022 for using 0.6 as a reference point).

Whereas control variables such as 'percentage of women on the board,' 'percentage of independent directors,' and 'board size' positively correlate with the dependent variable, other remaining control variables such as 'ROE,' 'market to book ratio,' and 'debt to equity ratio' negatively correlate with the dependent variable. In other words, board characteristics are positively correlated with 'investments in sustainability,' whereas firm characteristics are negatively correlated.

3.2. Hausman Test Results

The Hausman Test is conducted to determine which model is more appropriate: FE or RE. The null hypothesis of the Hausman Test is as follows: the coefficients difference is not systematic.

Based on the calculations, the Prob > Chi^2 is 0.00. With a p-value less than 0.05, the null hypothesis is rejected. To rephrase, the FE model is the more appropriate model for this study.

3.3. Regression Results

Table 5

Regression Results

Variables	Without Controls	With Controls: Board Characteristics	With Controls: Board & Firm Characteristics
Constant	17.264 (0.541)	20.861 (3.033)	20.992 (3.263)
NL (Contemporaneous)	-0.019 (0.011)	-0.020 (0.018)	-0.024 (0.020)
NL (Lagged 1 Year)	0.029 (0.023)	0.035 (0.021)	0.029 (0.020)
MS (Contemporaneous)	0.035 (0.041)	0.062 (0.056)	0.048 (0.066)
MS (Lagged 1 Year)	0.005 (0.063)	-0.032 (0.084)	-0.024 (0.092)
pct_wb		-0.044 (0.038)	-0.047 (0.040)
pct_ind		-0.032 (0.027)	-0.028 (0.026)
b_size		0.054 (0.137)	0.045 (0.144)
debt_eqy			0.001 (0.007)
roe			0.002 (0.009)
mkt_b			-0.095 (0.127)
Year Effect	N	Y	Y
Number of Obs.	86	86	86

Note. IS (natural logarithm of 'investments in sustainability'), NL (number of environmental litigations), MS (market share) (see Table 2 for abbreviations), Standard Errors in Parenthesis, No asterisks indicating statistical significance are displayed in the table: none of the coefficients reaches the conventional levels of 90% (*), 95% (**), and 99% (*).

Table 6 displays the regression results. Three scenarios have been tested: 'without controls,' 'with controls: board characteristics only,' and 'with controls: board and firm characteristics.' The year effect has been accounted for in the latter two scenarios. In addition, after excluding incomplete data, the total number of observations used in the regression has been reduced to eighty-six.

Without controlling for the board and firm characteristics, the p-values for NL (contemporaneous) and NL (lagged 1 year) are 0.109 and 0.230, respectively. Controlling for the board characteristics, the p-values are 0.274 and 0.114, respectively. Controlling for both the board and firm characteristics, the p-values are 0.249 and 0.166, respectively. The p-values exceed 0.05; hence, the analysis ***fails to reject the null hypothesis.***

