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Research Report

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Title of Research Report: Regulatory Uncertainty and Corporate Climate Strategies: Evidence from the SEC's Climate Disclosure Rule

Regulatory Uncertainty and Corporate Climate Strategies: Evidence from the SEC's Climate Disclosure Rule

Lawrence Lin Lee and Yerin Kang

Abstract

With the UN's 2030 climate target drawing closer, investor concerns over corporate environmental impacts have intensified. In response, the Voluntary Carbon Market (VCM), a market where individuals and firms purchase carbon credits to offset their emissions, has emerged as a popular tool to meet environmental commitments. However, there is growing concern regarding corporations engaging in the VCM without a genuine commitment to emission reductions. In March 2022, the U.S. Securities and Exchange Commission (SEC) published draft rules mandating climate-related disclosures from U.S. public firms above the $700 million in public float threshold (classified as large accelerated filers). These draft rules were highly controversial and were only formally adopted in March 2024. This two-year period of regulatory uncertainty between proposal and adoption offers a quasi-experimental setting to examine corporate responses to anticipated disclosure requirements. Using Difference-in-Differences (DiD) and Regression Discontinuity Design (RDD) methods, we find consistent evidence that large accelerated filers increase carbon offset retirements following the draft rule's publication to strategically lower anticipated reported emissions after the publication of the draft rule. Our results shed light on the effect of regulatory uncertainty on firms' environmental strategies in the context of carbon offset projects.

Keywords: Voluntary Carbon Market, Carbon Credit Retirement, Carbon Offsets, Regulatory Uncertainty, Corporate Sustainability

JEL: G38, K23, Q52, Q54

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This research was sparked by participating in a carbon offsetting project and a mutual interest in the burgeoning field of ESG, specifically corporate climate strategies. The scholars were particularly intrigued by corporations' exploitation of the Voluntary Carbon Market as a tool to enhance their climate strategies.

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Above all, the authors would like to express their heartfelt gratitude for the S.T. Yau High School Science Award for facilitating this opportunity. In addition, they are thankful for the data provided by all public registries, BeZero Carbon, and Yahoo Finance.

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3. observe the common standard of academic integrity adopted by most journals and degree theses.
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Name of team member: Lawrence Lin Lee

Name of team member: Yerin Kang

Name of supervising teacher: Tse-Chun Lin

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Name of school principal: Christine Doleman, Chinese International School

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1. Introduction

As awareness of climate change spreads globally, investors are demanding greater corporate environmental responsibility. Modern society's investors not only seek profits but also care about the social role of corporations, evidenced by the growing popularity of environmental, social, and governance (ESG) issues among shareholder proposals and investor demands. In particular, climate change and environmental concerns have been at the top of the demand list, and firms have consequently set emission reduction targets and committed to net-zero goals. Instead of reducing actual emissions, firms have been increasingly utilising carbon offsets or carbon credits in the voluntary carbon market (VCM) as a strategic tool to meet reduction targets and net-zero commitments.

The VCM is a decentralised market where individuals and firms can purchase carbon credits to offset their emissions. Each carbon credit represents one metric ton of Carbon Dioxide (tCO_2e) or the equivalent of any other greenhouse gases (GHGs) that have been removed or reduced in emission through carbon mitigation projects that investors contribute to via the purchase of carbon credits. Due to its carbon-neutralising nature, VCM has faced rapid expansion, with corporations like Microsoft purchasing approximately one million carbon credits to fulfil their sustainability goals in 2021. The wide range of co-benefits provided by carbon offsetting, such as job creation and greater biodiversity, further accelerates the growth of this market (Lou et al., 2023). VCM is expected to grow exponentially from under $1 billion in 2020 to tens or even hundreds of billions by 2030.

However, VCM also faces criticism regarding its credibility, quality, and additionality: when projects reduce or remove CO_2 from the atmosphere that otherwise would not have remained constant (Valiergue and Ehrenstein, 2022; Ramseur, 2007; Kreibich and Hermwille, 2021; Probst et al., 2023; Trencher et al., 2024). Empirical evidence supports these concerns, such that 87% of offsets that major corporate buyers procure are classified as non-compliant and high risk, often sold at prices of $0.98 to $5.39 per tonne (Trencher et al. 2024). Moreover, cost-saving pressures drive companies to resort to subpar renewable energy forms or avoidance offsets, thus revealing credibility gaps (Lou et al., 2023; Trencher et al., 2024).

This study aims to examine the effects of the initial announcement of the U.S. Securities and Exchange Commission (SEC)'s proposed climate disclosure rules on corporate carbon offsets. This study examines differences in the likelihood, frequency, and quantity of carbon credits retired by companies before and after the proposal's announcement date (March 21, 2022). Additionally, we also examine the differences between large accelerated filers (LAFs), who faced the prospect of direct change in emissions reporting regulations, and other firms. We hypothesize that LAFs, facing heightened regulatory uncertainty and direct exposure to the SEC's proposed disclosure rule, will strategically increase their carbon credit retirement activities relative to non-LAFs following the draft rule's announcement in March 2022. Furthermore, while regulatory pressure may drive increased market participation, we examine whether this translates into meaningful climate impact, given persistent concerns about the quality and additionality of many offset projects.

This study explores the causal effect of regulatory uncertainty on corporate responses to climate disclosure rules using a quasi-experimental research approach. One of the core components of this research design applies a Difference-in-Differences (DiD) approach, analysing changes in the carbon credit retirement behaviours of U.S. firms. The firms that this study focuses on are publicly traded U.S. companies specified as LAFs, i.e., companies with public floats of USD 700 million or greater. The empirical strategy exploits time-based variation surrounding the policy announcement, incorporating firm and month fixed effects. Additionally, it controls a comprehensive set of firm-level characteristics, including assets, book-to-market ratio, return of assets, leverage, and institutional ownership, to mitigate heterogeneity issues.

In order to improve causal identification and address potential risks of non-parallel pre-trends and endogenous selection, we employed a sharp Regression Discontinuity Design (RDD), targeting the SEC's $700 million public float threshold. By limiting analysis to firms whose values fall within an 80% bandwidth of this regulatory requirement, this RDD effectively controls for the effects of regression exposure and allows for estimation of the local average treatment effect from exceeding the threshold. Aiming to observe the cross-sectional changes in carbon credit retirements, we also implement a subsample DiD model, comparing industries that are prone to carbon management with ones that aren't.

We source carbon credit retirement data from the Berkeley Carbon Trading Project and major public registries, enabling near-complete and accurate reporting of offset activity at both project and firm levels. We complement this data with project-level quality indicators from BeZero's ratings and detailed financial and governance information from Yahoo Finance.

Our research provides strong evidence suggesting that uncertainty over regulations strongly encourages voluntary carbon offsetting behaviours by large publicly traded firms. The DiD analysis indicates that the treated group, large accelerated filers, increased their average monthly retirements of carbon credits by roughly 22% after the shock. This result is not only statistically significant but also of considerable magnitude, considering that only 7% of firm-months observe any offset action taken, and the average retirement per period is significantly skewed. Moreover, this pattern holds when we measure the likelihood of retirements and monthly transaction frequencies as well; treated firms register a 3.9% higher chance of retiring and 13% more transactions between proposal announcement and rule adoption. Firm reactions depend primarily on the institutional setting and inherent attributes of certain organizations. We found that organizations with greater return on assets and institutional ownership tend to increase the quantity of retirements. The sub-sample shows that firms in the industries that are more prone to carbon management increase their total carbon credit retirements by 39.3% (49.9% with controls) relative to those in industries less prone to carbon management. We therefore infer that regulatory uncertainty has a large-scale impact on firms across different industries as well.

