Greenwashing or Going Green? An Empirical Analysis of the Drivers and the Effects of Carbon Offsets and Renewable Energy Certificates on Firm Performance

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Carbon offsets and renewable energy certificates (RECs) are widely used instruments that help firms mitigate their greenhouse gas emissions (GHG). This paper investigates which internal firm characteristics are associated with investments in carbon offsets or RECs and how these purchases impact firms' performance. Based on data from publicly traded firms in North America and Europe from 2012-2022, this paper uses a propensity score matching approach to analyze the effects of these investments on firms' environmental scores, GHG emissions, and financial performance. Additionally, this paper employs an instrumental variable approach to examine whether board gender diversity increases carbon offset or REC purchases. The findings reveal that firms that purchase carbon offsets or RECs face higher environmental scores and higher GHG emissions, suggesting corporate greenwashing behavior. This paper also demonstrates that these purchases lead to higher sales, profitability, and assets, but lower Tobin's Q for REC buyers. Lastly, this paper finds that a greater presence of women on the board does not lead to greater purchases of carbon offsets or RECs.

Keywords: corporate sustainability, greenwashing, GHG emissions, carbon offset, renewable energy certificate, environmental performance, board gender diversity

INTRODUCTION

In recent years, the urgency to address climate change has led to a significant increase in firms pledging to reduce their greenhouse gas emissions (GHG)[1] and striving to become carbon neutral or achieve net zero GHG emissions. While firms have various options to lower their greenhouse gas emissions, there has been unprecedented growth in demand for voluntary carbon offsets and renewable energy certificates (REC) to help achieve their sustainability goals. Firms that purchase carbon offsets can manage their emissions footprint by investing in projects that reduce or remove GHG emissions elsewhere in the world, such as direct air capture projects or reforestation initiatives (Jiang et al., 2022; EPA Green Power Partnership, 2018).[2] On the other hand, RECs are a way for firms to support the generation of low or zero-emissions energy by purchasing certificates equivalent to the amount of renewable energy produced by another entity (e.g., wind or solar energy farm) (EPA Green Power Partnership, 2018).[3] By purchasing carbon offsets or RECs, firms can indirectly offset their own GHG emissions. Demand for carbon offsets is expected to grow considerably to potentially $50 billion by 2030 (up from <$1 billion in 2020) (Jiang et al., 2022). Forecasts expect demand for RECs in the US to more than double from $12.1 billion in 2023 to $26.5 billion by 2030 (Wilson et al., 2022). Despite this heightened interest in these two instruments, there is limited research on the factors influencing firms' decisions to purchase carbon offsets or RECs and the potential effects of these actions on firms' value and environmental performance. This paper aims to fill this gap by investigating the firm characteristics associated with investments in carbon offsets or RECs and examining their impact on greenhouse gas emissions levels and the financial performance of companies in North America and Europe.

Developed-country markets, such as North America and Europe, dominate the voluntary market for carbon offsets and RECs and thus provide an ideal setting to analyze how firms utilize these two instruments. Driven by corporate commitments and external pressures from regulators and stakeholders to transition away from fossil fuels, developed-market firms—such as Shell, Volkswagen, Chevron, Delta Airlines, and Microsoft, etc.—have become the biggest buyers of voluntary carbon offsets and RECs over the last few years (Donofrio et al., 2023). The annual traded value in voluntary carbon markets has grown more than six times the 2019 level ($320 million), reaching almost $2 billion in 2021 (Donofrio et al., 2022). Traded volumes in the REC market have also grown rapidly (reaching $11.45 billion in 2021). The voluntary market is expected to form more than two-thirds of total US renewable generation by 2026 (Wilson et al., 2022). Amidst this growth, the concern of greenwashing has also become more prevalent. Greenwashing refers to a firm's practice of using carbon offsets and RECs as green marketing tactics to create an image of environmental responsibility, without substantially reducing their own carbon emissions. Given that carbon offsets and RECs are being increasingly traded as commodities and that greenwashing may be a widespread problem throughout the marketplace, it is crucial to evaluate the effectiveness of these instruments in firms' efforts to reducing their carbon footprints.

Based on this context, this paper investigates the following research questions. First, how does the *quantity* of carbon offsets or REC purchases affect firm-level outcomes, such as environmental and financial performance? More specifically, do carbon offsets or RECs lead to a significant reduction in firms' GHG emissions or an improvement in environmental scores and firm value? Second, what internal firm characteristics are associated with investment in carbon offsets or RECs? To examine these questions, this paper employs a unique panel data set using financial and environmental data from Bloomberg. In particular, this paper focuses on North American firms from the Russell 3000 index and European firms from the STOXX Europe 600 from 2012 to 2022.[4] Our final sample consists of 561 firms, which includes 131 firms that have purchased carbon offsets (23% of the sample) and 117 have purchased RECs (21% of the sample).

The main area of focus of this paper is to determine whether there is a positive relationship between firms' purchases of carbon offsets or RECs and their environmental performance. This paper expects firms engaging in carbon offset or REC purchases to potentially have lower GHG emissions for the following reasons. First, by definition, purchasing a carbon offset or REC allows a firm to report lower GHG emissions on their environmental reports, thereby reducing a firm's carbon footprint and improving their environmental ratings. Additionally, a profit-maximizing firm incurring a voluntary business cost for purchasing carbon offsets or RECs is incentivized to lower its GHG emissions to reduce its operating costs. On the other hand, firms may be purchasing carbon offsets or RECs in order to publicly demonstrate a commitment to the environment, but do not make significant efforts to reduce their GHG emissions. In other words, firms may be investing in carbon offsets or RECs to capture the upside of green branding and higher environmental ratings without having to undergo costly changes to their business models to reduce their GHG emissions. If the above holds true, then we would expect to see a negative relationship between firms' carbon offset or REC purchases and its environmental performance, which could indicate that firms are using these purchases as a form of greenwashing.

To conduct this analysis, this paper uses GHG emissions voluntarily disclosed by publicly traded firms and environmental scores assigned by Bloomberg. Unlike previous studies (Park et al., 2022), this research focuses on the *quantity* or *volume* of carbon offsets[5] or RECs[6] purchased by a firm rather than simply using a binary variable indicating a purchase of an offset. Using this approach, this paper can better evaluate the extent of a firm's efforts in reducing its GHG emissions. To address potential selection bias concerning the voluntary purchase of RECs or carbon offsets and a firm's environmental performance, we use propensity score matching (PSM) to build a control group and then run regressions on a matched sample of firm-year observations. The findings of this paper reveal that firms that purchase carbon offsets or RECs receive higher environmental scores, but their GHG emissions also tend to increase. This discrepancy between higher environmental scores coupled with higher GHG emissions suggests the presence of corporate greenwashing behavior. As an additional test, this paper also employs firms' marketing expense as an instrumental variable to estimate the effects of purchasing carbon offsets or RECs on firms' GHG emissions.

Additionally, this paper examines the relationship between the volume of carbon offsets or RECs purchased by firms and their financial results. Initially, it is uncertain how the purchase of carbon offsets or RECs impacts the financial performance of firms. Previous studies have shown a positive association between a firm's carbon emissions, carbon disclosures, ESG ratings, and corporate financial performance (Matsumura et al, 2014; Tang et al., 2019; Delmas et al., 2011; Whelan et al., 2021). Furthermore, investing in carbon offsets or RECs may improve a firm's reputation for environmental responsibility. It may also result in financial advantages from the broader stakeholder community (e.g., greater customer or employee satisfaction, increased resource efficiency, or better access to financing sources) (Matsumura et al., 2014; Whelan et al., 2021). On the other hand, a firm's stakeholders may perceive the purchase of carbon offsets or RECs as unnecessary expenditures that diminish a firm's resources and dampen its profits, potentially devaluing a company and decreasing its financial performance (Delmas et al., 2011). In order to conduct our analysis, we use various measures of firms' financial performance, including sales, profitability, assets, and Tobin's Q. Similar to our previous analysis on environmental performance, a PSM approach is employed, and regressions are run on a matched sample. This paper finds that purchasing carbon offsets or RECs leads to higher sales, profitability, and assets, but lower Tobin's Q for REC buyers. These findings suggest that there is a segment of the market that sees buying carbon offsets and RECs as a beneficial means to enhance a company's environmental ratings and financial prospects in the short run. In contrast, another segment may view REC purchases as a burden on companies' resources in the long run.

Finally, this paper explores whether certain internal firm characteristics—namely board gender diversity—are associated with purchasing carbon offsets or RECs. A priori, it is unclear whether firms with a higher percentage of women directors on corporate boards purchase more carbon offsets or RECs. The limited number of studies that have studied the association between women in managerial or board positions and the effect on firms' environmental outcomes have found mixed results. Few studies have found a positive relationship between gender diversity on the board and the reduction of carbon emissions, renewable energy consumption, and implementation of environmental policies (Atif et al. 2021; Zhang et al., 2021; Liao et al., 2015; Martinez et al., 2022; Martin et al., 2019; Oyewo, 2023). However, some studies have noted that the presence of women on the board may not be enough to increase the likelihood of GHG emissions disclosure or reduce GHG emissions. This may be because the board may be more inclined to pursue more traditional value-creating objectives (e.g., profitability or shareholder wealth maximization) or because the difference in environmentally friendly attitudes between male and female board members is not as significant as expected (Prado-Lorenzo et al., 2010; Adams et al., 2012). To conduct our analysis, we use the percentage of women employees as an instrumental variable to address potential endogeneity concerns in the independent variable for the percentage of women on the board. Our results indicate that a greater presence of women on the board does not lead to greater carbon offsets or RECs purchases. This lends evidence to suggest that gender diversity does not play a significant role for firms using carbon offsets or RECs as decarbonization strategies.

This paper contributes to the growing literature on climate change and emissions reduction efforts in the following ways. First, to the best of our knowledge, this is the first study analyzing how the *quantity* of carbon offsets or RECs purchased by firms impact firms' environmental and financial performance in North America and Europe. This paper also utilizes more granular firm-level emissions data (including GHG Scope 1, GHG Scope 2 Market, and Total GHG Market emissions),[7] unlike previous studies that relied on carbon emission disclosures or other carbon performance indicators. By using this approach, this study can more clearly assess the effectiveness of using carbon offsets or RECs in mitigating firms' GHG emissions and achieving their sustainability goals. Second, our findings contribute to the literature on corporate greenwashing behavior by revealing that firms that purchase carbon offsets or RECs receive higher environmental scores, but also have higher GHG emissions. These findings are relevant and timely given that demand for carbon offsets and RECs has rapidly grown, particularly from developed-market firms in carbon-intensive industries. Third, this paper offers new insights into the relationship between carbon offset or REC purchases and firm financial performance, highlighting how stakeholders have diverging views on the benefits of these purchases. Lastly, this paper's findings also contribute to the literature on internal corporate governance by demonstrating that gender board diversity alone does not necessarily indicate a stronger inclination towards environmental initiatives such as carbon offsetting and investment in green energy. Overall, these findings have important implications for policymakers and businesses worldwide as they work towards reducing their carbon footprint and achieving their environmental targets.