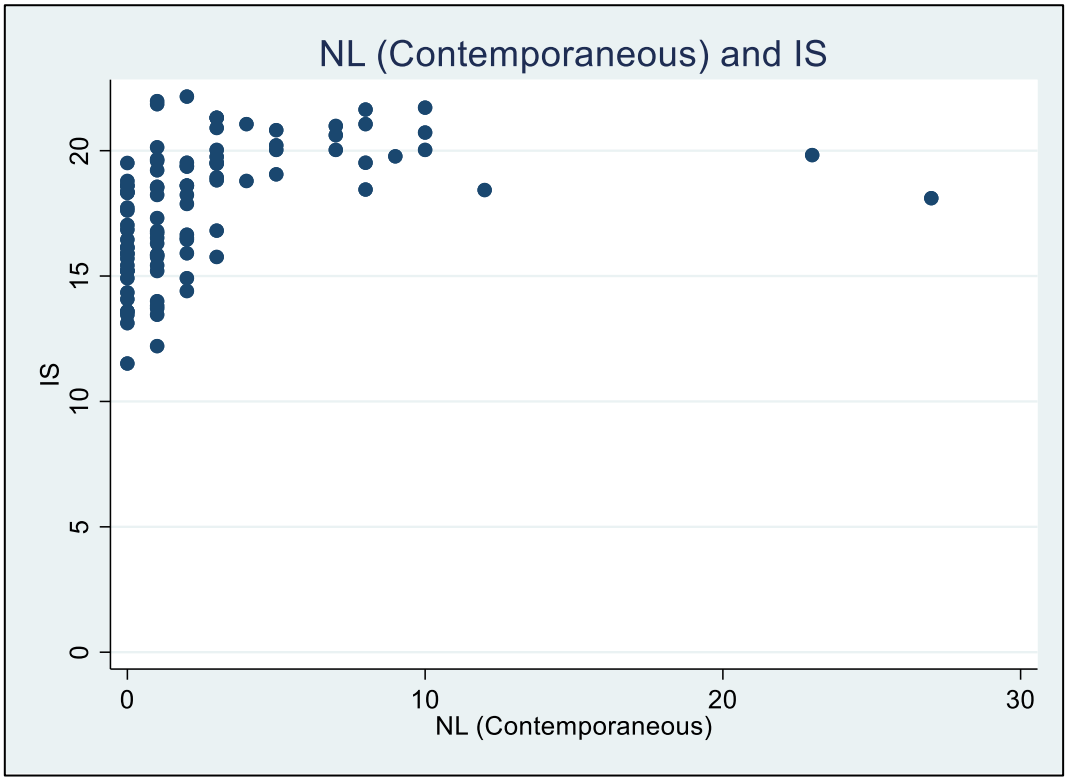
In sum, there is a lack of statistical significance to support the first alternative hypothesis of this paper — *H_{a1}: A higher number of environmental litigations is associated with a firm's higher 'investments in sustainability.'*

Additionally, the p-values for MS (contemporaneous) and MS (lagged 1 year) without controls are 0.406 and 0.934, respectively. Controlling for board characteristics, the p-values are 0.289 and 0.710, respectively; Controlling for both board and firm characteristics, the p-values are 0.481 and 0.799, respectively. The p-values exceed 0.05; hence, the analysis ***fails to reject the null hypothesis.***

In summary, there is a lack of statistical evidence to support the second alternative hypothesis of this paper — *H_{a2}: A firm's higher market share is associated with higher 'investments in sustainability.'*