However, the overall market is dominated by low-rated projects; over 60% of credit retirements lack ratings from BeZero, and a significant majority of the rated projects fall into the mid- and low-quality range (BB, B, C). In addition, nature-based and energy-based projects provide almost three-quarters of all offsetting activity, suggesting a preference for more traditional methods over more engineered or innovative solutions. Furthermore, the distribution of offset retirements is highly concentrated across industries. A few sectors—notably Transportation by Air, Business Services, and Communications—account for a disproportionately large share of retired credits. Within these sectors, certain firms or segments exhibit significantly higher transaction volumes than their peers, highlighting uneven participation in carbon offset markets.

The evidence across our DiD, RDD, and other analyses highlights the central importance of institutional investors and governance roles in enhancing the efficacy of carbon offsetting and the continued presence of poor and potentially ineffective engagement in the carbon market. These findings add to the literature in the ever-growing field of ESG. Specifically, our findings contribute to insights on the legitimacy of VCMs and are timely for policy discussion of the design and enforcement of climate-related disclosure rules, highlighting the importance of climate-related regulations to be reconsidered into more meaningful and lasting actions.

The remainder of the paper is organized as follows: Section 2 reviews past research on corporate accountability and the use of carbon offsets, highlighting key motivations and concerns in the VCMs. In Section 3, we describe the data sources and definitions of the variables used in our analyses. Section 4 presents our empirical framework, including the DiD and RDD approaches. In Section 5, we discuss the main empirical results, focusing on the impact of regulatory uncertainty on carbon offset retirements and corporate strategies. In Section 6, we discuss the main empirical results, findings from the DiD regression and RDD analyses, as well as robustness checks and placebo tests. Section 7 discusses the key findings, their policy implications, and the limitations of our study, while offering directions for future research. Section 8 concludes the paper by summarizing our contributions and the significance of our findings in the context of corporate climate strategies.

2. Literature Review

Corporations have faced increasing criticism for failing to meet emission reduction targets and with limited accountability (Probst et al., 2023; Jiang et al., 2025). Facing the pressure to reduce emissions and reach net-zero, corporations have been found to purchase cheap, low-quality offsets, often without real and additional emissions reductions (Trencher et al., 2024). With the exponential growth of the carbon offsets market in recent years, a burgeoning literature examines the motivations behind corporate usage of carbon offsets. A common view is that companies use carbon offsets as a carbon management tool to help them achieve emission targets without engaging in costly carbon removal or reduction practices. For example, Kim et al. (2024) found that low-emission firms employed cheap and low-quality offsets to improve their ESG ratings in response to an exogenous rating downgrade. Hsueh (2019) also documented a similar response after corporate adoption of ESG principles. Cost-minimizing firms may exploit regulatory uncertainty for greenwashing, while value-driven firms could increase high-quality retirements to signal credibility (Sasaki, 2025; Trencher et al., 2024).

Another view is that companies use carbon offsets because such a climate strategy contributes to company values and enhances market competitiveness. For example, Tiffany & Co., an American luxury jewelry retailer, invested in carbon offset projects from Kenya's Chyulu Hills where the company sourced coloured gemstones from (Lou et al., 2023). Value-driven firms, facing the same regulatory uncertainty, could increase high-quality retirements to signal credibility and avoid unwanted oversight (Sasaki, 2025). This divergence underscores how regulatory shocks may polarize corporate strategies based on underlying motivations. Research found that firms that are motivated by carbon management tend to prefer lower-cost projects, leading to the concern over greenwashing; while firms that are motivated by enhancing values and competitiveness are more willing to invest in higher-cost projects, demonstrating the value and benefits of the VCM (Lou et al., 2023). Systematic reviews confirm this dichotomy, where corporate drivers include four major factors of cost minimization, value maximization, ESG reputation, and compliance, which directly influence offset choice. Cost minimization, present in 60% of studies surveyed, related to low-cost, low-quality offsets (e.g., renewable energy credits), while value maximization, also present in 60% of instances, stimulates investment in higher cost projects with a better value proposition (Lou et al., 2023). While ESG drivers are relatively widespread, they carry significant greenwashing risks when not subject to existing quality standards (Valiergue and Ehrenstein, 2022). Likewise, corporate motivations for voluntary environmental actions include ameliorating productivity, appealing to 'green' consumers, and advancing the corporate regulatory framework (Lyon and Maxwell, 2019). Companies such as BP and Starbucks have demonstrated economic benefits of overcompliance with climate strategies, with BP generating $630 million from its overcompliance in reducing GHG emissions (Heal, 2007). It is also found that firms with higher institutional ownership, net-zero commitments, and international presence are more likely to use offsets (Kim et al., 2024; Park et al., 2022). Notably, such characteristics align with observed motivational drivers: corporations facing global pressure or committing to net-zero targets prefer to concentrate on reputation-based offsetting and ESG; yet, this focus does not guarantee better quality (Park et al., 2022; Kreibich and Hermwille, 2021). Conversely, firms emphasizing cost-minimization, often those without stringent sustainability mandates, predominantly select low-quality credits (Trencher et al., 2024). Overall, the research underlines the complex relationship between corporate motivations, firm characteristics, and the effectiveness of the VCM. This gap between market activity and actual climate impact poses a challenge. Jiang et al. (2025) postulate that the prevailing focus on offset quantities rather than the quality and verifiable impact of underlying projects risks undermining VCM's credibility and environmental goals. Their analysis suggests that without mechanisms to prioritize high-integrity projects, increased offsetting driven by any pressures may yield limited tangible benefits.

3. Institutional Background

The regulatory context for this study centers on the SEC's rulemaking on climate-related disclosures. Historically, corporate climate reporting operated under voluntary frameworks yielded inconsistent disclosures. A regulatory shift occurred on March 21, 2022, when the SEC proposed a new rule, mandating comprehensive climate disclosures for all affected. The draft rule required Scope 1 and 2 emissions disclosures with limited assurance by FY2024, Scope 3 emissions reporting where material, and established a phased compliance timeline tied to filer status. Critically, it defined LAFs as firms with public floats exceeding $700 million (a threshold creating discontinuous regulatory exposure). Public float (market value of freely tradable shares) served as an objective metric to identify significant entities. The proposal triggered unprecedented opposition, generating over 24,000 comments, primarily contesting Scope 3 requirements.

On March 6, 2024, the SEC adopted the final rule which eliminated mandatory Scope 3 disclosures, delayed implementation to FY2025 for LAFs, and limited Scopes 1 and 2 reporting to firms with material climate risks. The 24-month interim period (March

2022-March 2024) thus created a quasi-experimental setting: firms faced binding disclosure expectations that were abruptly suspended, inducing prolonged regulatory uncertainty. This sequence established the $700 million threshold as an exogenous determinant of differential regulatory obligations.

4. Data and Variables

4.1 Data Source

For this investigation, we employ the data for carbon ratings from BeZero, a public carbon ratings registry. Bezero utilises verified project information, extensive developer engagement, and in-house geospatial tools to evidence the scope of carbon accounting in order to establish the project claims for every project. It then builds unique datasets, with the contribution of local expertise and global research partnerships, and uses sector-specific models to identify the risks to every project's climate claims. Finally, Bezero's ratings scientists use sector-specific frameworks to evaluate results from the models, and evaluate risks that cannot be modelled before assessing the five key risks associated with whether each project will reach operation successfully and assigning a rating. The five key risks associated with the projects are (1) Team Experience, (2) Financial Risk, (3) Regulatory Risk, (4) Technical Risk, and (5) Operational Risk.

We also utilise data concerning carbon credit retirements from Berkeley Carbon Trading Project and public registries, including American Carbon Registry, Gold Standard, Climate Action Reserve, Puro.earth, and Verra Carbon Registry. The American Carbon Registry relies on project plans and monitoring data developed by the project while Gold Standard utilises stakeholder consultations and project documentation. Climate Action Reserve uses a combination of project documentation and monitoring reports, and Verra Registry similarly obtains its data from project descriptions, monitoring plans, and periodic reporting. All four public registries' information is verified by third parties to ensure credibility. Berkeley Carbon Trading Project sources the aforementioned four public registries before integrating the raw data from these registries into unified databases. They then apply advanced data engineering and classification techniques, as well as conducting methodological reviews to assess the credibility and impact of carbon offset projects.