LITERATURE REVIEW

Despite the significant expansion in the voluntary market for carbon offsets and RECs over the last few years, surprisingly, little is known about the internal governance characteristics of companies that have invested in carbon offsets or RECs or how these purchases impact firms' environmental and financial performance. To the best of our knowledge, no empirical research has been carried out in developed markets such as North America and Europe, where firms are increasingly utilizing these tools to reduce their carbon footprint.[8] We begin our analysis by considering the link between carbon offsets and RECs on the following three variables: i) environmental performance; ii) financial performance; and iii) board gender diversity.

Environmental Performance

In recent years, greenwashing has become so widespread in corporate marketing that it is considered by some studies to have reached epidemic proportions (Trouwloon, 2023). However, despite its prevalence, there is a lack of studies that measure its impact on firms' climate actions and environmental performance. This paper's main contribution to the literature is to address the ongoing greenwashing debate on whether carbon offsets and RECs lead to a reduction in firms' GHG emissions or whether they function as an accounting maneuver that allows firms to continue polluting (Rathi et al., 2022). To the best of our knowledge, this is the first study analyzing how the *quantity* of purchased carbon offsets or RECs have an impact on firms' environmental performance in North America and Europe.

This paper expects firms that purchase carbon offsets or RECs may potentially have positive environmental performance for the following reasons. First, by definition, purchasing a carbon offset or REC allows a firm to report lower GHG emissions on their environmental reports, thereby reducing a firm's carbon footprint and boosting their environmental ratings. Additionally, a profit-maximizing firm incurring a voluntary business cost for purchasing carbon offsets or RECs is incentivized to lower its GHG emissions to reduce its operating costs. On the other hand, firms may purchase carbon offsets or RECs to publicly demonstrate a commitment to the environment, but do not make significant efforts to reduce their GHG emissions. In other words, firms may be purchasing carbon offsets or RECs to capture the upside of green branding and higher environmental ratings without having to undergo costly changes to their business models to reduce their GHG emissions. If the above holds true, then we would expect to see a negative relationship between a firm's carbon offset or REC purchases and its environmental performance. This result could indicate that firms may be using these purchases as a form of greenwashing or "carbonwashing", as it could create a misleading impression to consumers and stakeholders that companies are taking steps to address their carbon emissions when, in reality, they are not (Young et al., 2021; Trouwloon, 2023).

Our paper is related to a few studies on corporate offsetting and greenwashing behavior. Regarding carbon offsets, Wei et al. (2021) conducts a systematic literature review of carbon offset research and finds that most of the existing literature does not cover corporate involvement in the carbon offset market. Instead, extant studies focus on the following areas: individuals carbon offsets (e.g., aviation passenger carbon offset); forest and land carbon offsets; public transportation carbon offsets; and the impact of carbon offsets on ecosystem development. Furthermore, these studies on carbon offsets are focused on examining the effects of specific projects. For example, studies such as Jaraite et al. (2022) and Guizar-Coutiño et al.

(2022) analyze the impact of 339 carbon offset projects in India and forty global deforestation projects on GHG emissions, respectively. By contrast, our paper adopts a firm-level rather than project-level focus. Additionally, our paper analyzes the effects of firms' purchases of carbon offset and RECs on GHG emissions, firms' environmental ratings, and renewable energy usage. Regarding corporate greenwashing, Mateo-Marquez et al. (2022) study a sample of international firms from twelve countries and find that there is a negative relationship between the number of regulations related to climate change and the propensity of firms to engage in greenwashing. This study defined greenwashing as firms who reported positive communication regarding their environmental performance, but featured a high carbon intensity ratio (i.e., high carbon emissions/total revenue). Since the carbon offsets and RECs market is largely voluntary and therefore lacks strict regulation, this may imply a greater presence of greenwashing behavior in our dataset.

While the study by Park et al. (2022) also examines firms' carbon offset purchases in South Korea during 2011-2019, our paper improves upon this existing study in the following ways. First, our paper focuses on the *quantity* or volume of carbon offsets or RECs purchased by a firm rather than simply using a binary variable indicating a purchase of an offset.[9] Unlike previous studies on carbon emission disclosures or other carbon performance indicators, our paper utilizes more granular firm-level emissions data (including GHG Scope 1, GHG Scope 2 Market, and Total GHG Market emissions). Combined with a PSM approach to deal with concerns on potential selection bias, this study can more clearly assess the effectiveness of using carbon offsets or RECs in mitigating firms' indirect or direct GHG emissions and achieving their sustainability goals. Second, as mentioned before, we broaden the geographic focus in our paper by examining developed-market firms in North America and Europe as they constitute the largest buyers of carbon offsets worldwide. For example, 83.7% of all offsets in 2021 were bought by firms in North America and Europe, thus we may expect to see a greater degree of GHG emissions reductions in firms in our data set (Harrison et al., 2022). Lastly, this paper analyzes the effect of REC purchases on firms' subsequent renewable energy usage and intensity, a new channel that Park et al. (2022) did not explore.

Overall, our findings contribute to the literature on corporate greenwashing behavior by revealing that firms that purchase carbon offsets or RECs receive higher environmental scores, but also have higher GHG emissions. These findings are relevant and timely given that demand for carbon offsets and RECs has been rapidly growing, particularly from developed-market firms in carbon-intensive industries.

Financial Performance

The question on whether it "pays to be green"— i.e., companies profiting from improving their environmental performance— has been the subject of long-standing debate in the literature, but little empirical evidence exists within the context of carbon emissions (Delmas et al., 2011; Ghisetti et al., 2014; Tang, 2019). Our analysis is motivated by the question of whether it pays to be green when it comes to firms' investment in carbon offsets or RECs in developed markets.

Recent studies in the literature on financial and environmental performance have primarily focused on the role of firms' carbon emissions, carbon disclosures, and ESG ratings (Matsumura et al, 2014; Tang et al., 2019; Delmas et al., 2011; Whelan et al., 2021). Several studies have found a positive association between environmental and financial performance, supporting a "win-win" hypothesis first posited by Porter and van der Linde (1995). This viewpoint supports the idea that firms gain a competitive advantage when implementing proactive environmental strategies, which can reduce regulatory obligations, minimize business risks, improve operational efficiencies through eco-friendly innovation, and attract important stakeholders (Porter et al., 1995; Delmas et al., 2011). Empirical evidence supporting this view includes Matsumura et al. (2014), which analyzes firms' GHG emissions data and voluntary emissions disclosures for S&P 500 firms during the period 2006-2008. This study finds a positive relationship between lower carbon emissions and increased voluntary carbon disclosures on firm value, suggesting that the market rewards firms for exhibiting environmentally responsible behavior. Another study by Tang et al. (2019), analyzing data from China and Hong Kong from 2012 to 2013, also finds that firms' efforts to reduce carbon emissions are compensated by higher profitability (e.g., return on assets and Tobin's Q). Lastly, Whelan et al. (2021) conduct a meta-analysis for the period 2015-2020 and find a positive relationship between ESG and financial performance for 58% of firm-level studies focused on measures such as return on equity, return on assets, or stock price. This "win-win" viewpoint may be extended to investing in carbon offsets or RECs as they may improve a firm's reputation for environmental responsibility and may also result in financial advantages from the broader stakeholder community (e.g., greater customer or employee satisfaction, increased resource efficiency, or better access to financing sources) (Matsumura et al., 2014; Whelan et al., 2021).

On the other hand, some studies find evidence that does not support Porter's hypothesis. Delmas et al. (2011) examine over 1,100 US firms during the period 2004-2008 and find mixed results on the effects of GHG emissions on short and long-term measures of financial performance. This study demonstrates that higher levels of carbon emissions positively impact firms' financial performance when using short term, accounting-based measures (e.g., ROA), but a negative impact when considering long term, market-based measures of financial performance (e.g., Tobin's Q). These results suggest that from an accounting-based perspective, firms have no financial incentive to minimize their GHG emissions in the absence of carbon regulation in voluntary markets. However, evidence Delmas et al. (2011) also suggests that investors see the potential long-term value of improved environmental performance, manifested by an increase in Tobin's Q. With regards to carbon offsetting and RECs, a firm's stakeholders may perceive the purchase of these instruments as unnecessary costs that diminish a firm's resources and detracts their focus from profit-maximization, which may potentially devalue a company and decrease its financial performance (Delmas et al., 2011).

Based on the literature mentioned above, this paper analyzes the effect of carbon offsets and RECs on various measures of firms' financial performance, including sales, profitability, assets, and Tobin's Q. This paper contributes to the extant literature by analyzing whether carbon offsets or RECs have a strengthening or weakening effect on firms' financial performance in the short term and long term. We also improve upon existing studies, such as Park et al. (2022), by employing a PSM approach to deal with potential selection bias concerns. Lastly, our findings help answer whether firms have a financial incentive to use carbon offsets or RECs to manage their GHG emissions and renewable energy consumption.

Board Gender Diversity

In general, many studies have examined different solutions to reduce GHG emissions, including carbon taxes, carbon-contingent securities, green bonds, and cap-and-trade systems (Allen et al., 2023; Stavins, 2020). However, the role of internal corporate governance—namely gender diversity on a firm's board—is largely overlooked in the existing literature. The limited number of empirical studies on the effects of board gender diversity on GHG emissions and other environmental outcomes exhibit mixed results.

Few studies have found a positive relationship between board gender diversity and firms' environmental performance, including GHG emissions, carbon disclosures, and renewable energy consumption (Martin et al., 2019; Martinez et al., 2022; Oyewo, 2023; Liao et al., 2015; Atif et al. 2021; Zhang et al., 2021). Regarding GHG emissions, a study by Martin and Herrero (2019) analyzes a sample of 644 European companies from 2002 to 2017. It demonstrates that board gender diversity is positively associated with firms' implementation of environmental initiatives and GHG emission reduction efforts. Studies by Oyewo (2023) and Martinez et al. (2022) also exhibit similar findings between board gender diversity and reductions in carbon emissions for international MNEs and emerging market firms. Regarding carbon disclosure, Liao et al. (2015) examines a sample of 329 UK-based firms and finds a significant positive association between board gender diversity and greater likelihood of GHG disclosures. Lastly, studies such as Atif et al. (2021) and Zhang et al. (2021), which examine samples of US and international firms over the last decade, highlight a positive relationship between board gender diversity and renewable energy consumption. These empirical results lend support to theories such as the gender socialization theory by Chodorow (1978) and the social role theory by Eagly (1987), which predict that female decision-makers are key drivers on environmental issues thanks to their abilities to empathize, collaborate, manage risk, and pay attention to detail (Altunbas et al., 2022).

However, some studies have noted that the presence of women on the board may not lead to favorable environmental outcomes. For example, Haque (2017) examines a sample of 256 UK-based firms from 2002 to 2014 and does not find any relationship between board gender diversity and firms' GHG emissions. Haque (2017) findings lend evidence to suggest firms may be more focused on pursuing carbon initiatives in order to be seen as environmentally responsible and improve their financial performance, rather than make any actual GHG emissions reductions. Other studies have also shown that this negative relationship may also be because the board may be more inclined to pursue more traditional value-creating objectives (e.g., profitability or shareholder wealth maximization) or the difference in perspectives on environmental issues between male and female board members is not as significant as expected (Prado-Lorenzo et al., 2010; Adams et al., 2012; Altunbas et al., 2022).

