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Climate Commitments, Environmental Resource Allocation, and Board Independence: Evidence from China

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Abstract

This study examines how the specificity of corporate climate commitments relates to environmental resource allocation and whether board independence conditions these associations. We link sustainability reports with financial, governance, and environmental data for 10,767 firm-year observations from 1864 Chinese listed firms, covering report years 2010–2022 and environmental outcomes through 2023. Commitments are classified as No Commitment, General Commitment (GC), or Quantified Commitment (QC). Firm- and year-fixed-effects models examine positive environmental expense or capitalized environmental asset records, monetary amounts, and intensities across alternative observation horizons. In the main full-sample analysis, GC is associated with a higher probability of positive environmental records, whereas QC shows no stronger association than GC. Greater board independence is associated with a more favorable QC–GC contrast. These patterns vary with data coverage and do not consistently extend to greater amounts or intensity, with some asset-based estimates showing negative associations. A sensitivity analysis using an alternative coding procedure yields statistically insignificant estimates for the GC association and the comparative moderation contrast. The study links research on climate commitments to environmental accounting by distinguishing the presence of recorded resources from their monetary scale.

Keywords: corporate climate commitment; commitment specificity; green investment; board independence; corporate sustainability; climate governance; sustainable corporate action; China

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1. Introduction

Corporate climate commitments express how firms intend to respond to climate change. Their relevance to corporate environmental action depends on how these objectives relate to organizational decisions and resource allocation. Recent research identifies weaknesses in the accountability surrounding such commitments. Jiang et al. document limited transparency and stakeholder responses when corporate emissions targets are missed or cease to be reported [1]. Bingler et al. examine how cheap talk in climate disclosures relates to climate initiatives, emissions, and reputational risk [2]. Ko and Prakash find little evidence that participation in the Science Based Targets initiative increases stock prices among S&P 500 firms [3]. These studies examine different dimensions of corporate climate commitments, from disclosure content and accountability to market rewards. They raise a complementary question about firms' operations: how does the content of a climate commitment relate to the environmental resources recorded by the firm?

Commitments differ in the specificity of their objectives and the benchmarks they provide for assessing progress. General commitments express an intention to address climate change, whereas quantified commitments attach more concrete attributes to that intention. Research by Dahlmann et al. links the characteristics of climate targets to environmental performance [4]. Bolay et al. find that progress towards emissions targets varies with target design, time horizons, ambition, and organizational arrangements [5]. Romito et al. report lower greenhouse gas emissions among firms participating in the Science Based Targets initiative than among comparable nonparticipants [6]. Weaver et al. assess corporate decarbonisation ambition against low-carbon pathways, extending the evaluation of stated targets to their alignment with broader climate futures [7]. This literature shows that target adoption, ambition, credibility, and achievement are distinct dimensions. Our focus is the connection between commitment specificity and annual environmental resource allocation. Long-term objectives may require substantial operational changes, but the timing and scale of resources devoted to those changes need not follow directly from the specificity of the announced target.

China offers a setting in which corporate climate objectives coexist with policy and financing pressures for environmental improvement. Hong et al. find that China's dual-carbon policy promotes green innovation among heavy-polluting enterprises [8]. Zhao et al. show how green credit policy encourages investment in green projects through external constraints and internal governance [9]. Li and Guo examine the influence of energy use rights trading on industrial firms' green investment [10]. These studies provide recent evidence on corporate responses to external incentives, with outcomes ranging from innovation to investment. Research on carbon information and capital investment also examines the processes through which environmental considerations enter organizational investment decisions [11]. Building on these perspectives, we examine firms' own stated objectives and their associations with environmental expense and capitalized asset records. The comparison between general and quantified commitments adds a dimension of corporate communication to research on the policy and organizational determinants of environmental resource allocation.

Board governance provides a further reason why these relationships may vary across firms. Albitar et al. associate climate governance and eco-innovation with corporate climate commitment [12], while Aguilera et al. emphasize the need to connect governance arrangements with specific environmental strategies and outcomes [13]. Directors can influence corporate decisions through monitoring, advice, and access to resources [14]. Kim et al. find that board independence is associated with lower subsequent greenhouse gas emissions intensity among South Korean listed firms [15]. These studies establish the relevance of governance to climate engagement and environmental performance, but leave a more specific question: whether board independence shapes the relationship between commitment content and environmental resource allocation differently for general and quantified commitments. More specific objectives may provide clearer benchmarks for board scrutiny, while independent oversight may also influence which environmental activities receive resources.

This study addresses three related questions. Are general climate commitments associated with positive environmental records relative to the absence of an identified commitment? Do quantified commitments exhibit stronger associations than general commitments? Does board independence shape the difference between these relationships? The study's objective is to distinguish commitment adoption from commitment specificity and assess how each relates to environmental resource allocation under different levels of board independence. Examining both the presence and the scale of environmental records allows

us to determine whether the patterns extend beyond the occurrence of a positive recorded amount.