Finally, we retrieve each firm's detailed governance and financial information, including but not limited to Return on Assets, Book/Market, Leverage Ratio, Total Assets, Institutional Ownership, and Standard Industry Code from Yahoo Finance: a publicly available website providing up-to-date information and news regarding corporations.

4.2 Variables

4.2.1 Main Dependent Variables: Quantity, Frequency, and Consistency of Carbon Credits

This study employs three distinct dependent variables to comprehensively capture firm-level carbon credit retirement behaviour, each designed to measure a specific dimension of market participation. The primary variable, Retired Credits, is defined as the natural logarithm of the total volume of carbon credits retired by a firm in a given calendar month. The logarithmic transformation facilitates the interpretation of regression coefficients as approximate proportional changes in credit retirement volumes. The second dependent variable, Retirement Dummy, is a binary indicator equaling unity if a firm executed at least one carbon credit retirement during a specific month and zero otherwise. This specification models the extensive margin of retirement participation, where coefficients represent changes in the probability of retirement occurrence. The third variable, Monthly Transactions, quantifies the frequency of retirement actions undertaken by a firm within a monthly interval. Collectively, these longitudinal metrics enable robust assessment of how retirement patterns evolve following regulatory milestones, capturing shifts in strategic behaviour, retirement intensity, and market participation dynamics.

4.2.2 Main Explanatory Variable: Large Accelerated Filer

The binary explanatory variable LAF is used to distinguish between companies subject to intensified disclosure requirements as per the SEC's 2022 draft climate regulation. The variable is operationalized as a binary indicator, with companies whose fiscal year 2021 public float exceeded the regulation threshold of $700 million being assigned a value of 1, and otherwise 0. Public float is calculated by multiplying the percentage of each company's free float by the total market capitalization which is obtained from the Russell 3000 Index.

By quasi-exogenously distinguishing large accelerated filers from non-LAFs, as per the regulation threshold defined in SEC Release No. 33-11275, defines such large companies as those requiring "enhanced disclosure" due to their importance per the SEC's classification.

This LAF variable is critical in distinguishing the effects of differential regulatory pressures along this discontinuity: large accelerated filers face upfront compliance expenses as well as intensified investor attention under the new regulation, relative to control firms continuing under existing expectations.

4.2.3 Control Variables

Besides the major explanatory variables of the extent of various forms of regulatory treatment and corporate drivers of motives, other organizational features can similarly affect activities involving offset retirements. This study employs pre-treatment control variables in our DiDiD and RDD regressions to account for heterogeneity in firm characteristics. The control variables, such as firm size (public float), institutional ownership concentration (% of shares held), and net-zero commitments, are measured in the fiscal year 2021 (pre-treatment) to avoid post-treatment bias. These covariates absorb time-invariant confounders related to financial capacity, stakeholder pressures, and operational contexts that independently influence offsetting behaviour, while preserving the identification assumptions of our quasi-experimental designs.

As established previously, institutional ownership and climate commitments create baseline pressures for environmental action regardless of regulation. Firms with high institutional ownership face amplified ESG scrutiny through shareholder resolutions (Dyck et al., 2016), while those with net-zero targets display a systematically higher offset demand due to pre-existing strategic obligations (Probst et al., 2023).

To differentiate the unique effect of uncertainty surrounding SEC regulations from other confounding factors, this study includes carbon intensity (Scope 1 and 2 emissions) as a critical control variable. The metric captures baseline environmental profiles of companies, as companies with high emissions face essentially different decarbonization challenges and stakeholder demands than low-emission firms (Cenci and Tang, 2024). Including this variable ensures that our treatment effects capture regulatory shocks and not differences in underlying emission profiles. All control variables are observed at the pre-treatment time (fiscal year 2021) to reduce possible post-treatment bias.

4.3 Summary Statistics

Table 3 illustrates all summary statistics. It is observed from the table that out of the total 10,437 observations regarding carbon credit retirement activities of firms between March 2020 and March 2024, the mean credits retired across all firms was 3,651.650 per month with the standard deviation of 55,654.770. The maximum recorded total credits was 2,422,893 metric tonnes of tCO_2e, while the maximum individual transaction in a month was 38 transactions. This indicates a significantly high ratio of transactions to metric tonnes of CO_2; thus, we can infer that firms tend to retire a large volume of tCO_2e in each transaction as opposed to making smaller, frequent transactions. Additionally, the retirement dummy, which indicates whether firms retired any amounts of carbon credits in a month, supports the inference as the low mean value of the variable (0.072) shows that firms are less likely to retire any credits in a particular month than to retire any. This suggests that firms possess the propensity to retire large tCO_2e of credits in a given month, then retire no credits in the following few months, rather than to consistently retire a smaller tCO_2e of credits. In Table 3, we can also observe that the mean Market Capitalization is USD 9.87 billion with the standard deviation being USD 299.541 billion. From the high standard deviation, we can logically conclude that the data for market capitalization is extremely dispersed, and from the large difference between the mean value of market capitalization and the proposed threshold of USD 700 million, we can assert that most public corporations in the US were directly subject to the potential new disclosure rules. The names log(Assets), B/M, ROA, and Leverage each represent the log of total assets, the book-to-market ratio, return on assets, and the leverage ratio, respectively. The above variables are the control variables of this investigation.

5. Methodology

Through the use of multiple public registries, the research captures nearly exhaustive representation of voluntary carbon offset activity in organizational contexts, considering each registry meets high standards of verification. Integration was carried out using the Berkeley Carbon Trading Project and extensive data engineering in Stata to harmonize these disparate sources into a unified panel dataset to enable accurate monitoring of retirement events at both the project and organizational levels. Each retirement event is recorded with rich detail, including the using entity, broker, transaction date, quantity of credits in metric tonnes of CO_2, project category, location, and vintage year. The baseline dataset is supplemented with project-level quality measures based on industry-specific risk measurement models from BeZero Carbon Ratings that assess five main dimensions: team ability, financial risk, technical uncertainty, and operational risk. BeZero's ratings are on a scale of AAA (highest quality) through D (poorest quality). Financial and governance data are sourced from Yahoo Finance and include market capitalization, book-to-market ratios, return on assets (ROA), leverage ratio, and institutional ownership percentages. Association of these financial variables with the using entity of each individual carbon retirement instance is made possible through fuzzy matching entities' legal names and merging using identifiers such as Ticker and CUSIP. Thus, the resulting dataset covers an expansive period from March 2020 through March 2024 and results in an equally weighted panel of 10,437 firm-month observations covering all publicly traded U.S. firms active in the carbon retirement reporting business. We also utilized a fuzzy match to connect subsidiaries and identify them as their respective parent companies.

Our empirical strategy employs the quasi-experimental design set by the SEC's rule-making effort in 2022 (Release No. 33-11042). The March 2022 draft defined a categorical threshold of $700 million in public float, measured as the product of freely-traded shares and market capitalization, to determine entities to be LAFs. Due to limited access to public float data, we use 90% of market capitalization as a proxy for public float in our analysis. This threshold level creates an exogenous variation in regulatory exposure, thus allowing two identification strategies. First, a DiD model is applied to examine the post-regulatory modification retirement behaviour of the treatment group (LAFs) compared to the control group (non-LAFs), both before and after the regulatory change.