This paper also expands upon a study by Park et al. (2022), which shows insignificant evidence on the relationship between gender board diversity and firms' carbon offset purchases in South Korea between 2011-2019. Our paper expands upon the narrow single-country focus in Park et al. (2022) by examining a multi-country dataset comprised of over fifteen countries across Europe and North America. While board gender diversity is virtually non-existent in South Korea (Park et al., 2022), we expect to find that our wider range of developed-country markets could consist of firms with greater diversity of corporate leadership. Furthermore, this paper expands on the role of board gender diversity by exploring the effects on renewable energy certificates, which is a new environmental dimension that Park et al. (2022) do not consider. This paper also employs a more robust instrumental variable approach than Park et al. (2022) to account for potential endogeneity concerns (e.g., omitted variables may drive the positive relationship between women on the board and firms' purchases of carbon offsets or RECs).[10]

While this paper also investigates the link between gender board diversity and environmental outcomes, the focus on carbon offsets and RECs is new to the literature. Our findings contribute to the extant literature by demonstrating whether gender board diversity plays a role in environmental initiatives such as carbon offsetting and investment in green energy.

RESEARCH DESIGN

Sample Data Source

The data sample used in the following empirical analysis includes annual data on North American firms from the Russell 3000 index and European firms from the STOXX Europe 600 index from 2012 to 2022. In order to avoid selection bias in our data sample, firms are selected from these two indexes as they both consist of the broadest range of small, medium, or large capitalization firms in North America or Europe[11]. The data is sourced from Bloomberg, which reports financial, environmental, and governance data for any global, publicly traded firms based on corporate financial reports, environmental reports, real time market data, and voluntary disclosed data reported directly by firms. Our final sample consists of 561 firms or 6171 firm-year observations, which all have non-missing data for their GHG emissions. From this sample, 131 firms that have purchased carbon offsets (representing 23% of the sample) and 117 have purchased RECs (21% of the sample).

Empirical Model and Variables

Carbon Offsets, RECs, and Firm Performance

The first part of our analysis focuses on how the purchase of carbon offsets or RECs affects firm-level outcomes, such as environmental and financial performance. In particular, this paper evaluates whether carbon offsets or RECs affect firms': 1) level of GHG emissions; 2) total renewable energy consumption; 3) environmental score; and 4) financial performance. The following models are employed:

$$GHGEmissions_{ifjt} = a + \beta_1 CarbonOffset_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (1)$$

$$GHGEmissions_{ifjt} = a + \beta_1 REC_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (2)$$

$$RenewableEnergyUse_{ifjt} = a + \beta_1 REC_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (3)$$

$$EnvScore_{ifjt} = a + \beta_1 CarbonOffset_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (4)$$

$$EnvScore_{ifjt} = a + \beta_1 REC_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (5)$$

$$Firm\ Performance_{ifjt} == a + \beta_1 CarbonOffset_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (6)$$

$$Firm\ Performance_{ifjt} = a + \beta_1 REC_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (7)$$

The dependent variable in models 1 and 2 is $GHGEmissions$, which is the natural log of GHG Scope 1 emissions, GHG Scope 2 market emissions, and Total GHG market emissions in a given year *t* for a firm *i*. The dependent variable for model 3 is $RenewableEnergyUse$, which we measure using 2 ways including: 1) the natural logarithm of a firm's renewable energy consumption for a given year *t* and 2) renewable energy intensity (i.e., a ratio of a firm's renewable energy consumption over its total energy consumption*)*. In models 4 and 5, we also measure the effect of carbon offsets on another dependent variable $EnvScore$, which indicates the natural logarithm of a firm's environmental score. Furthermore, we analyze the effects on a firm's financial performance, which we measure using log sales, log operating income, log assets, and Tobin's Q. The one-year lagged independent variable in models 1, 4, and 6 is *CarbonOffset*, which is the natural logarithm of the total amount of carbon offsets purchased in thousands of metric tons (CO2) for a given firm *i* in year *t*. The one-year lagged independent variable in models 2, 3, 5, and 7 is REC, the natural logarithm of the total amount of renewable energy certificates purchased in thousands of megawatt hours (MWh). Table 1 displays the descriptions of all the variables included in the empirical analysis.

To address concerns for potential selection bias regarding the voluntary, and thus non-random, purchase of RECs or carbon offsets and a firm's environmental and financial performance, we use propensity score matching to build a control group and then run regressions on a matched sample of firm-year observations. We first assign firms who have purchased carbon offsets or RECs to the treatment group and firms who have not purchased anything to the control group. Next, we estimate the probability that a firm has purchased carbon offsets or RECs. We run a logit regression to explain a dummy variable which equals one if a firm has purchased carbon offsets or RECs, respectively, and zero otherwise. Additionally, the nearest-neighbor approach is employed to ensure that firms in the treatment and control groups are sufficiently identical. Each firm-year observation with firms who have purchased carbon offsets or RECs is matched with a firm-year observation of non-buyers and with the closest propensity score (i.e., we require the caliper not to exceed 0.1% in absolute value). Based on the matched sample of firm-year observations, we employ logit regressions in models 1-7 to estimate the effect on firms' financial and environmental performance. In this case, β_1 measures the change in a firm's financial or environmental performance after purchasing carbon offsets or RECs.

Our study also includes several controls for firms' financial performance. These controls are as follows. Cash holdings is the ratio of cash and cash equivalents to total assets. Leverage is the ratio of total debt (short term and long term) to total assets. Investment is the ratio of capital expenditures to total assets. Return on assets (ROA) is a measure of a firm's efficiency and equals the ratio of net income to total assets. Return on equity (ROE), a measure of a firm's profitability, is the net income ratio to total shareholder's equity. Capital spending is the ratio of a firm's capital expenditures to total sales. One-year lagged levels (i.e., *t-1)* of the independent and control variables are used to mitigate endogeneity concerns and because it may take time for carbon offset or REC purchases to affect firms' environmental policies. Additionally, for firm *i*, γ_f refers to industry (based on two-digit SIC industry codes) effects, δ_t refers to year effects, and ζ_j refers to country effects, which are included in all regressions. Lastly, standard errors are clustered at the industry level to control for heteroskedasticity and intra-industry correlation in the residuals.

Percentage of Women on the Board and the Purchase of Carbon Offsets or RECs

The second part of our analysis focuses on whether a certain internal governance characteristic (i.e., women directors on the board) have an impact on the volume of carbon offsets or RECs purchased. Models 8 and 9 are employed to conduct this investigation:

$$CarbonOffset_{ifjt} = a + \beta_1 \%WomenonBoard_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (8)$$

$$REC_{ifjt} = a + \beta_1 \%WomenonBoard_{i,t-1} + \beta_2 Controls_{i,t-1} + \gamma_f + \zeta_j + \delta_t + \varepsilon_{ifjt} \quad (9)$$

TABLE 1
VARIABLE DESCRIPTION

Variable Name	**Definition**
Panel A: Independent Variables	
% Women on Board	The number of women directors on the board expressed as a percentage of total board size
% Women Employees	The number of women employees expressed as a percentage of total employment
Carbon Offsets	The natural logarithm of total carbon offsets purchased in thousand metric tons of carbon emissions
REC	The natural logarithm of renewable energy certificates purchased in thousands of megawatt hours
Panel B: Dependent Variables	
CO2 & CO2 Equivalent Emissions	
GHG Scope 1 Emissions	The natural logarithm of GHG Scope 1 emissions in thousand metric tons GHG emissions
GHG Scope 2 Market Emissions	The natural logarithm of GHG Scope 2 Market emissions in thousand metric tons GHG emissions
Total GHG Market Emissions	The natural logarithm of Total GHG Market emissions (Scope 1 & 2) in thousand metric tons GHG emissions
Renewable Energy	
Renewable Energy Use	Natural logarithm of total annual renewable energy consumption in thousands of megawatt hours
Renewable Energy Intensity	The share of renewable energy use over total energy consumption (%)
Environmental Performance	
Environmental Score	Natural logarithm of Bloomberg’s Environmental Score
Financial Performance	
Tobin’s Q	Market value of equity plus total assets minus the book value of equity, all divided by total assets
Sales	The natural logarithm of total sales
Assets	Firm size measured by the natural logarithm of total assets
Operating Income	The natural logarithm of operating income

Panel C: Control Variables	
Cash Holdings	Ratio of cash to total assets
Leverage	Ratio of long-term & short-term debt to total assets
Investment	Ratio of capital expenditure to total assets
Return on assets	Net income as a percentage of total assets
Return on equity	Net income as a percentage of total equity
Capital Spending	Ratio of capital expenditure to total sales
Board Size	The total number of directors on the firm's board

The dependent variable in model 8, *CarbonOffset*, is the natural logarithm of the total amount of carbon offset purchase(s) in metric tons of carbon emissions for a given firm *i* in year *t*. The dependent variable in model 9, *REC,* is the natural logarithm of the total renewable energy certificate purchase(s) in thousands of megawatt hours (MWh). The same financial control variables are employed as in the previous analysis (i.e., cash holdings, leverage, investment, ROA, ROE, and capital spending) and industry, year, and country fixed effects. Board size is also included in the regression as a control variable. Our variable of interest in this analysis is a characteristic of firms' internal governance, namely the percentage of women directors on the board *(%WomenonBoard)*. To address potential endogeneity in the independent variable *(%WomenonBoard)* as noted by the extant literature (Atif et al., 2021), we use an instrumental variable (IV) approach to determine the percentage of women on the board of directors. We use the percentage of women employees *(%WomenEmployees)* as an IV for the *%WomenonBoard*. Like (Martinez et al., 2022), we expect this instrument to be relevant given that firms that employ more women are more likely to have a larger group of female candidates to elect as members to the board. Thus, we anticipate *%WomenEmployees* to be positively correlated to *%WomenonBoard*.

Additionally, we expect this instrument be excludable[12] as the purchase of carbon offsets or RECs are costly investments that require oversight and budget approval by firms' boards rather than its employees. This view is supported by a recent study by Ecosystem Marketplace,[13] which revealed that companies that purchase voluntary carbon offsets have a dedicated budget towards GHG emission reduction activities and invest an average of $1.3 million.[14] Additionally, 97% of these carbon-offset buyers mandate board-level supervision and approval for these investment initiatives.

To estimate the effect on 1) carbon offsets and 2) RECs, a two-stage least squares (2SLS) approach is employed. While previous studies have studied the effect of female board members on renewable energy consumption or corporate social responsibility performance, the relationship between the female board membership and the volume of green power purchases (i.e., RECs) and carbon offsets has not been studied. Studying the volume and magnitude of RECs or carbon offset purchases is important as it focuses on the scale of GHG emission reduction or energy efficient policies, which is of vital importance to firms who have set emissions targets or made commitments to reduce their environmental impact.

Descriptive Statistics

Table 2 displays the descriptive statistics for the full sample of firms as well as the sub-samples with 1) carbon offset buyers and without carbon offset buyers and 2) with REC buyers and without REC buyers. The t-statistics for the differences in means between the control and treatment groups are shown based on a two-sample t-test. In particular, Panel A exhibits that firms on average have purchased approximately 525.89 thousand metric tons of carbon offsets and 407.40 thousand of MWh of RECs.[15]

Panel B shows that firms in our full sample emit an average volume of 3446.14 thousand tons of Total GHG Market emissions, with a higher average volume of GHG Scope 1 emissions than GHG Scope 2 Market emissions (3894.64 vs. 659.89 thousand tons). On average, firms who have purchased carbon offsets emit higher volumes of Total GHG Market emissions than non-buyers of carbon offsets (4967.83 vs. 2787.26 thousand tons). This difference is significant at the 1% level. Additionally, buyers of carbon offsets also display a higher average environmental score than non-buyers.