Figure 2

Graphical Illustration – Number of Environmental Litigations



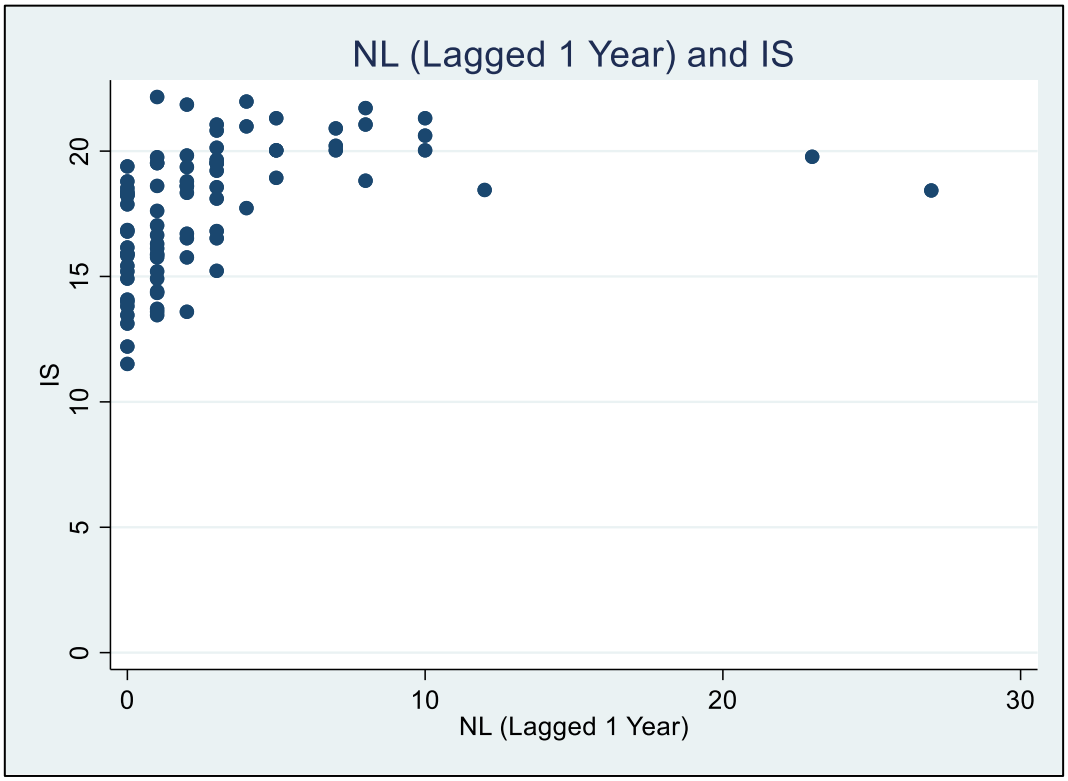
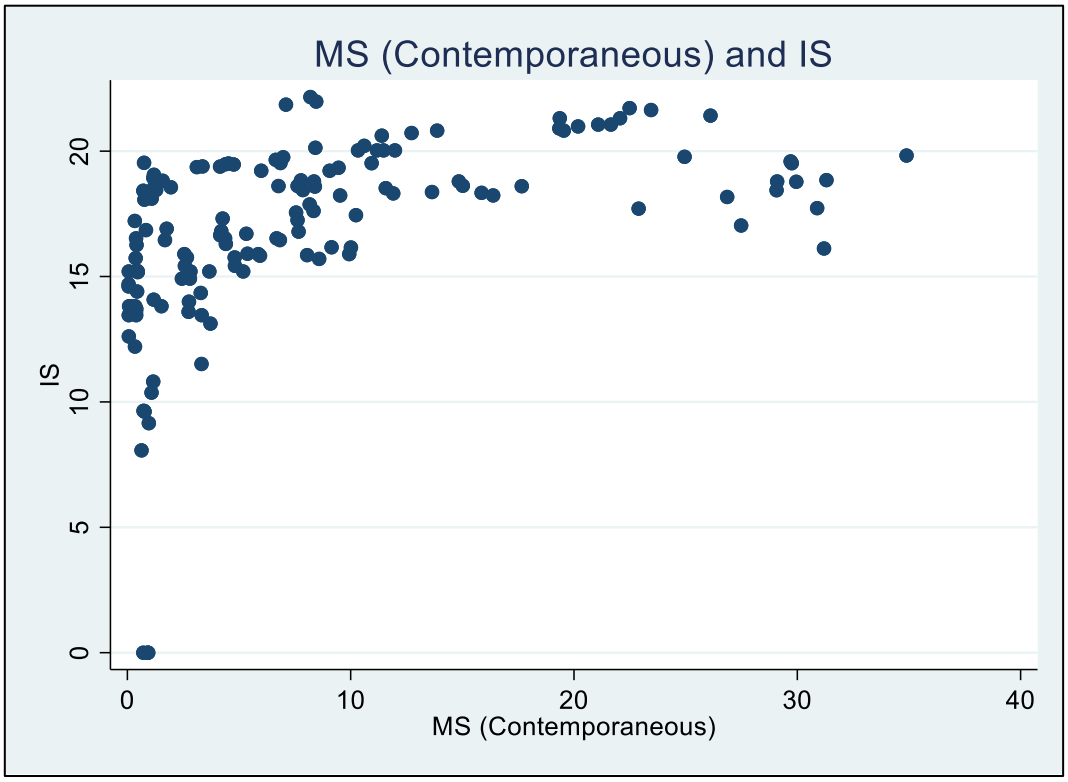