5.1. Difference-in-Differences

5.1.1. Difference-in-Differences: Total Retired Credits

The aggregate retired carbon credits, expressed in terms of metric tonnes CO_2 equivalent (tCO_2e), serve as the key dependent variable measuring the intensive margin of corporate offsetting behaviour. Due to the skewed retirement sizes, characterized by sporadic and substantially higher retirements, a log transformation of the data is implemented. This eliminates heterogeneity and allows for proportional interpretation of the coefficient results, which represent percentage changes. The regression equation is as follows:

$$RetiredCredits_{it} = \beta_1 \times Treated_i \times Post_t + \beta_3 Post_t + X_{it}^{'}\delta + a_i + \gamma_t + \epsilon_{it}$$

where a_i and γ_t represent firm and monthly fixed effects, X_{it} includes firm-level controls such as total assets, book-to-market ratio, return on assets, leverage, and institutional ownership, and E_{it} is the error term clustered at the firm-level. This variable captures whether the firms under increased regulatory scrutiny, namely the LAFs, changed their carbon credit retirement procedures in reaction to the SEC's proposed new rule on climate disclosures. This is in accordance with the strategic corporate carbon management strategies emphasized in recent literature, as mentioned previously. A statistically significant and positive coefficient on the interaction term suggests that LAFs significantly increased their offsetting activity, thus demonstrating the role of the VCM as a platform for compliance or mitigation under regulatory uncertainty.

5.1.2. Difference-in-Differences: Retirement Dummy

To analyze the vast range of operations in the carbon market, the binary variable indicates 1 when a firm has retired any carbon credits during any month, and otherwise 0. The regression equation is as follows:

$$RetirementDummy_{it} = \beta_1 \times Treated_i \times Post_t + \beta_3 Post_t + X_{it}^{'}\delta + a_i + \gamma_t + \epsilon_{it}$$

These findings analyze the impact of disruptions to regulations on firm involvement in the VCM, identifying a critical behavioural threshold depending on the level of carbon credit retirements. This variable mitigates the heterogeneous factor of larger firms naturally retiring more credits. Surprisingly, about 93% of firm-month observations report no retirements (see Table 3), and so tracking this metric may efficiently capture the impacts of the SEC disclosure announcement on the tendency of firms to begin, reinitiate, or continue their carbon offsetting efforts. Overall, this variable aims to capture whether the regulatory environment triggered broader corporate participation in the VCM beyond volume fluctuations.

5.1.3. Difference-in-Differences: Total Retirement Transactions

The rate of retirement of carbon credits is determined by using a count variable number of transactions representing the number of unique carbon offset transactions made by firms. The regression equation is as follows:

$$Transactions_{it} = \beta_1 \times Treated_i \times Post_t + \beta_3 Post_t + X'_{it}\delta + a_i + \gamma_t + \epsilon_{it}$$

This variable provides important insights into the operating dynamics involved in offsetting arrangements across different organizations by examining whether organizations have adjusted their rate of retirement transactions amid regulatory pressures. A higher transaction rate can be interpreted to follow certain financial reporting cycles or the increased execution of offsetting transactions that intend to lay out commitments towards climate targets. On the other hand, a constant rate accompanied by volume growth can indicate significant endeavors; however, an elevated rate in the absence of corresponding volume increase can represent performative or strategic attempts aimed at demonstrating continued climate undertakings to stakeholders, such as investors and end-consumers, among others. The analysis of retirement transactions thereby improves the intensive margin metrics (volume-related) and extensive margin (participation), shedding light on tactical adjustments firms make within the VCM.

5.1.4. Difference-in-Differences: Industry Subsample Analysis

To examine the heterogeneous effect across industries, we conduct a subsample analysis classifying industries based on their baseline propensity for carbon offsetting. Drawing on Kim et al. (2024), who documented that low-emitting firms historically utilise carbon offsets more intensively than high-emitting firms due to their proximity to net-zero targets and ESG commitments. Thus, we define our treatment group *IndTreated* to include both high-emitting industries (which, in theory, retire more credits due to their high emissions) and low-emitting industries (e.g., finance). The regression equation is as follows:

$$y_{it} = \beta \times IndTreated_i \times Post_t + \beta_3 Post_t + X'_{it}\delta + a_i + \gamma_t + \epsilon_{it}$$

where Y_{it} represents the dependent variables of total retired credits and retirement participation dummy, for industry i at time t; a_i and y_t represent industry and time fixed effects; X_{it} includes industry-level controls such as the average book-to-market ratio, return on assets, leverage, and institutional ownership, and E_{it} is the error term of robust standard error.

5.2. Regression Discontinuity Design (RDD)

To complement the DiD and confirm the causal finding about the impact of the SEC's $700 million threshold, we employ a sharp Regression Discontinuity Design. This approach restricts the sample to companies with public floats (90% market capitalization) in an 80% bandwidth around the threshold, precisely from $140 million to $1.26 billion. This approach targets those firms immediately around the regulatory threshold, just above and below, to estimate local average treatment effects. The fixed effects regressions used in the panel data include both firm-specific and monthly fixed effects, cluster the standard errors at the firm level, and, in more extensive models, include important firm-level controls like the total assets, book-to-market ratio, return on assets, leverage ratio, and institutional ownership. The RDD model equation is as follows:

$$Y_{it} = \beta \times Treated_i \times Post_t + \phi(MarketCap_i) + X_{it}^{'}\delta + a_i + \gamma_t + \epsilon_{it}$$

where Y_{it} denotes each dependent variable mentioned previously, i.e., total retired credits, retirement participation dummy, and number of retirement transactions, for firm i at time t; a_i and y_t represent firm and time fixed effects; $Treated_i$ indicates firms just above the threshold; *Post* captures the post-announcement period; $\phi(MarketCap_i)$ is a function of the market capitalization of firm i smooths effects of the forcing variable; and X_{it} includes firm-level covariates.

This RDD may not reach statistical significance due to its limited sample size (only 392 control observations in contrast to 10,045 treated observations) leading to reduced statistical power. In spite of the positive coefficients, however, they qualitatively align with the broader results in the DiD, suggesting a possible but imprecise local treatment effect that should be interpreted with caution.

6. Empirical Results

6.1. Baseline Results

6.1.1. Difference-in-Differences (DiD) Regression

To examine the difference in the effects of the proposed regulation between large accelerated filers and non-accelerated filers, we employ a Difference-in-differences (DiD) model. Table 5 illustrates the difference in the changes of carbon credit retirement behaviour between LAFs and non-LAFs through the number of credits retired (Column (1) and (2)), retirement dummy (Column (3) and (4)), and number of transactions in a month (Column (5) and (6)). This DiD model showcases a positive coefficient for all three measures of carbon credit retirement activities, indicating that the treatment group (LAFs) experienced a relative increase in their general carbon credit retirement compared to the control group (non-LAFs). In this model, all values for the interaction term (Treated x Post) are statistically significant with Columns (2), (3), (4), and (5) possessing a p-value lower than 0.01, Column (1) possessing a p-value lower than 0.05, and Column (6) possessing a p-value lower than 0.1. Such statistical significance permits the rejection of the null hypothesis and thereby permits the assertion that the announcement of the draft disclosure rule in March 2022 affected the treated group (LAFs).

Column (1) displays the effect of the draft disclosure rule announcement on firms with no control variables. This column yields the value of 0.217 for treated x post, hence indicating that the total number of credits retired increased by 21.7% for LAFs relative to non-LAFs after the SEC disclosure rule announcement. Although the coefficient 0.217 is lower in comparison to 0.450 (Post variable) and can possibly suggest lower relative increase of credit retirement in percent for LAFs compared to the control group's (non-LAFs') change after the announcement of the new disclosure rule, it is proven in Column (2) that (with the coefficient of 0.364) LAFs experience a 36.4% higher increase in quantity of credits retired compared to non-LAFs which is larger than the percent increase experienced by non-LAFs. This shows that LAFs reduced their emissions by 36.4% more in comparison to non-LAFs after the announcement, therefore illustrating a dramatic rise in the quantity of credits relative to non-LAFs. Columns (3) and (4) display a similar pattern as it is only with the control variables that the treated x post variable experiences a rise greater than the post variable. The coefficient 0.057 indicates a positive treatment effect; the probability of a firm retiring in any month rises by 5.7% more compared to non-LAFs after the announcement of the SEC disclosure rule. Although it is observed in Columns (5) and (6) that LAFs experience a higher relative increase in the number of monthly transactions (in relation to non-LAFs) compared to Post, Column (6) is less statistically significant, highlighting a non-uniform effect across all dependent variables. This difference also suggests that the result of this model is sensitive to the inclusion of certain control variables. Additionally, the negative coefficient in the Post (-0.099) of the number of transactions describe that after the announcement of the SEC disclosure rules non-LAFs faced a decrease in the number of transactions. This further supports the claim that the carbon credit retirement for LAFs increased in comparison to non-LAFs. However, the lower percentage increase in Column (6) compared to Column (2) and (4) reveals that firms had a disproportionate increase in the quantity of credits retired compared to the number of transactions; hence, it can be inferred that firms retired larger quantities of credits per transaction even after the announcement of the SEC climate disclosure regulation.