Additionally, the sub-sample of firms that have purchased RECs differs from firms that have not. Panel B shows that firms in our full sample have an average renewable energy intensity of 22.60%. Notably, buyers of RECs display a higher usage of renewable energy as a percentage of total energy consumption than non-buyers of RECs (33.22% vs. 17.94%). This difference is significant at the 1% level. Furthermore, buyers of RECs display a lower average volume of Total GHG market emissions compared to non-buyers (996.29 vs. 4329.36 thousand MWh). Furthermore, buyers of RECs also display a higher average environmental score than non-buyers of RECs.

Panel C of Table 2 focuses on the financial variables that may impact firms' propensity to buy carbon offsets or RECs and their GHG emissions. Firms in the sample have average cash holdings of 0.12, leverage of 0.30, investment of -0.03, ROA of 0.04, ROE of 19.57, and capital spending of -0.12. The average board size of firms is ~11 members.

TABLE 2
DESCRIPTIVE STATISTICS

	Full Sample		With Carbon Offsets	Without Offsets		With RECs	Without RECs	
	N= 6,171		N= 1,441	N= 4,730		N=1,287	N= 4,884	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Mean**	**t-stat of difference in means**	**Mean**	**Mean**	**t-stat of difference in means**
Panel A: Independent Variables								
% Women on Board (WOB)	24.347	11.490	27.482	23.351	-11.904	26.776	23.691	-8.456
Carbon Offsets	525.890	2089.595	525.924	-		112.079	734.444	3.899
RECs	407.406	987.921	595.170	273.574	-4.122	407.406	-	-
ln(Carbon Offsets)	3.916	2.325	3.912	-	-	3.229	4.248	5.497
ln(RECs)	4.478	1.966	5.014	4.091	-6.019	4.478	-	-
Panel B: Dependent Variables								
GHG Emissions								
GHG Scope 1 emissions	3894.649	14315.26	7382.713	2415.23	-10.328	604.418	4944.455	8.414
GHG Scope 2 Market emissions	659.8981	2042.873	842.582	580.798	-2.948	603.625	680.186	0.827
Total GHG Market emissions	3446.141	11336.280	4967.830	2787.265	-4.435	996.297	4329.364	6.545
ln(GHG Scope 1 emissions)	4.650	2.988	4.813	4.581	-2.277	3.915	4.883	8.971
ln(GHG Scope 2 Market emissions)	4.529	2.393	4.282	4.635	3.339	4.185	4.650	4.213
ln(Total GHG Market emissions)	5.505	2.473	5.451	5.529	0.727	5.006	5.686	6.107
Renewable Energy								
ln(Renewable Energy use)	4.449	2.651	5.023	4.139	-8.117	4.835	4.268	-5.038
Renew. Energy Intensity	0.226	0.279	0.323	0.176	-13.305	0.332	0.179	-13.372
Environmental Performance								
ln(Environmental Score)	3.288	1.068	3.578	3.184	-11.519	3.492	3.228	-7.285
Financial performance								
Tobin's Q	2.281	3.001	2.420	2.237	-1.998	2.353	2.262	-0.948
ln(Sales)	9.007	1.554	9.815	8.754	-23.524	9.444	8.889	-11.425
ln(Assets)	9.816	1.817	10.987	9.449	-29.956	10.380	9.665	-12.625
ln(Operating Income)	7.046	1.597	7.878	6.782	-22.627	7.615	6.891	-13.974
Panel C: Control Variables								
Cash Holdings	0.128	0.138	0.149	0.121	-6.631	0.150	0.121	-6.694
Leverage	0.305	0.223	0.255	0.320	9.662	0.248	0.320	10.237
Investment	-0.039	0.043	-0.033	-0.041	-6.560	-0.033	-0.041	-6.352
Return on assets	0.043	0.580	0.058	0.038	-1.118	0.057	0.039	-0.943
Return on equity	19.572	68.733	26.363	17.360	-4.245	20.581	19.296	-0.577
Capital Spending	-0.125	0.499	-0.081	-0.138	-3.780	-0.087	-0.135	-3.063
Board Size	11.011	2.664	12.393	10.572	-23.391	11.387	10.909	-5.634

Table above exhibits the descriptive statistics for the full sample as well as the sub-samples with 1) carbon offset buyers and without carbon offset buyers and 2) with REC buyers and without REC buyers. ***, **, * Denotes significance at the 1%, 5% and 10% level respectively.

Lastly, Panel A shows that the firms, on average, have 24.34% of women directors on the board. When comparing the subsamples, firms who have purchased carbon offsets or RECs exhibit a higher percentage of women directors on the board than firms who have not purchased carbon offsets or RECs (27.48% vs 23.35% and 26.77% vs 23.69%, respectively). Figure 1 (shown in the Appendix) also displays the increase in the average percentage of women directors on the board from 2012-2022. The percentage of women on the board almost doubled from an average of 16.71% in 2012 to comprising a third (33.39%) of the board in 2022. According to Figure 1, this pattern of an increasing average of percentage of women on the board is seemingly higher for buyers of carbon offsets or RECs.

Table 3 presents the average GHG market emissions, average carbon offsets purchased, average RECs purchased, average renewable energy intensity, average environmental score, and average percentage of women on board for different industry sectors. Table 3 indicates that firms in carbon-intensive industries, such as energy, utilities, materials, and industrials, emit the highest average volume of GHG market emissions. In contrast, the information technology, real estate, and financial sectors emit the lowest. Firms in these carbon-intensive industries are also the biggest buyers of carbon offsets. For example, firms in the energy and industrial sectors purchase the highest average volumes of carbon offsets (2003.47 and 1429.26 thousand tons of CO2e respectively). This is followed by the communications, consumer discretionary, and information technology sectors.[16]

On average, the real estate (71.49%), information technology (44.79%), and financials sector (42.90%) use the most renewable energy as a percentage of total energy consumption. On average, the biggest buyers of RECs have been communications and information technology firms (average volume of 846.96 and 756.56 thousand MWh respectively). The utilities, energy, and financials sectors follow this.[17]

With regards to the percentage of women on the board, the industry sectors with the highest averages are financials, communication, and consumer staples. Conversely, on average, the materials and energy sectors feature a lower percentage of women on the board. Interestingly, on average, there seems to be a higher percentage of women on the board in less carbon-intensive industries, whereas a lower presence of women on the board in more polluting industry sectors. Lastly, carbon-intensive industries such as utilities, materials, and energy feature a high average environmental score (43.45, 41.02, and 38.73, respectively). On the other hand, the communication and real estate sectors feature the lowest average environmental scores.

TABLE 3
INDUSTRY AVERAGES

GICS Industry Sectors	N	GHG Market Emissions (Thousand metric tonnes CO2e)	Carbon Offsets (Thousand metric tonnes CO2e)	RECs (Thousand MWh)	Renew. Energy Intensity	Environmental Score	Women on Board
Communication	253	1262.773	570.582	846.965	30.57%	24.093	26.74%
Consumer Discretionary	737	1537.081	242.952	294.045	5.57%	30.467	26.47%
Consumer Staples	517	1880.880	87.896	326.322	17.13%	39.311	26.69%
Energy	275	29212.843	2003.472	365.600	3.77%	38.731	21.53%
Financials	847	96.494	80.767	327.928	42.90%	28.032	27.63%
Health Care	539	869.204	81.752	226.893	8.79%	35.230	25.06%
Industrials	990	3877.555	1429.260	213.315	1.95%	32.511	22.68%
Information Technology	869	375.620	174.609	756.561	44.79%	31.018	22.00%
Materials	495	4730.770	0.000	126.166	30.53%	41.027	21.20%
Real Estate	418	209.883	5.050	237.289	71.49%	25.746	22.32%
Utilities	231	25895.820	7.888	453.333	7.26%	43.451	24.64%

Table 3 displays the number of observations, average GHG market emissions, average carbon offsets purchased, average RECs purchased, average renewable energy intensity, average environmental score, and average percentage of women on board for different industry sectors.

RESULTS AND DISCUSSION

Carbon Offsets, RECs, and Firm Performance

Effect of Carbon Offset Purchases on Firm Environmental and Financial Performance

The first part of our analysis examines whether the volume of carbon offsets purchased affects firms' environmental and financial performance. In particular, we focus on whether carbon offsets affect firms': 1) level of GHG emissions; 2) environmental score; and 3) financial performance (i.e., log sales, log operating income, log assets, and Tobin's Q). Logit regressions are run on a matched sample of firm-year observations using the propensity scores as weights to address endogeneity concerns.[18] Table 4 reports the results of the logit regression explaining the impact on firms' environmental score (column 1), the log of Total GHG market emissions (column 2), the log of GHG Scope 2 Market emissions (column 3), and the log of GHG Scope 1 emissions (column 4).

TABLE 4
EFFECT OF CARBON OFFSET PURCHASES ON FIRMS' ENVIRONMENTAL PERFORMANCE

	Post-Match Sample			
Dependent Variable:	**(1) Environmental Score**	**(2) ln (Total GHG Market Emissions)**	**(3) ln(GHG Scope 2 Market Emissions)**	**(4) ln (GHG Scope 1 Emissions)**
ln Carbon Offset	0.025***	0.293***	0.252**	0.321**
	(0.006)	(0.089)	(0.110)	(0.110)
Cash Holdings	0.139	-4.547***	-5.364**	-3.887***
	(0.286)	(1.363)	(1.765)	(0.986)
Investment	-2.517	-36.884**	-40.854***	-35.467***
	(1.945)	(11.965)	(6.991)	(8.331)
Leverage	-0.190	3.790***	3.527*	2.823**
	(0.208)	(1.115)	(1.734)	(1.165)
ROE	0.001***	-0.001	0.001	-0.001
	(0.000)	(0.001)	(0.002)	(0.001)
ROA	-0.680**	-2.834	-2.461	0.814
	(0.257)	(1.818)	(6.456)	(2.111)
Capital Spending	0.156	4.378	6.612**	2.389
	(0.376)	(2.710)	(2.245)	(1.819)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1367	969	922	1371
R^2	0.42	0.72	0.54	0.83

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, **, and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

Column 1 shows that the coefficient on the log of carbon offsets (thousand tons of CO2e) is significantly positive at the 1% level suggesting that the purchase of carbon offsets leads to an improvement in firms' environmental score. Columns 2 to 4, on the other hand, suggests a positive relationship between the volumes of carbon offsets purchased and the level of a firm's direct and indirect GHG emissions (i.e., Scope 1 emissions, Scope 2 market emissions, and Total GHG market emissions). The coefficient on the log of carbon offsets is significant at the 1% level in column 2 and 5% level in columns 3 and 4. Using the propensity score matching method suggests that these results are not affected by observable differences between firm-year observations for carbon offset buyers and non-buyers of carbon offsets.