Figure 3

Graphical Illustration – Market Share



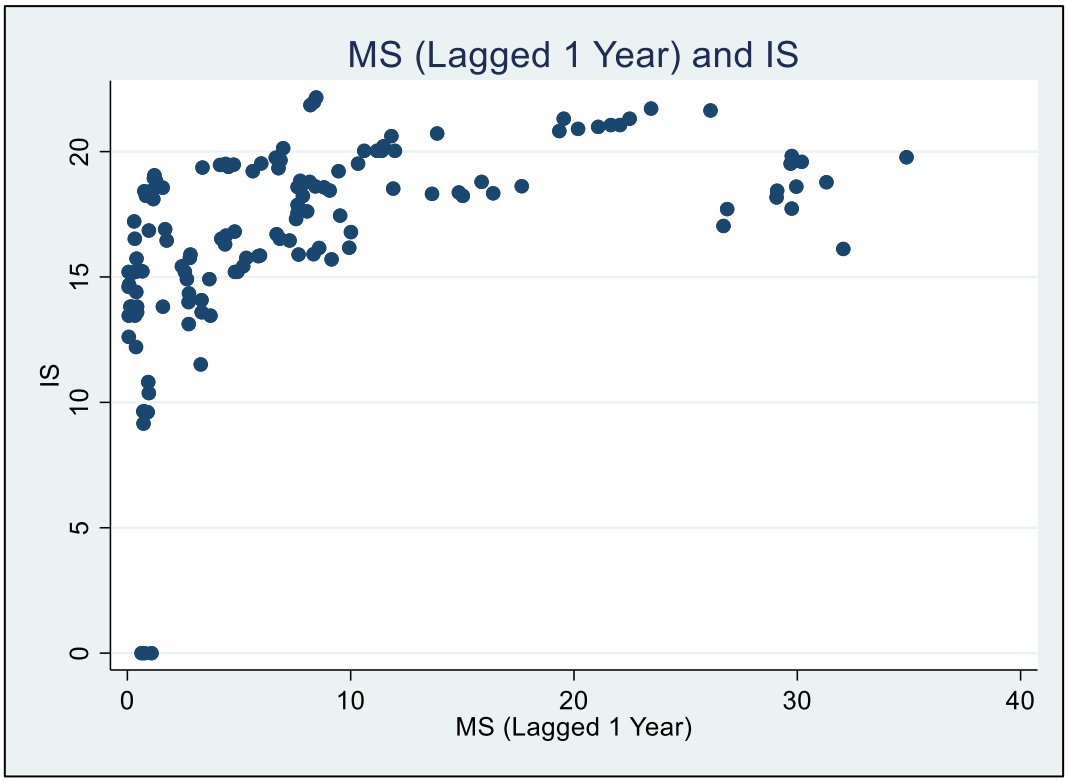


Figure 2 and Figure 3 represent graphically the relationship between the variables.

DISCUSSIONS

4.1. Contributions and Implications

The regression results in section 3 indicate that:

(1) There is a lack of statistical significance to support the relationship between a higher number of environmental litigations and a firm's higher 'investments in sustainability;' and

(2) The relationship between a firm's higher market share and higher 'investments in sustainability' also lacks statistical significance to support it.

These findings contribute to the literature discussing the relationship between carbon performance and various company aspects (de Villiers, 2011; Preston, 2011; Albertini, 2013; Lee, S. Y. & Klassen, 2016; Alam et al., 2019; Velte et al., 2020; Do et al., 2022). A number of business aspects have been shown to be connected or unrelated to carbon performance. This paper adds to this literature by introducing unexplored new variables and relationships to the discussion. It provides a basis for future research utilizing the new variables. As exploratory research, this paper suggests new directions for further research.

This study also contributes to the discussions on environmental performance measurements (Press, 2007; Trumpp et al., 2015) and adds to the understanding of how 'investments in sustainability' work as a proxy for measuring carbon performance. This paper provides a scaffold for utilizing 'investments in sustainability' in empirical studies via its research framework. NGOs, third parties, and future research may use this additional measurement to evaluate firms while minimizing the concerns for greenwashing.