Therefore, large accelerated filers experience an overall increase in quantity and consistency of carbon credit retirements in the post period in comparison to the control group. However, the number of transactions does not experience a dramatic rise compared to the quantity of credits retired, suggesting that firms continued to retire a large number of credits per transaction even after the announcement. The results are sensitive to the inclusion of certain control variables. This nonetheless broadly supports current literature, such as Lyon and Maxwell (2019), which assert that regulatory frameworks are one of the key incentives for carbon offsetting in firms. This also parallels and supports our hypothesis that the prospect of regulation change will still lead to changes in carbon credit retirement activities of LAFs compared to non-LAFs.

6.1.2. Regression Discontinuity Design

In an attempt to further tease out the causal inference of crossing the USD 700 million threshold, we employed a sharp Regression Discontinuity Design (RDD) with the bandwidth of ±80%. This is presented in Table 6. Table 6 describes the difference of change in carbon credit retirement between firms that are above and below the USD 700 million threshold (large accelerated filers and non-accelerated filers) through the dependent variables of credits retired in tCO_2e (Column (1) and (2)), retirement dummy of whether firms retired any credits in a given month (Column (3) and (4)), and the number of transactions in a given month (Column (5) and (6)).

The coefficients across the results for treated x post were positive, indicating an increase in the quantity, consistency, and the frequency of credits retirement for LAFs compared to non-LAFs after the draft rule announcement. The negative coefficients for the post reveal that the rule announcement, in contrast to the treatment x post results, had a negative impact on the carbon credit retirement levels for the control groups and led to a decrease in the quantity, consistency, and frequency of retirements for firms below the USD 700 million threshold. Although these support our hypothesis of large accelerated filers facing a significant increase in carbon offsetting levels in comparison to non-accelerated filers after the draft rule announcement, the high p-values ($p > 0.10$) of all results highlight the statistical insignificance of the RDD model. We mainly attribute this insignificant result to the lack of observations within the selected bandwidth, as our RDD model only contained 5 unique firms in the control group that were within the respective bandwidth, undermining the significance of our results. Therefore, we fail to reject the null hypothesis, and the probability of such patterns being the result of random statistical occurrences is upheld, leading us to not reference this RDD model when presenting the difference of carbon offsetting activities between LAFs and non-LAFs after the exogenous shock.

6.1.3. Subsample DiD Regression

In order to observe the industry-level changes in carbon credit retirement, we employ a subsample Difference-in-Differences model. Table 7 presents the difference in changes of credit retirement levels between industries that are more likely to carbon offset and industries that are less likely to carbon offset after the exogenous shock of the SEC draft rule announcement (March 2022). The carbon credit retirement levels are measured through the quantity of credits retired on a monthly basis (Column (1) and (2)) and the consistency of credit retirement (Column (3) and (4)). Specifically, the Retirement Dummy shows the consistency of retirement through a binary indicator which reads 1 if an industry retired any carbon credits in a month and 0 if it did not retire any carbon credits. This subsample DiD model showcases a positive coefficient for both measures of carbon credit retirement hence indicates that the treatment group (industries with the most and least emissions that are more likely to utilise carbon offsetting) faces a higher increase in carbon credits retirement compared to the control group (industries that are neither the highest or lowest emitters hence less likely to utilise carbon offsetting). All coefficients in the interaction variable (treated x post) are statistically significant with a p-value under 0.05 apart from Column (4) which has a p-value less than 0.01. This allows us to reject the null hypothesis of the type of industry having no effect on the changes of carbon credit retirements after the announcement of the draft SEC disclosure rule, thus strengthening the narrative that industries less likely to retire carbon credits face a higher increase in carbon credit retirement after the draft rule announcement compared to industries that are more likely to retire carbon credits.

In Column (1) the coefficient for the interaction term treated x post reads 0.393 which shows that industries more likely to use carbon offsetting experiences a 39.3% higher increase in quantity of carbon credits retired than industries less likely to utilise carbon offsetting. This is further strengthened in Column (2) where, with the inclusion of control variables, the interaction term shows that industries more likely to carbon offset increase the quantity of carbon credits retired by 49.9% more than industries less likely to carbon offset. Therefore industries that are more likely to use carbon offsetting experience a larger increase in the metric tonnes of credits retired after the announcement of the draft rule compared to the industries less likely to carbon offset. Moreover Column (3) and (4) display similar patterns and further support the assertion by showing that industries more likely to emit carbon credits are 5.9% more likely to retire credits in a month without controls (Column (3)) and 7.3% more likely to with controls (Column (4)). Thus through this table we are able to infer that after the announcement of the draft disclosure rule in March 2022 industries more prone to utilising carbon offsetting increase their carbon credit retirements by a higher percentage compared to industries less likely to utilising carbon offsetting.

This builds onto existing literature, such as Kim et al. (2024), which asserts that low-emission firms are more likely to rely on the VCM. This simultaneously demonstrates the substantial influence of regulatory uncertainty not only on individual firms but also across different industries.

6.2. Robustness

Despite the official announcement for the draft rule being on March 21, 2022, firms experienced several news and regulatory shifts in the months preceding March 2022, deeming them potential quasi-exogenous shocks. Two notable dates include March 2021 and June 2021. In March 2021, the SEC Acting Chair Allison Herren Lee issued a public request for input on climate-related disclosures (*SEC.gov | a Climate for Change: Meeting Investor Demand for Climate and ESG Information at the SEC*, 2021). Due to its nature in seeking feedback and potentially updating its 2010 guidance on climate change disclosures, the public request signalled the SEC's intent to develop climate disclosure regulation, thus acting as an exogenous shock for corporations. Similarly, in July 2021, the SEC published their Spring 2021 Unified Agenda, where a structured and comprehensive roadmap of regulations (with particular emphasis on climate-related disclosures and ESG factors) was presented under the new SEC leadership (*SEC.gov | SEC Announces Annual Regulatory Agenda*, 2021). This period serves as another exogenous shock due to it being the first concrete articulation of the upcoming policies regarding climate-related disclosures.

In reference to the two aforementioned exogenous shocks, this study conducted placebo testing to check for differential effects, utilising two alternative post variables: post2 and post3. Post2 identified the public announcement of March 2021 as the exogenous shock; therefore, we created a post2 variable with February 2019 to February 2021 being set as 0 and March 2021 to March 2023 being set as 1 (post period). Likewise, post3 identified June 2021 as the exogenous shock, and we consequently coded the period between May 2019 to May 2021 as 0 and the period between June 2021 and June 2023 as 1.

However, the DiD model with the above post variables is statistically insignificant, highlighting the absence of spurious effects. Hence, we sensibly conclude that our DiD model is valid and that the increases in carbon credit retirements in LAFs did not derive from confounding factors or violations of key assumptions. Therefore, on account of the insignificance of the placebo testing, we confirm the credibility and robustness of our DiD model.