These findings suggest that while the volume of carbon offsets purchased positively impacts environmental scores, it does not lead to an improvement in volumes of direct or indirect GHG emissions. These results lend evidence to greenwashing (as proposed in Park et al., 2022), whereby firms are rewarded for pursuing sustainable initiatives such as buying carbon offsets, but do not substantially reduce the volume of their GHG emissions. While the study by Park et al. (2022) also examines this concept of greenwashing, the relationship between firms' environmental and financial performance and the *volume* of carbon offsets purchased has not been studied. Studying the volume and magnitude of carbon offset purchases is important as it focuses on the scale of GHG emission reduction policies, which is vital to firms who have set emissions targets or made commitments to reduce their environmental impact. Studying the impact of these carbon offset purchases on firm performance is relevant and timely given the volume of carbon offsets purchased has been rapidly growing, particularly from buyers in carbon-intensive industries, and is forecast to substantially increase (Martinez et al., 2023).

TABLE 5
EFFECT OF CARBON PURCHASES ON FIRMS' FINANCIAL PERFORMANCE

	Post-Match Sample			
	(1)	**(2)**	**(3)**	**(4)**
Dependent Variable:	**Tobin's Q**	**ln (Sales)**	**ln (Operating Income)**	**ln (Assets)**
ln Carbon Offset	-0.320	0.190***	0.177***	0.205***
	(0.191)	(0.040)	(0.047)	(0.050)
Cash Holdings	7.249	-0.818	-0.237	-0.869
	(4.288)	(0.476)	(0.564)	(0.830)
Investment	14.349	-17.517***	-6.761	-10.902*
	(16.695)	(5.437)	(4.984)	(5.202)
Leverage	1.851	0.178	0.478	-0.191
	(1.186)	(0.788)	(0.951)	(0.875)
ROE	0.001	0.0002	0.0003	-0.002
	(0.005)	(0.002)	(0.001)	(0.003)
ROA	25.479***	-1.619	0.522	-2.277**
	(3.191)	(1.085)	(1.290)	(0.866)
Capital Spending	-0.572	2.070	0.297	0.696
	(3.069)	(1.939)	(1.273)	(1.825)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1803	1828	1665	1898
R^2	0.58	0.56	0.41	0.70

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, **, and * refer to statistical significance at the 1%, 5%, and 10% level.

Table 5 reports the results of the logit regression that explains the effects of the volume of carbon offsets purchased on firm financial performance using a matched sample of firm-year observations. Column 1 displays a negative relationship between Tobin's Q and the quantity of carbon offsets purchased, although this effect is statistically insignificant. On the other hand, columns 2 to 4 show the coefficients on the log of carbon offsets are statistically significant and positively correlated with other accounting-based measures of short-term financial performance, including log sales, log assets and log operating income. This evidence may suggest that in the short term, firms can use carbon offsets to boost their ESG ratings, which existing studies have linked with better financial performance due to lower carbon risk and cost of capital (Whelan et al., 2021).

Effect of REC Purchases on Firm Environmental and Financial Performance

Similar to Tables 4 and 5, Tables 6 and 7 report the effects of REC purchases on firm environmental and financial performance. Table 6 reports the results of the logit regression explaining the impact on firms' environmental score (column 1), the log of Total GHG market emissions (column 2), the log of GHG Scope 2 market emissions (column 3), renewable energy intensity (column 4), and the log of renewable energy usage (column 5).

TABLE 6
EFFECT OF REC PURCHASES ON FIRMS' ENVIRONMENTAL PERFORMANCE

	Post-Match Sample				
Dependent Variable:	**(1) Environmental Score**	**(2) ln (Total GHG Market Emissions)**	**(3) ln(GHG Scope 2 Market Emissions)**	**(4) Renewable Energy Intensity**	**(5) ln(Renewable Energy Use)**
ln REC	0.039*	0.203*	0.205*	0.041***	0.609***
	(0.018)	(0.099)	(0.096)	(0.010)	(0.100)
Cash Holdings	-0.059	-4.653*	-7.697**	0.737***	0.393
	(0.450)	(2.214)	(3.188)	(0.198)	(0.501)
Investment	2.319	-8.277	-11.478	-0.070	-6.232
	(1.902)	(11.025)	(19.171)	(1.234)	(7.905)
Leverage	0.344	0.321	2.574	-0.473	1.491*
	(0.421)	(2.368)	(2.463)	(0.314)	(0.756)
ROE	0.002*	0.004	-0.004	0.000	0.007**
	(0.001)	(0.007)	(0.013)	(0.001)	(0.003)
ROA	-0.564	-4.572	-0.404	0.191	-2.146
	(0.540)	(6.628)	(10.995)	(0.525)	(2.197)
Capital Spending	0.076	1.847**	1.383	-0.126	-0.105
	(0.198)	(0.592)	(1.777)	(0.091)	(0.529)
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
N	1614	1242	1163	1043	988
R^2	0.37	0.49	0.39	0.44	0.66

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

Column 1 shows that the coefficient on the log of RECs (thousand MWh) is significantly positive, implying that the volume of RECs purchased leads to an improvement in firms' environmental score. Additionally, column 2 displays a statistically significant and positive relationship between the volumes of

RECs purchased and the level of a firm's Total GHG market emissions. Furthermore, this positive effect also continues if we look at more granular emissions data, namely firms' Scope 2 Market emissions (noted in column 3). Lastly columns 4 and 5 demonstrate a statistically positive relationship between the volume of RECs purchased and firms' renewable energy usage and intensity. Similar to carbon offsets, the purchase of RECs may also be another form of greenwashing as firms get rewarded (with greater environmental scores) for investing in green energy, but this is not enough to significantly cut back their Total GHG market emissions. Nevertheless, while RECs may not reduce firms' GHG emissions, these findings suggest that they may be more effective in increasing a company's usage and intensity of renewable energy.

TABLE 7
EFFECT OF REC PURCHASES ON FIRMS' FINANCIAL PERFORMANCE

	Post-Match Sample			
	(1)	**(2)**	**(3)**	**(4)**
Dependent Variable:	**Tobin's Q**	**ln (Sales)**	**ln (Operating Income)**	**ln (Assets)**
ln REC	-0.131***	0.208***	0.153**	0.266***
	(0.037)	(0.065)	(0.056)	(0.053)
Cash Holdings	4.738**	-0.096	2.402***	0.223
	(1.521)	(0.711)	(0.612)	(0.500)
Investment	-6.905***	1.842	-6.044***	4.793*
	(0.974)	(5.104)	(1.638)	(2.252)
Leverage	0.599	-0.221	0.764	0.826
	(1.040)	(0.733)	(1.170)	(1.000)
ROE	0.002	0.004***	0.003***	0.003***
	(0.003)	(0.001)	(0.001)	(0.000)
ROA	6.067**	2.182*	3.104	0.823
	(2.402)	(1.168)	(1.746)	(1.407)
Capital Spending	0.309	0.966	1.637***	-0.382
	(0.187)	(0.596)	(0.183)	(0.219)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1988	2088	1810	2137
R^2	0.45	0.54	0.61	0.70

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, **, and * refer to the statistical significance at the 1%, and 5%, and 10% levels, respectively.

Lastly, Table 7 reports the logit regression results that explain the effects of the volume of RECs purchased on firms' financial performance using a matched sample of firm-year observations. Similar to the purchase of carbon offsets, column 1 shows that there is a statistically significant and negative relationship between the volume of RECs purchased and firms' Tobin's Q. Tobin's Q is typically a measure of how the market values a company and how it represents investors' beliefs about its long-term profitability (Delmas et al., 2011). This may suggest that the market perceives the purchase of RECs as an additional expenditure that diminishes firms' resources, leading to a reduction in firms' long-term value. These results suggest that profit-maximizing firms may not have a financial incentive to reduce their GHG emissions by using RECs. Conversely, columns 2-4 display a statistically significant and positive relationship between the volume of RECs purchased and log sales, log assets, and log operating income. Overall, the market may view RECs as a costly use of firms' resources, leading to a decline in long-term firm value. However, investing in green energy by purchasing RECs may also promote greater energy efficiency and serve as a helpful way to boost ESG ratings, thus improving short-term financial performance for firms.

Percentage of Women on the Board and the Purchase of Carbon Offsets or RECs

The second part of our analysis investigates whether women directors on the board impact the quantity of 1) carbon offsets or 2) RECs purchased. Table 8 reports the results of the 2 SLS regressions for the effect on the volume of carbon offsets purchased in columns 1 and 2 and the effects on the volume of RECs purchased in columns 3 and 4. The one-year lagged percentage of women employees was used as an IV for the percentage of women on board.

TABLE 8
TWO STAGE LEAST SQUARES REGRESSION ANALYZING EFFECT OF WOMEN ON THE BOARD ON VOLUME OF CARBON OFFSETS & RECS PURCHASED

	(1)	(2)	(3)	(4)
	First Stage	Second Stage	First Stage	Second Stage
Dependent Variable:	% Women Board Members	ln(Carbon Offsets)	% Women Board Members	ln(REC)
% Women Employees	0.168***		0.178***	
	(0.034)		(0.038)	
% Women Board Members Fitted		-0.121*		-0.193***
		(0.064)		(0.063)
Board Size	0.232	-0.008	1.017***	0.280***
	(0.156)	(0.046)	(0.180)	(0.072)
Cash Holdings	1.017	0.914	-0.580	2.051**
	(2.863)	(0.890)	(3.190)	(0.959)
Investment	33.501*	-6.512	-33.912*	-21.322***
	(19.367)	(5.804)	(20.506)	(6.164)
Leverage	-6.175*	-0.474	-3.395	1.086
	(3.334)	(1.094)	(3.585)	(1.003)
ROE	0.019***	0.0003	-0.001	-0.001
	(0.006)	(0.002)	(0.015)	(0.005)
ROA	0.569	-1.124	8.186	2.014
	(2.974)	(1.123)	(8.487)	(2.496)
Capital Spending	-7.222	2.325	7.018*	0.305
	(6.032)	(1.828)	(3.728)	(0.891)
Industry Effects	Y	Y	Y	Y
Country Effects	Y	Y	Y	Y
Year Effects	Y	Y	Y	Y
N	593	593	506	506
F-statistic	266.62		26.80	
Wald Chi Squared		2585.57		256.72

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, **, and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

Column 1 displays the results of the first-stage regression, which includes the contemporaneous level of percentage of women on board as a dependent variable and one-year lagged financial characteristics and board size as control variables. We confirm that the percentage of women employees is a valid IV given that it is positively correlated with the percentage of women on board, and the coefficient is significant at the 1% level. The value of the F-statistic is also greater than ten and statistically significant.

The results for the second-stage regression are shown in column 2 of Table 8, which uses the predicted percentage of women on the board from the first-stage regression to estimate the effect on the volumes of carbon offsets purchased. The results suggest a negative relationship between the percentage of women on the board and the volumes of carbon offsets purchased. The coefficient on the predicted percentage of women on the board is significant at the 10% level in column 2. This result suggests that having women directors on the board does not lead to a significant increase in the purchase of carbon offsets, despite the evidence in literature suggesting having gender board diversity are positively correlated to firms' environmental performance and that women foster sustainable environmental initiatives (Martin et al., 2019).

Columns 3 and 4 in Table 8 report the results of the 2 SLS regression for the effect of board gender diversity on the volume of RECs purchased. The first-stage regression is displayed in column 3 where the one-year lagged percentage of women employees was used as an IV for the percentage of women on board with the same control variables as our previous analysis. We confirm that the percentage of women employees is a valid IV given that it is positively correlated with the percentage of women on board and the coefficient at the significant at the 1% level. The value of the F-statistic is also high and statistically significant.