Also, this paper adds to the literature examining company behavior based on the legitimacy theory (Giannarakis et al., 2017; Marselita et al., 2021; Siddique, 2021; Ajeigbe & Ganda, 2022; Goud, 2022; Manurung et al., 2022). By generating hypotheses based on the legitimacy theory, this paper expands the theory's applicability.

In addition, should future studies confirm conclusively the non-significance of statistical evidence for the relationships, the findings will have high implications and real-life applications. The findings will imply that a mere increase in firms' awareness of societal concerns is unlikely to induce the firms to take proactive actions toward carbon neutrality. NGOs and concerned individuals who desire changes in corporate practices will need to improvise additional strategies in order to cause firms to strengthen their carbon reduction efforts. Also, a mere increase in the number of environmental litigations will unlikely generate the desired effects. NGOs and concerned individuals will need to focus on building their lawsuit cases more robustly in order to have an impact. Additionally, it will not be prudent for NGOs and concerned individuals to solely concentrate their efforts on persuading or pressuring market-share leaders — it will be more advisable to approach firms of various market standings. Hence, building upon this study and verifying the findings hold meaning and weight.

Finally, this paper contributes to the literature employing 'investments in sustainability' in empirical research (Chen & Ma, 2021; Atif et al., 2022) and discussions on carbon-intensive industries (Cadez & Czenry, 2016).

4.2. Limitations and Future Research

This paper has some limitations, however. Firstly, as exploratory research, the sample size is not extensive; the data for several of the variables is also incomplete for some firms,

reducing the number of observations used in the regression analysis. Due to this scarcity of data, the sample generation has been primarily based on data availability and assessment, which is a source of potential bias. Secondly, when considering the number of litigations, the duration, content, and intensity of the lawsuits have not been controlled due to resource constraints. Incorporating further information about the nature of the lawsuits is recommended in future studies. Thirdly, when measuring the industry (or sector) revenue, the differences in market subsegments have not been accounted for. Finally, revenues generated external to the designated industry (or sector) of a firm have not been controlled.

Future research may extend the sample size or investigate the relationship with a broader U.S. sample including other industries. A study into the relationships among the variables using international data (cross-national) will also render meaningful research.

Also, conducting research utilizing the 'cumulative environmental litigation numbers' in a given industry (or sector) will produce interesting studies.

Finally, examining which 'environmental management performance' indicator (Trumpp et al., 2015) affects 'investments in sustainability' the most will yield much interest — for instance, investigating whether a firm's environmental policy has more impact than its monitoring practices.

CONCLUSION

This exploratory paper seeks to investigate empirically how environmental litigation and market share relate to a firm's 'investments in sustainability.' For this purpose, the paper utilizes a sample comprising carbon-intensive firms operating in the United States over the period of 2013 to 2021. This study also proposes a research framework that incorporates 'investments in sustainability' as a proxy for measuring carbon performance and contribution towards carbon neutrality.

The findings of this paper show that both environmental litigation and market share indicate a lack of statistical significance in their relationship with 'investments in sustainability,' prompting further research.

This paper contributes to the existing literature on the relationship between carbon performance and various company aspects by introducing new unexplored variables and relationships to the discussion. This paper also contributes to the extant literature on firms' environmental performance measurements by employing 'investments in sustainability' as a proxy for carbon performance measurement. This paper proposes a research framework that adds to the understanding of how 'investments in sustainability' function in empirical studies and suggests new directions for further research.

Future studies may expand the size or scope of the sample to provide a deeper insight. Conducting cross-national or cross-industry analyses will also yield much interest. Additionally, identifying which 'environmental management performance' indicator exhibits the most influence on 'investments in sustainability' will render interesting research that has practical applications. Examining the relationship between the cumulative environmental litigation numbers in an industry and 'investments in sustainability' will also produce meaningful study.

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