7. Discussion

7.1. Key Findings

Through our empirical analysis, we find that LAFs (> USD 700 million in public float) and industries previously less likely to retire carbon credits increase the quantity, consistency, and frequency of their carbon credit retirements, thus decreasing their emissions after the announcement of the updated SEC climate disclosure rule (Table 5). Although the statistical insignificance of our RDD model caused reliance on the DiD models, positive effects on the carbon credit retirement behaviours of LAFs are nevertheless highlighted, and its increase is larger in relation to the control group. The subsample DiD (Table 7) analysis supports this by highlighting the sharp increase of carbon credit retirement for industries previously less likely to carbon offset (high-emission industries) due to such industries constituting majority of LAFs (Table 9). Additionally, the insignificant results of the placebo testing verify the robustness of our DiD model.

Such an increase in carbon offsetting for LAFs is in accordance with current literature that highlights the relationship between climate regulations and carbon credit retirements, but more specifically, in relation to our hypothesis, which explicitly states that the retirement of carbon credits for LAFs will increase despite this announcement not being an official regulation, but merely a prospect of one. Therefore, we can sensibly conclude that regulatory uncertainty can also drive firms to increase their carbon credit retirements in compliance with the potential regulation, especially in the context of today’s market, where consumers and investors also prioritise firms’ social and environmental contributions. Corporations display an increase in carbon credit retirements despite the regulation not directly enforcing emissions reductions due to firms’ need to demonstrate corporate social and environmental responsibility to investors and consumers.

However, it is simultaneously true that such an increase in retirements does not correlate to practical environmental benefits. In Table 1, we observe that the top industries measured in credits retired are Transportation by Air (19,584,206 credits retired), Business Services (7,253,737 credits retired), and Communications (7,133,077 credits retired). With reference to Table 8, we find that the above three firm industries are the top investors in the sectors of Energy, Engineered Carbon Removals, and Nature-Based Solutions. However, in Panel C of Table 2, we can also observe that the most prevalent rating for the Energy sector is B (68.69% of projects), and the most prevalent rating for the Nature-Based Solutions sector is BB (31.78% of projects). Through this observation, we can logically infer that most projects pertaining to the aforementioned sectors are poor in quality, thus highlighting the lack of practical environmental benefits of the majority of carbon offsetting projects. Although all Engineered Carbon Removal projects are rated A, therefore substantially higher than Energy and Nature-Based Solutions projects, it is evident from Panel C of Table 2 that Engineered Carbon Removals projects only constitute 0.05% of the total projects. Thus, the majority of projects that firms invest in lack substantial environmental benefits and are poor in quality.

7.2. Policy Implications

The empirical findings from our quasi-experimental analysis have important implications for the development of climate disclosure policies. First, the increase in retired credits among top accelerated filers after the announcement of the SEC's draft rule reveals that regulatory uncertainty, even without finalized rules, may induce significant behavioural changes. This implies that policymakers have not sufficiently examined mechanisms for the rapid acceleration of corporate climate efforts via carefully structured stages of proposal development, especially if formal rulemaking faces implementation delays. However, the clustering of these retirements in lower- to medium-quality credits underscores an important void in policy: disclosure rules without explicit quality or project sector requirements may inadvertently stimulate symbolic emissions reductions instead of genuine reductions.

Secondly, the different corporate responses noted signify a need for the development of more sophisticated regulatory mechanisms. Firms featuring high levels of institutional ownership showed substantially increased responses to regulatory cues, and the effectiveness of these disclosure requirements is bolstered by investor scrutiny. This line of thought supports regulatory frameworks to hasten compliance deadlines among organizations featuring poor governance, and concomitantly for organizations qualifying for closer investor analysis. Finally, the continued reliance of the market on nature-based projects, even with recognized quality inadequacies, signals future policies to encompass technology-neutral additionality standards instead of tipping in favour of specific types of projects. The evidence also shows that mandatory disclosure regimes should distinguish clearly between reductions achieved through operational changes and those through market mechanisms. Our findings suggest that carbon offsetting largely served as a compliance mechanism and not as a transition device to reaching complete decarbonization. To mitigate this problem, disclosure guidelines could require the reporting of Scopes 1-2 emissions reductions from investing in reductions separately from those reported as a result of offset retirement, in order not to hide operational inaction behind market mechanisms. Finally, although the SEC's threshold-based implementation strategy provides valuable identification opportunities, it may have the perverse incentive effect of encouraging firms near regulatory breakpoints. Accordingly, policymakers should consider multi-tiered compliance requirements to minimize transition discontinuities.

Shifting focus from quantity to quality, Jiang et al. (2025) found results pointing to the abundance of poor-quality retirements, illustrating an underlying failure of the singular reliance on reported retirement figures. Regulations in the future are urged to go beyond the simple recording of retirement figures. Policymakers need to demand greater disclosure about the quality attributes of retired credits, such as project types, authentication, BeZero ratings, and assessed additionality and permanence. This could require the establishment of standardized reporting protocols mandating organizations to disclose, besides the quantity of credits they retire, the quality of projects they certify, and their third-party verified environmental quality. Jiang et al. (2025) also noted that proper disclosure is necessary when directing corporate and investor focus towards projects that truly make a difference and lift the VCM out of symbolic gestures towards genuine climate mitigation.

7.3. Limitations

The primary empirical limitation of this study stems from the limited sample size available for analysis. Specifically, the acute number of observations within the bandwidth of the RDD framework reduces statistical power to detect effects and constrains the robustness and generalizability of the findings. Future research employing the RDD on a larger bandwidth would enhance the reliability of inferences drawn from this quasi-experimental setting. Beyond this methodological limitation, significant gaps in the extant literature are observed due to abundant development in recent years. Among these is the underexplored heterogeneity in corporate motivations driving participation in carbon markets.

8. Conclusion

In response to the proposal of updates to SEC climate disclosure rules in March 2022, this paper explores the interplay between climate regulatory uncertainty and corporate engagement in the VCM. Our empirical findings highlight that the prospect of updated disclosure policies resulted in increased quantity, consistency, and frequency of carbon credit retirements for LAFs. Moreover, their escalation in carbon offsetting in relation to the policy proposal exceeded that observed in the control group (non-LAFs). The results also demonstrate the large influence of regulatory uncertainty on an industry-level.

Our paper employs both DiD and RDD methodologies to analyse the differential responses of LAFs and non-LAFs following the introduction of the new policy proposal. The significant results gleaned from our DiD analysis deepen our understanding of corporate behaviours in the face of prospective regulatory changes. The observed increase in carbon credit retirements among LAFs post-March 2022 supports our hypothesis that corporations are driven not only by considerations of regulatory compliance but also to the desire to enhance their brand image among consumers and investors. Even without legal mandates, companies retire carbon credits to attract consumers and investors. However, in support of previous literature (Trencher et al. (2024)), the industry-level analysis validates that the majority of carbon offsetting projects firms invest in are poor in quality and lack concrete environmental impact. This poor project quality can be attributed to the lack of attention the truthful environmental impacts of projects receive, as this leads to companies minimizing cost while adhering to regulations and improving their reputation through sourcing cheap, low-quality credits.

Our study contributes to the literature on the interplay between regulation and the VCM. We find that corporations that are addressed in upcoming environmental policies, even towards uncertain, unconsolidated regulations, respond to it by increasing their carbon credit retirements. We also reveal that firms reduce their emissions through the VCM in response to changes in transparency regulations; regulations not explicitly addressing emissions reductions also resulted in emissions reductions through carbon credit retirement. Through such findings and their connection to modern investor priorities (evidenced by the rise of

ESG issues), we can conclude that corporations are sensitive to environmental regulations and will react to reduce their emissions in order to showcase their social and environmental responsibility for investors and consumers. These findings are crucial in shaping the future of regulatory frameworks and investor decisions, urging corporations to minimize their detrimental effects on GHG emissions, where the corporate-driven society requires the intervention of investors and policies to mitigate corporate destruction of the environment.