The results for the second-stage regression are shown in column 4 of Table 8, which suggests a negative relationship between the percentage of women on the board and the volumes of RECs purchased. The coefficient on the predicted percentage of women on the board is significant at the 1% level in column 4. This result suggests that having women directors on the board does not lead to a significant increase in the purchase of RECs, contrary to the extant literature suggesting that gender board diversity is positively correlated to firms' renewable energy consumption (Atif et al., 2021; Zhang et al., 2021).

ROBUSTNESS CHECKS AND FURTHER ANALYSIS

In this section, we examine the effects of buying carbon offsets or RECs on firms' financial and environmental performance for subsamples of different industries. In particular, we exclude firm-year observations for the top two carbon-intensive industry sectors (i.e., energy and utilities) in our sample to ensure that a specific group of industries is not influencing the results. Employing the same methodology as before, Tables 9, 10, and 11 in the Appendix show that the coefficients for log carbon offsets and log RECs are statistically significant and exhibit patterns consistent with our main findings. Most of these results also hold if we exclude the top three carbon-intensive industries (i.e., energy, utilities, and industrials). These results are available upon request.

Furthermore, this paper also examines the effects of board gender diversity on the quantity of carbon offsets or RECs purchased if we exclude the top two industries with the highest number of observations for the percentage of women on the board. In Table 12 (please refer to Appendix), we focus on a subsample of carbon offset buyers that excludes the financial and IT sectors. Additionally, Table 13 (please refer to Appendix), displays the results for a subsample of REC buyers that also disregards the financial and IT sectors. Employing the same IV methodology as before, Tables 12 and 13 show that the coefficients for log carbon offsets and log RECs are statistically significant and display patterns consistent with our main analysis. These results also hold if we exclude the industrial sector. These results are available upon request.

As a further check, we use an instrumental variable approach to estimate the effects of purchasing carbon offsets or RECs on firms' GHG emissions. Specifically, we use a firm's marketing expense (proxied by a firm's selling expense from its financial statements) at $t=-1$ as an instrumental variable for carbon offsets or RECs. We expect firms' selling expenses to be relevant and positively related to carbon offsets or RECs if they attempt to greenwash or market themselves as environmentally sustainable. For example, a study of voluntary carbon offsets in the aviation industry by Guix et al. (2022) found that thirty-seven airlines are vulnerable to greenwashing due to "poor communication and low transparency" in their carbon offset marketing. Additionally, we expect firms' selling expenses to be excludable as it does not directly influence business operations (which lead to Scope 1 emissions) or energy purchasing decisions (which result in Scope 2 emissions). We add sales growth as an additional control variable to further control for firm size. Tables 14 and 15 in the Appendix demonstrate that the results following this approach are consistent with the main analysis and suggest that firms that purchase carbon offsets or RECs continue to pollute rather than decrease their GHG emissions.

Lastly, we employ an event study model to verify that buyers and non-buyers of carbon offsets or RECs do not exhibit significant differences before acquiring these instruments. Our results confirm that these two groups of firms are not significantly different from each other prior to their first purchase of a carbon offset or REC, and that their financial and environmental performance only diverges after they have made these investments. These results are available upon request.

CONCLUSION

As carbon offset and REC markets continue to grow, it is essential to understand the internal governance characteristics of companies purchasing these instruments and the effects of these purchases on firm-level outcomes. This paper aims to fill this gap by examining how board gender diversity affects firms' investment in carbon offsets and RECs and how these instruments impact firms' financial and environmental performance in developed-country markets.

This paper contributes to the growing literature on climate change and GHG emissions reduction efforts in the following ways. First, this study employs a novel approach by analyzing the relationship between the *quantity* of carbon offsets or RECs purchased and firms' environmental and financial performance. Our paper also expands upon the narrow single-country focus of previous research by examining a multi-country dataset comprised of over fifteen countries across Europe and North America. This paper also uses detailed firm-level emissions data (including GHG Scope 1, GHG Scope 2 Market, and Total GHG Market emissions),[19] unlike previous studies that relied on carbon emission disclosures or other carbon performance indicators. Combined with a PSM approach to deal with concerns on potential selection bias, this study can more clearly examine the effectiveness of using carbon offsets or RECs in mitigating firms' indirect or direct GHG emissions and achieving their sustainability goals. As an additional test, this paper employs firms' marketing expense as an instrumental variable to estimate the effects of purchasing carbon offsets or RECs on their GHG emissions. The results from using this approach are consistent with our main findings.

Second, our findings shed light on corporate greenwashing behavior by demonstrating that firms that purchase carbon offsets or RECs receive higher environmental scores, but also have higher GHG emissions. Additionally, our findings point out that while purchasing RECs may not reduce firms' GHG emissions, they are more effective in increasing a firm's usage of renewable energy. These findings are relevant and timely given that demand for carbon offsets and RECs has rapidly grown, particularly from developed-market firms in carbon-intensive industries.

Third, this paper offers new insights into the relationship between carbon offset or REC purchases and firms' financial performance, highlighting how stakeholders have diverging views on the benefits of these purchases. While carbon offsets and RECS may be a useful tool to boost ESG ratings and financial performance in the short term, our findings suggest that firms may have less financial incentive in the long-term to use such tools to manage their GHG emissions and renewable energy consumption.

Lastly, this paper's findings contribute to the literature on internal corporate governance by demonstrating that gender board diversity alone does not necessarily indicate a stronger inclination towards environmental initiatives such as carbon offsetting and investment in green energy. We also refine the existing methodology by following an instrumental variable approach that deals with potential endogeneity in the variable for the percentage of women on the board.

Overall, this paper's findings may have important implications for policymakers, businesses, and other stakeholders in understanding the potential benefits of investing in carbon offsets and RECs. By comprehending these dynamics, firms can also make better decisions toward reducing their carbon footprint and achieving their environmental targets.

ENDNOTES

1. GHG emissions comprise of CO2 and CO2-equivalent emissions that are typically classified in three categories: Scope 1, Scope 2, and Scope 3 emissions. Scope 1 emissions include direct emissions from sources that are owned or controlled by a firm (e.g., vehicles, equipment, power plants, landfills, wastewater treatment, etc.). Scope 2 emissions refer to indirect emissions that result from the generation of electricity, heat, or steam purchased by a firm, but not produced directly by the firm. These emissions are associated with the company's energy consumption and can include purchased electricity, heating and cooling, and steam generation. Lastly, Scope 3 emissions include all other indirect emissions that occur due to the company's value chain and activities but are not owned or directly controlled by the company (e.g., business travel, employee commute, supply chain, wastewater from contractors, etc.) Scope 3 emissions are often the most challenging to track and manage due to their broader scope and dependence on external factors. (EPA Green Power Partnership, 2018).
2. In terms of GHG emissions reporting, firms who purchase carbon offsets can reduce their scope 1, 2 or 3 emissions, as a net adjustment (EPA Green Power Partnership, 2018). The main focus of this paper is on the effects of carbon offset purchases on a company's Scope 1 and 2 emissions. Since Scope 3 emissions have a broader range and can be challenging to accurately quantify, they are not included in the analysis.
3. Firms who purchase RECs can lower their gross Scope 2 market-based emissions from purchased electricity generated by another entity (EPA Green Power Partnership, 2018).
4. To avoid sample selection bias, firms are selected from these two stock indexes as they both consist of the broadest range of small, medium, or large capitalization firms in North America or Europe.
5. Specifically, this paper uses the natural logarithm of total carbon offsets purchased in thousands of metric tons of CO2 and CO2-equivalent emissions.
6. This paper uses the natural logarithm of renewable energy purchased in thousands of Megawatt (MWh) hours.
7. GHG Scope 1 emissions includes direct emissions that originate from sources owned or controlled by the firm. GHG Scope 2 Market emissions include indirect emissions from the firm's consumption of electricity, heat, or steam purchased from another entity (e.g., wind or solar farm). Lastly, Total GHG Market emissions encompass both direct and indirect emissions, providing a comprehensive picture of a firm's GHG emissions (EPA Green Power Partnership, 2018).
8. For example, according to Net Zero Tracker, which analyses the climate pledges from over 1,000 of the largest firms in North America and Europe, roughly 61% companies have made a commitment to achieving net zero emissions as of 2023. Out of those companies, nearly 45% have expressed their intentions to use carbon offsets as a means to help meet their climate goals (for more information, please see zerotracker.net).
9. Using a binary variable to indicate whether a firm has purchased a carbon offset may lead to misinterpretation of the data. For example, if we used a dummy variable approach, the biggest buyer of carbon offsets in our sample of data are firms in the financial sector. Financial firms, on average, typically emit low levels of GHG. On the other hand, the industrials sector is the largest buyer of carbon offsets when considering the quantity or volume of offsets bought by firms. Industrial firms, on average, are more carbon-intensive than financial firms in our data set. We could expect to see high carbon-emitting firms, which on average buy more carbon offsets, may have a greater impact on reducing carbon emissions compared to low carbon-emitting firms that purchase fewer carbon offsets. Anecdotally, there has been increased criticism that firms from the financial sector, such as Credit Suisse Group, are heavily relying on carbon offsets that do not lead to actual GHG emissions reductions (Rathi et al., 2022). Thus, focusing on the quantity of carbon offsets or RECS purchased may lead to a better understanding of the scale of firms' efforts to reduce GHG emissions.
10. This paper uses the percentage of women employees as an instrumental variable for the percentage of women on the board.
11. The STOXX 600 Europe consists of small, mid, and large-cap firms from seventeen countries in Europe: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.
12. By excludability, we imply that the instrumental variable is only affecting carbon offset or REC purchases through the women on the board, but not directly.
13. The study by Ecosystem Marketplace examined over 830 global firms that purchased voluntary carbon offsets.
14. Anecdotal evidence indicates that some large-cap companies are spending even more than $1 million on carbon offset purchases. For example, Shell invested $300 million in carbon offsets from mid-2019 through

mid-2022 (Forest Trends, 2019). Additionally, companies such as Disney, ConocoPhillips, and Poseidon Resources bought $6.7 million worth of offsets to reforest a state park in San Diego (Niller, 2020).

15. While we are comparing the actual values of carbon offsets (in thousands of metric tons of CO2e), RECs (in thousands of MWh), and GHG emissions (in thousands of metric tons of CO2e), for simplicity in our discussion of Table 2, we use the natural logarithm of carbon offsets, REC, and GHG emissions in the regression analysis.

16. Figures 2 in the Appendix shows the total volumes of carbon offsets purchased by industry and confirms that firms in the industrials and energy sectors are the largest buyers of carbon offsets. Furthermore, Figures 3 and 4 in the Appendix show the evolution of carbon offset purchases over the period 2012-2022. Figure 3 shows that the purchases conducted by firms in the energy and industrial sectors have increased significantly since 2019. Figure 4, which shows the evolution of carbon offset purchases but excludes the energy and industrial sectors, exhibits the rise of other key sector players over the last few years, particularly the information technology, communications, and consumer discretionary sectors.

17. According to Figure 5 in the Appendix, which displays the total volumes of RECs purchased by industry, the information technology and financial sectors have been the largest buyers of RECs. Figure 6 in the Appendix also shows the evolution of REC purchases over the last 10 years. Similarly, the information technology, financials, and communications sectors have been purchasing the most RECs, most notably after 2018.