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Table 1 reports the top ten industries that retire the largest quantity of carbon credits from a sample size of 144 firms across the period of March 2020 to March 2024. Column (1) displays the names of industries as classified by the Standard Industry Classification Code (SIC), which is specified up to two digits. While Columns (3) and (4) both measure the number of individual companies or transactions, one credit in Column (2) is measured in one metric tonne of CO2 (tCO_2e) or its equivalent for other greenhouse gases that have been reduced. Column (4) displays the average Market Capitalization of all public firms within the respective industry, and it is presented in US Dollar billions. Table 1 shows that the ten industries with the highest credit retirements are as follows: Transportation by Air, Business Services, Communications, Oil and Gas Extraction, Transportation Equipment, Textile Mill Products, Electric Gas and Sanitary Services, Motion Pictures, Chemicals and Allied Products, and Electronic & Other Electric Equipment.

Table 1: Top Ten Industries by Retired Credits

Industry	Retired Credits	Number of Companies	Number of Transactions	Market Capitalization ($billions)
Transportation by Air	19,584,206	6	128	1,3850
Business Services	7,523,737	60	267	242,500
Communications	7,133,077	4	58	46,010
Oil and Gas Extraction	7,051,732	6	70	22,120
Transportation Equipment	6,257,346	4	91	19,660
Textile Mill Products	6,072,221	1	117	279.8
Electric Gas and Sanitary Services	3,570,989	29	86	5091
Motion Pictures	3,216,473	2	23	10,650
Chemicals and Allied Products	2,288,035	22	62	18,440
Electronic & Other Electric Equipment	1,629,547	10	22	49,050

Table 2 reports the distribution across sectors and ratings within the sample size of 4314 projects available on the BeZero public database from March 2020 to March 2024. Panel A presents the numeric (Column (2)) and percent (Column (3)) distribution of projects' ratings that range from AAA to D in accordance with the rating scale on the Bezero database. Likewise, Panel B reports the numeric (Column (2)) and percent (Column (3)) distribution of projects across all sectors. The six sectors listed denote the six project sector groups as identified by the BeZero database, and the value "Unknown" denotes that the specific project's sector was not officially defined. Panel C exhibits the numeric and percent distribution of ratings in each project sector group as defined by the BeZero database out of the 1738 projects that were rated in the selected time frame (March 2020 - March 2024).

Table 2: Summary Statistics of Carbon Credit Projects

Panel A: By Ratings

Ratings	Number of Projects	%
AAA	0	0
AA	83	2.51
A	73	1.54
BBB	316	6.21
BB	453	14.42
B	446	13.62
C	277	6.38
D	90	4.81
No Rating	2,576	50.52

Panel B: By Sectors

Sectors	Number of Projects	%
Energy	1,156	26.70
Engineered Carbon Removals	51	0.05
Household Devices	228	1.78
Industrial Processes	439	14.48
Nature-Based Solutions	1,793	46.64
Waste	637	10.27
Unknown	10	0.07
Total	4,314	

Panel C: Ratings by Project Sectors

Sectors	AA	A	BBB	BB	B	C	D	Total
Energy	0	0	6	23	204	64	0	297
%	0	0	2.02	7.74	68.69	21.55	0	100
Engineered Carbon Removals	0	11	0	0	0	0	0	11
%	0	100	0	0	0	0	0	100
Household Devices	0	0	5	11	24	6	7	53
%	0	0	9.43	20.75	45.28	11.32	13.21	100

Industrial Processes	0	28	39	0	41	12	28	148
%	0	18.92	26.35	0	27.7	8.11	18.92	100
Nature-Based Solutions	83	27	263	347	128	189	55	1,092
%	7.6	2.47	24.08	31.78	11.72	17.31	5.04	100
Waste	0	7	3	72	49	6	0	137
%	0	5.11	2.19	52.55	35.77	4.38	0	100
Total	83	73	316	453	446	277	90	1,738
%	4.78	4.2	18.18	26.06	25.66	15.94	5.18	100

This table presents descriptive statistics for the DiD analysis sample (10,437 firm-month observations). *Retired Credits* measures the quantity of carbon credits retired which is equivalent to one metric ton of Carbon Dioxide. *Retirement Dummy* is an indicator equal to 1 if any credits were retired in a month. *Monthly Transactions* count discrete retirement events. *Market Capitalization* is the market value of equity in billions, and in this case it has been reduced to 90% of its original value to simulate a value close to public float. *log(Assets)* is the natural logarithm of total assets. B/M is the book-to-market ratio. *ROA* is the return on assets (net income / assets). *Leverage* is long-term debt divided by total assets. *Institutional Ownership* is the fraction of shares held by institutional investors

Variables	Observations	Mean	Std. Dev.	Min	Max
Retired Credits	10,437	3651.650	55654.770	0	2,422,893
Retirement Dummy	10,437	0.072	0.2582672	0	1
Monthly Transactions	10,437	0.191	1.163542	0	38
Market Capitalization (USD Billions)	10,437	98.130	299.541	0.0002575	2,698.909
log(Assets)	9,974	9.870	1.842457	5.23292	15.20251
B/M	9,155	0.470	0.47	0.00	4.18
ROA	9,596	0.100	0.11	-0.65	0.55
Leverage	9,608	0.660	0.19	0.07	1.09
Institutional Ownership	9,768	0.814	0.1550732	0.1622153	2.235908

Table 3: Summary Statistics

Table 4 reports the correlation between each dependent variable and the control variables. Columns (1), (2), and (3) display the three dependent variables of this investigation — Retired Credits, Retirement Dummy, and Monthly Transactions. Retired Credits denote the total quantity of credits in tCO_2e retired by a firm per month, and Monthly Transactions denote the number of individual retirements made by firms in a given month. Retirement Dummy is a binary indicator equating to 1 if a firm retired any quantity of carbon credits in a given month, and 0 if a firm did not retire any quantity of carbon credits in a given month. Columns (4), (5), (6), (7), (8), (9) display the control variables. Market Capitalization of firms that we substituted for public float and log(Assets) represents the log of the total assets of a given company. ROA denotes Return On Assets, which showcases the profitability of a company, and B/M denotes Book-to-Market ratio which shows a firm's value through the ratio between the firm's book value and market value. Leverage represents the leverage ratio of a company that is determined by the total liabilities of a firm divided by its total assets. Table 4 illustrates a moderate, positive correlation between the three dependent variables, but the low coefficients between the dependent and control variables suggest a weak correlation between firms' carbon credit retirement activities and their financial profiles.

Table 4: Correlation Table

	Retired Credits	Retirement Dummy	Monthly Transactions	Market Capitalization	log(Assets)	ROA	B/M	Leverage	Institutional Ownership
Retired Credits	1.0000								
Retirement Dummy	0.2358	1.0000							
Monthly Transactions	0.5534	0.5889	1.0000						
Market Capitalization ($billions)	0.0263	0.0542	0.0262	1.0000					
log(Assets)	0.0233	0.0322	0.0148	0.3846	1.0000				
ROA	0.0066	0.0187	0.139	0.2604	-0.0190	1.0000			
B/M	-0.0133	-0.0213	-0.0108	-0.1449	0.2673	-0.2070	1.0000		
Leverage	0.0212	0.0118	0.0241	-0.0427	0.3461	-0.1962	0.1475	1.0000	
Institutional Ownership	-0.0208	-0.0104	-0.0061	-0.2099	-0.2385	0.1383	-0.0348	-0.0827	1.0000

This table reports Difference-in-Differences estimates for three dependent variables: Retired credits (intensive margin), Retirement Dummy (extensive margin), and Monthly Transactions (count). The key estimator *Treated x Post* is an interaction term that captures the causal treatment effect. *Post* is a dummy for identifying the pre and post-treatment periods. Columns (1), (3), (5) display specifications without controls, whilst columns (2), (4), (6) display specifications without controls. In sum, odd-numbered columns show baseline specifications, and even-numbered columns have additional controls of the natural logarithm of *Total Assets,* the *Book-to-Market ratio, Return on Assets, Leverage ratio, and Institutional Ownership*. All models include firm and month fixed effects.