18. Results of PSM balance tests for either the carbon offsets or REC analysis are available upon request.

19. GHG Scope 1 emissions includes direct emissions that originate from sources owned or controlled by the firm. GHG Scope 2 Market emissions include indirect emissions from the firm's consumption of electricity, heat, or steam purchased from another entity (e.g., wind or solar farm). Lastly, Total GHG Market emissions encompass both direct and indirect emissions, providing a comprehensive picture of a firm's GHG emissions (EPA Green Power Partnership, 2018).

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APPENDIX

TABLE 9
EFFECT OF CARBON OFFSET PURCHASES ON FIRMS' FINANCIAL & ENVIRONMENTAL PERFORMANCE

	Post-Match Sample			
	(1)	(2)	(3)	(4)
Dependent Variable:	**ln (Sales)**	**ln (Assets)**	**Environmental Score**	**ln (Total GHG Market Emissions)**
ln Carbon Offset	0.132*	0.166**	0.024*	0.293**
	(0.068)	(0.057)	(0.011)	(0.109)
Cash Holdings	-1.493**	-1.451*	0.139	-3.396***
	(0.454)	(0.624)	(0.377)	(0.992)
Investment	-19.519***	-8.881*	-1.119	-41.977***
	(2.481)	(3.878)	(1.837)	(8.541)
Leverage	-0.135	0.685	0.036	2.722**
	(0.969)	(0.647)	(0.211)	(0.948)
ROE	-0.0010	-0.002	0.001*	0.000
	(0.002)	(0.003)	(0.0002)	(0.0005)
ROA	-0.562	-1.640	-0.315	-2.861**
	(1.252)	(1.231)	(0.376)	(1.164)
Capital Spending	2.081	-0.933	-0.221	0.553
	(2.039)	(1.510)	(0.516)	(0.974)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1641	1594	1359	994
R^2	0.54	0.75	0.26	0.69

Note: The above analysis focuses on a subsample that excludes the top 2 industries with the highest GHG emissions: energy and utilities. Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 10
EFFECT OF REC PURCHASES ON FIRMS' ENVIRONMENTAL PERFORMANCE

	Post-Match Sample			
	(1)	(2)	(3)	(4)
Dependent Variable:	**Environmental Score**	**ln (Total GHG Market Emissions)**	**Renewable Energy Intensity**	**ln(Renewable Energy Use)**
ln REC	0.034**	0.283***	0.037***	0.649***
	(0.012)	(0.070)	(0.007)	(0.091)
Cash Holdings	0.262	-4.934**	0.897***	0.243
	(0.501)	(1.839)	(0.164)	(0.846)
Investment	2.615**	-7.728	-0.252	-6.620
	(0.925)	(10.236)	(0.958)	(7.030)
Leverage	0.229	0.521	-0.467**	1.291
	(0.389)	(1.509)	(0.165)	(0.961)
ROE	0.0002	0.004	0.002	0.005
	(0.0006)	(0.011)	(0.001)	(0.004)
ROA	-0.430	-4.723	-0.207	-1.251
	(0.608)	(7.769)	(0.505)	(2.343)
Capital Spending	0.143	1.412*	-0.206	0.731
	(0.095)	(0.669)	(0.115)	(0.421)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1501	1201	949	902
R^2	0.39	0.48	0.54	0.68

Note: The above analysis focuses on a subsample excludes the top 2 industries with the highest GHG emissions: energy and utilities. Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 11
EFFECT OF REC PURCHASES ON FIRMS' FINANCIAL PERFORMANCE

	Post-Match Sample			
	(1)	(2)	(3)	(4)
Dependent Variable:	**Tobin's Q**	**ln (Sales)**	**ln (Operating Income)**	**ln (Assets)**
ln REC	-0.139***	0.242***	0.173**	0.311***
	(0.038)	(0.069)	(0.058)	(0.061)
Cash Holdings	3.713**	0.452	2.164***	0.710
	(1.205)	(0.661)	(0.478)	(0.600)
Investment	-9.633***	-5.204	-11.319***	3.070
	(2.402)	(7.182)	(3.308)	(3.035)
Leverage	-0.500	0.500	1.097	0.719
	(1.083)	(0.698)	(1.441)	(0.853)
ROE	0.002*	0.005***	0.007	0.004***
	(0.001)	(0.001)	(0.005)	(0.001)
ROA	8.387***	0.509	0.427	-0.491
	(1.646)	(1.601)	(2.546)	(2.272)
Capital Spending	0.586***	1.604**	1.416***	-0.123
	(0.124)	(0.582)	(0.290)	(0.215)
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	1761	1782	1602	1782
$\mathbf{R^2}$	0.48	0.58	0.59	0.70

Note: The above analysis focuses on a subsample that excludes the top 2 industries with the highest GHG emissions: energy and utilities. Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 12
TWO-STAGE LEAST SQUARES REGRESSION ANALYZING EFFECT OF WOMEN ON BOARD ON VOLUME OF CARBON OFFSETS PURCHASED

	(1)	(2)
	First Stage	**Second Stage**
Dependent Variable	**% Women Employees**	**ln(Carbon Offsets)**
% Women Employees	0.255***	
	(0.036)	
% Women Board Members Fitted		-0.075*
		(0.064)
Board Size	0.568**	-0.013
	(0.226)	(0.064)
Cash Holdings	0.637	-0.559
	(5.068)	(1.416)
Investment	18.349	-17.278***
	(23.561)	(6.655)
Leverage	-5.560	-2.338
	(5.445)	(1.481)
ROE	0.024***	0.001
	(0.008)	(0.001)
ROA	-2.446	-2.397***
	(3.506)	(0.853)
Capital Spending	8.820	5.949***
	(6.624)	(2.169)
Industry Effects	Y	Y
Country Effects	Y	Y
Year Effects	Y	Y
N	326	326
F-statistic	168.43	
Wald Chi Squared		1778.94

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 13
TWO-STAGE LEAST SQUARES REGRESSION ANALYZING EFFECT OF WOMEN ON BOARD ON VOLUME OF RECS PURCHASED

	(1) First Stage	(2) Second Stage
Dependent Variable:	**% Women Employees**	**ln(REC)**
% Women Employees	0.268***	
	(0.046)	
% Women Board Members Fitted		-0.091**
		(0.042)
Board Size	1.108***	0.185***
	(0.244)	(0.053)
Cash Holdings	2.569	-0.897
	(5.743)	(1.142)
Investment	-58.585**	-9.701
	(28.056)	(6.291)
Leverage	3.057	2.731***
	(5.516)	(1.050)
ROE	0.040*	0.009***
	(0.020)	(0.002)
ROA	-4.973	-1.397
	(11.948)	(2.104)
Capital Spending	8.179*	0.367
	(4.198)	(0.770)
Industry Effects	Y	Y
Country Effects	Y	Y
Year Effects	Y	Y
N	279	279
F-statistic	23.54	
Wald Chi Squared		648.77

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 14
TWO STAGE LEAST SQUARES REGRESSION ANALYZING EFFECT OF CARBON OFFSETS ON GHG EMISSIONS

	(1) First Stage	(2) Second Stage
Dependent Variable	**ln(Carbon Offset)**	**ln(Total GHG Market Emissions)**
ln (Selling Expense)	0.531***	
	(0.104)	
ln(Carbon Offset)		1.762***
		(0.297)
Cash Holdings	2.497**	-10.027***
	(1.217)	(2.059)
Investment	-0.101	-41.916***
	(11.445)	(15.802)
Leverage	4.574**	-1.49
	(2.055)	(2.586)
ROE	-0.006*	0.010**
	(0.003)	(0.004)
ROA	7.153**	-13.267***
	(2.949)	(4.546)
Capital Spending	11.043*	-16.873*
	(5.875)	(9.880)
Sales Growth	0.505	0.242
	(1.248)	(1.826)
Industry Effects	Y	Y
Country Effects	Y	Y
Year Effects	Y	Y
N	203	203
F-statistic	260.41	
Wald Chi Squared		2946.30

Note: Numbers in parentheses are standard errors, which are clustered at the industry level.
***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 15
TWO STAGE LEAST SQUARES REGRESSION ANALYZING EFFECT OF RECS ON GHG EMISSIONS

	(1) First Stage	(2) Second Stage
Dependent Variable	**ln(REC)**	**ln(Total GHG Market Emissions)**
ln (Selling Expense)	0.370***	
	(0.118)	
ln(REC)		2.516***
		(0.700)
Cash Holdings	2.905***	-11.915***
	(1.037)	(3.287)
Investment	-7.478	8.895
	(7.221)	(16.268)
Leverage	3.400**	-5.260
	(1.495)	(4.590)
ROE	-0.026**	0.048
	(0.011)	(0.030)
ROA	8.693**	-20.340*
	(4.092)	(11.334)
Capital Spending	-2.215	5.831
	(2.189)	(4.200)
Sales Growth	-2.129***	3.410
	-0.673	(2.193)
Industry Effects	Y	Y
Country Effects	Y	Y
Year Effects	Y	Y
N	252	252
F-statistic	21.29	
Wald Chi Squared		197.56

Note: Numbers in parentheses are standard errors, which are clustered at the industry level. ***, ** , and * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

FIGURE 1
AVERAGE PERCENTAGE OF WOMEN DIRECTORS ON THE BOARD BY YEAR

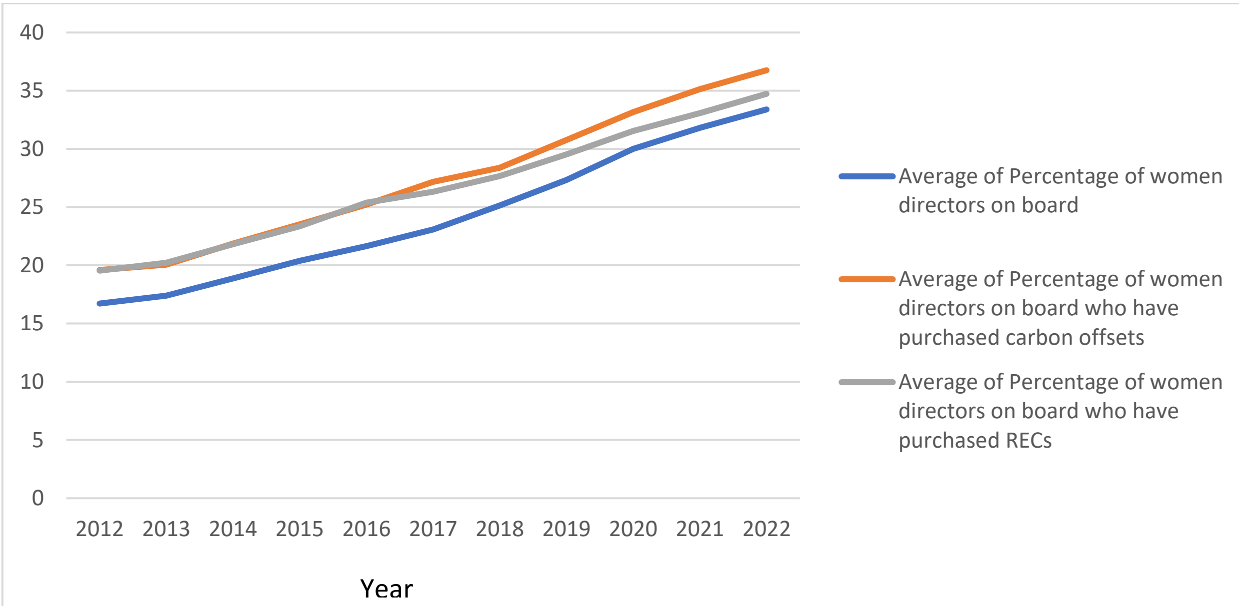

FIGURE 2
TOTAL VOLUME OF CARBON OFFSETS BY INDUSTRY

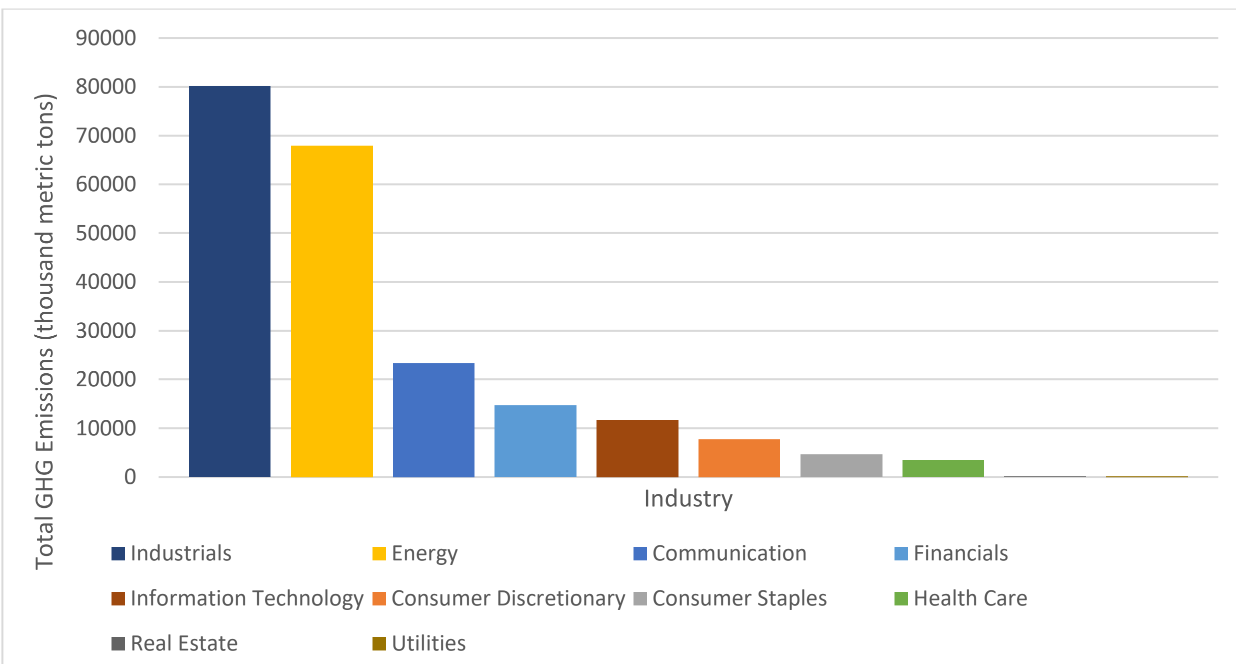

FIGURE 3
TOTAL CARBON OFFSETS PURCHASES BY INDUSTRY SECTORS & YEAR

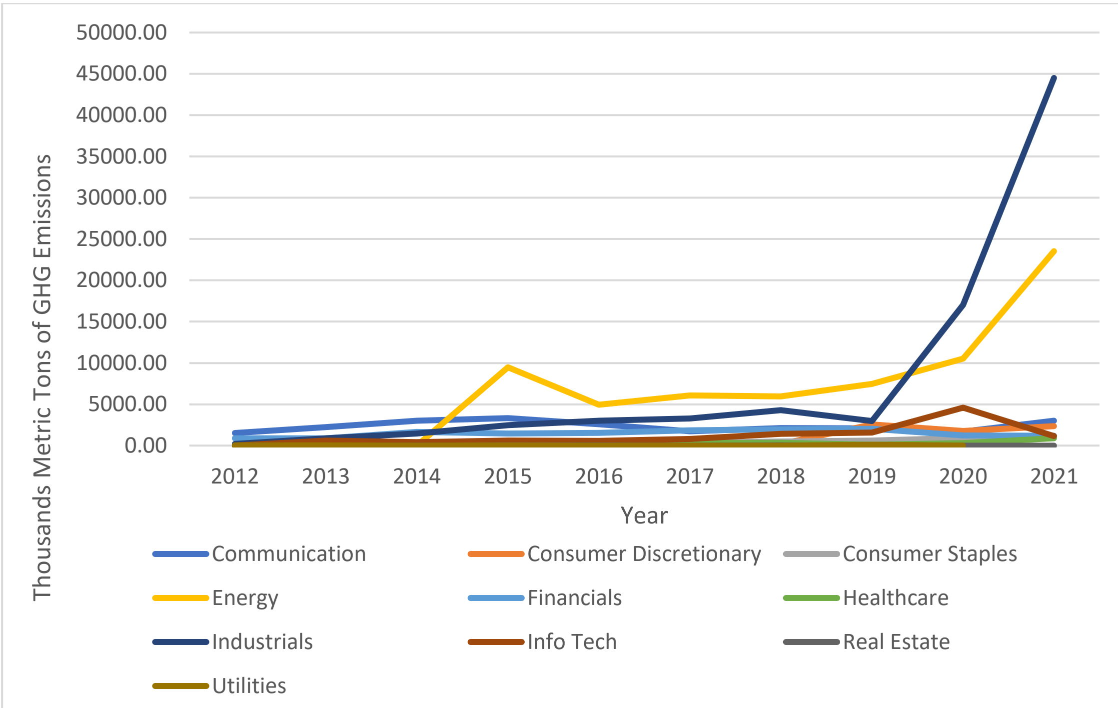

FIGURE 4
TOTAL VOLUME OF CARBON OFFSETS BY INDUSTRY & YEAR EXCLUDING INDUSTRIALS & ENERGY

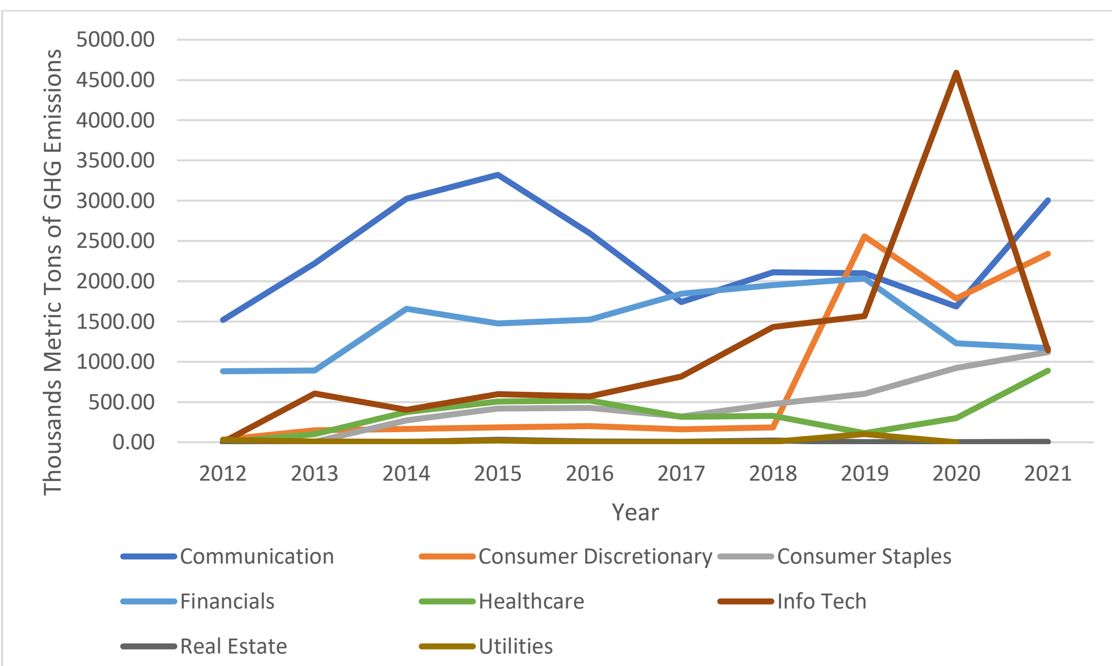

FIGURE 5
TOTAL VOLUME OF RECS PURCHASED BY INDUSTRY (MWH)

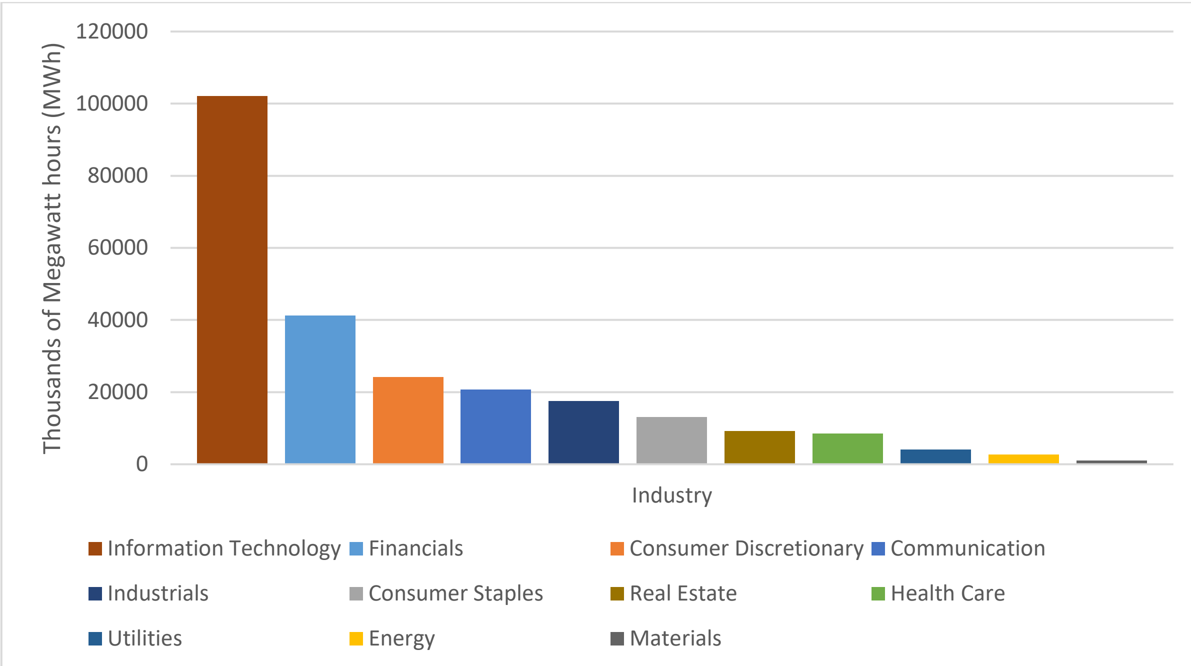

FIGURE 6
TOTAL VOLUME OF RECS PURCHASED BY INDUSTRY & YEAR