Table 5: Panel Regression on Retired Credits: Difference-in-Differences (DiD)

Dependent Variable:	Retired Credits		Retirement Dummy		Monthly Transactions	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated x Post	0.217**	0.364***	0.039***	0.057***	0.134***	0.170*
	(0.109)	(0.102)	(0.013)	(0.012)	(0.045)	(0.101)
Post	0.450**	0.195	0.052**	0.021	0.002	-0.099
	(0.228)	(0.242)	(0.026)	(0.027)	(0.109)	(0.156)
log(Assets)		0.179		0.028		0.188
		(0.266)		(0.033)		(0.128)
B/M		-0.131		-0.010		-0.087
		(0.131)		(0.016)		(0.060)
ROA		1.558**		0.172**		0.271
		(0.618)		(0.078)		(0.260)
Leverage		-0.159		0.010		0.248
		(0.686)		(0.081)		(0.361)
Institutional Ownership		0.391		0.051		-0.112
		(0.600)		(0.077)		(0.256)
Constant	0.450**	0.195	0.052**	0.021	0.002	-0.099
	(0.228)	(0.242)	(0.026)	(0.027)	(0.109)	(0.156)
Firm FE	Y	Y	Y	Y	Y	Y
Month FE	Y	Y	Y	Y	Y	Y
Observations	10437	9143	10437	9143	10437	9143
R^2	0.014	0.015	0.017	0.019	0.007	0.008

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 presents Regression Discontinuity Design estimates using the same outcomes as Table 5. *Treated x Post* measures the discontinuous treatment effect at the threshold of $700 million in market cap, corresponding to SEC's guidelines for LAFs. Specifications mirror Table 5: columns (1) /(2) = *Retired Credits*; (3) / (4) = *Retirement Dummy*; (5)/(6) = *Monthly Transactions* (odd columns: fixed-effect only; even columns: fixed-effect and controls). The reduced sample size (449-539) reflects RDD bandwidth selection.

Table 6: Panel Regression on Retired Credits: Regression Discontinuity Design (RDD)

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
	Retired Credits	Retired Credits	Retirement Dummy	Retirement Dummy	Number of Transactions	Number of Transactions
Treated x Post	0.119	0.185	0.035	0.047	0.120	0.128
	(0.621)	(0.583)	(0.070)	(0.066)	(0.111)	(0.125)
Post	-0.844	-1.078	-0.019	-0.012	-0.156	-0.148
	(1.425)	(2.077)	(0.171)	(0.258)	(0.319)	(0.473)
log(Assets)		0.691		0.051		0.024
		(1.229)		(0.143)		(0.208)
B/M		0.307		0.025		0.066
		(0.903)		(0.106)		(0.163)
ROA		2.827		0.379		0.170
		(2.614)		(0.266)		(0.586)
Leverage		2.209		0.236		0.334
		(1.448)		(0.167)		(0.212)
Institutional Ownership		1.482		0.171		0.539
		(1.485)		(0.163)		(0.681)
Constant	1.792	-5.595	0.182	-0.462	0.364^{*}	-0.439
	(1.035)	(8.965)	(0.106)	(1.040)	(0.175)	(1.645)
Firm FE	Y	Y	Y	Y	Y	Y
Month FE	Y	Y	Y	Y	Y	Y
Observations	539	448	539	448	539	448
R^2	0.069	0.098	0.068	0.096	0.080	0.100

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table reports Difference-in-Differences estimates for two dependent variables: Retired credits (intensive margin) and Retirement Dummy (extensive margin). The key estimator *Treated x Post* is an interaction term that captures the causal treatment effect. *Post* is a dummy for identifying the pre and post-treatment periods. Treated is a dummy that is classified as 1 if an industry is more likely to use carbon offsetting, encompassing both the highest and lowest emitters, and it is classified as 0 if an industry is less likely to use carbon offsetting (includes industries that are neither the top nor the bottom emitters). Columns (1), (3) display specifications without controls, whilst columns (2), (4) display specifications without controls. In sum, odd-numbered columns show baseline specifications, and even-numbered columns have additional controls of the natural logarithm of *Total Assets,* the *Book-to-Market ratio, Return on Assets, Leverage ratio, and Institutional Ownership*. All models include firm and month fixed effects.

Table 7: Panel Regression on Industry Subsample: Difference-in-Differences

	(1)	(2)	(3)	(4)
	Total Retirements		Retirement Dummy	
IndTreated x Post	0.393**	0.499**	0.059**	0.073***
	(0.192)	(0.205)	(0.025)	(0.027)
IndTreated	-0.013	-0.427***	0.005	-0.041**
	(0.138)	(0.145)	(0.017)	(0.018)
Average B/M		-0.293		-0.027
		(0.225)		(0.023)
Average ROA		-9.301***		-1.109***
		(1.079)		(0.127)
Average Leverage		0.650		0.070
		(0.594)		(0.068)
Average Institutional Ownership		-0.027		0.013
		(0.486)		(0.056)
Constant	1.672***	2.502***	0.192***	0.276***
	(0.080)	(0.740)	(0.010)	(0.084)
Observations	2350	2150	2350	2150
R^2	0.001	0.034	0.003	0.041

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8 reports the three industries investing the highest quantity of credits for each sector group as defined by the BeZero database. Column (1) depicts the six project sector groups — with the addition of "Unknown" which denotes the absence of identification of a particular project's sector group by the BeZero database — identified by the BeZero Database. Column (2) showcases the industry of firms that is determined through the Standard Industry Classification code (SIC code) specific to two digits. Column (3) shows the percentage of investments each industry constitutes in the respective sector, while Column (4) displays the quantity of individual carbon credits of the respective sector group that were retired by all firms in the named industry (1 credit = 1 tCO_2e).

Table 8: Top Industries by Sector Group

Project Sector Group	Industry	Percentage Investment (%)	Quantity of Credits
Energy	TRANSPORTATION BY AIR	40.60	7,688,751
Energy	TRANSPORTATION EQUIPMENT MANUFACTURING INDUSTRY	16.10	3,048,563
Energy	TEXTILE MILL PRODUCTS INDUSTRY	15.25	2,887,777
Engineered Carbon Removals	BUSINESS SERVICES	90.17	32,096
Engineered Carbon Removals	TRANSPORTATION SERVICES	9.83	3,500
Engineered Carbon Removals	N/A	N/A	0
Household Devices	OIL AND GAS EXTRACTION INDUSTRY	22.51	284,563
Household Devices	TRANSPORTATION EQUIPMENT	19.14	241,942
Household Devices	TEXTILE MILL PRODUCTS	18.71	236,455
Industrial Processes	OIL AND GAS EXTRACTION INDUSTRY	31.62	3,247,961
Industrial Processes	TRANSPORTATION BY AIR	18.84	1,935,182
Industrial Processes	TRANSPORTATION EQUIPMENT	15.47	1,589,369
Nature-Based Solutions	TRANSPORTATION BY AIR	28.84	9,537,412
Nature-Based Solutions	COMMUNICATIONS INDUSTRY	16.93	5,599,700
Nature-Based Solutions	BUSINESS SERVICES	12.65	4,184,434
Unknown	OIL AND GAS EXTRACTION INDUSTRY	95.88	50,300
Unknown	INDUSTRIAL AND COMMERCIAL MACHINERY AND COMPUTER EQUIPMENT	1.73	905
Unknown	REAL ESTATE	1.43	750
Waste	ELECTRIC, GAS, AND SANITARY SERVICES	25.48	1,856,138
Waste	TEXTILE MILL PRODUCTS	21.12	1,538,400
Waste	OIL AND GAS EXTRACTION INDUSTRY	15.90	1,157,950

Figure 1 presents the top ten industries ranked by their volume of retired carbon credits in millions. The data highlights two key metrics: total retired credits per industry and average retired credits per company within each industry. The figure utilises a bar chart form to provide a comparative overview of credit retirement activity across different industries.