We combine corporate social responsibility, ESG, and sustainability reports with financial, governance, and environmental data for Chinese listed firms. The main sample comprises 10,767 firm-year observations from 1864 firms, covering reporting years 2010–2022 and environmental outcomes through 2023. Firm-years are classified as No Commitment (NC), General Commitment (GC), or Quantified Commitment (QC). The primary outcome identifies positive environmental expense or capitalized environmental asset records; additional analyses examine the two components and their monetary scale separately. Because expenses are annual flows and capitalized assets are closing balances, these measures capture different dimensions of environmental resources. The analysis also distinguishes the report's publication year from the first complete calendar year after publication and compares alternative treatments of environmental-data coverage. Panel models account for firm and year differences, financial and governance characteristics, and prior environmental status.

In the main full-sample analysis, GC is associated with a higher probability of a positive environmental record, whereas QC shows no stronger association than GC. The QC–GC contrast becomes more favorable to QC as board independence increases, with weaker evidence in the sample restricted to observations covered by the environmental data source. The monetary analyses distinguish these binary-outcome patterns from the scale of resource allocation. Positive-record associations do not consistently extend to larger environmental expenses, greater asset balances, or higher resource intensity, and some capitalized asset specifications show negative associations with GC. Additional estimates based on alternative commitment coding show no statistically significant GC association or comparative moderation contrast (Section 4.9 and Appendix I). The findings therefore concern conditional associations that vary with commitment measurement, outcome definition, sample coverage, and observation horizon.

The study contributes to research on climate commitments by distinguishing commitment adoption from target specificity and examining their respective associations with environmental resource allocation. It complements research on emissions and target achievement with evidence from environmental accounting records, separating the presence of positive records from their monetary scale and intensity. It also extends the governance perspective by examining whether board independence conditions the associations of general and quantified commitments differently. These comparisons connect the content of corporate climate objectives with the accounting measures through which environmental resource allocation is observed.

The remainder of the paper reviews the literature and develops the theoretical framework, explains the research design, presents the empirical results, and discusses their implications and limitations.

2. Literature Review and Hypothesis Development

2.1. Theoretical Framework

The relationship between climate commitments and environmental resource allocation involves both the information conveyed by a commitment and the organizational arrangements supporting its implementation. Legitimacy and signaling perspectives explain why firms announce climate objectives and why the content of those objectives matters. Institutional decoupling explains how public commitments can coexist with limited operational change. Agency and resource dependence perspectives explain how boards may influence the connection between stated objectives and the allocation of corporate resources.

Firms can use climate commitments to demonstrate alignment with stakeholder expectations and maintain organizational legitimacy [16]. From a signaling perspective, a commitment communicates information about managerial priorities that external stakeholders cannot fully observe [17]. Specific objectives can make a statement easier to evaluate, but specificity alone does not make the signal costly or credible. Its credibility also depends on implementation, monitoring, and the consequences of failing to meet the objective. Jiang et al.'s evidence of limited accountability for missed or disappearing emissions targets illustrates this distinction [1].

Institutional decoupling provides a complementary explanation: formal statements may be adopted without equivalent changes in organizational practices [18]. Research on greenwashing examines the incentives and conditions that can sustain gaps between environmental communication and action [19,20]. Climate commitments may therefore express substantive strategic priorities, symbolic responses to external pressure, or a combination of both. The text of a commitment identifies a stated objective; its relationship with environmental resources requires empirical examination.

Agency theory directs attention to managerial incentives and oversight [21]. Managers may benefit from announcing environmental objectives while facing immediate costs and uncertain returns from implementation. Boards can scrutinize these decisions and request evidence that proposed resource allocations serve the firm's objectives. Resource dependence theory adds the board's contribution of advice, expertise, and external connections [14]. These functions may support worthwhile environmental activities while constraining spending that lacks a sound rationale. This framework motivates examining both the specificity of climate commitments and the role of board independence.

2.2. Climate Commitments and Environmental Resource Allocation

Environmental resource allocation encompasses expenditures incurred in environmental activities and resources embodied in environmental assets. Research on Chinese firms identifies several conditions under which firms allocate resources to environmental activities. Alongside studies of green finance and energy use rights trading [9,10], Wan et al. examine climate risk and corporate green investment [22], while Hou et al. investigate firms' investment responses to climate investment and financing policy [23]. Wang and Li connect government digitalisation with green investment through environmental regulatory efficiency [24]. Feng and Li extend the analysis to common ownership along the supply chain [25]. These studies place environmental investment within a combination of risk exposure, financing conditions, regulation, and interfirm relationships.

Climate commitments may contribute to resource allocation by organizing managerial attention and providing a reference point for coordination. Operational departments and subsidiaries can use a stated objective when developing plans, while management can incorporate it into environmental budgeting. Research on carbon information and capital investment highlights the organizational processes through which environmental considerations enter investment decisions [11]. External attention also matters: Tavakolifar et al. associate greater media attention with a higher likelihood of corporate commitment to climate change action [26]. Research linking climate governance and eco-innovation to corporate commitment further supports examining these statements within a broader organizational strategy [12].

These relationships leave a distinct empirical question: whether the specificity of a firm's stated climate objective is associated with observable environmental resources after accounting for financial and governance characteristics. Policy exposure, climate risk, and ownership networks describe influences on firms' decisions; commitment categories describe the objectives firms articulate. Examining those categories alongside subsequent

environmental records helps connect the literature on climate communication with the literature on resource allocation.

Environmental communication and performance can also be jointly determined. Firms with stronger environmental performance may disclose more information, and disclosure, environmental performance, and financial outcomes can reflect common organizational conditions [27,28]. Accordingly, a positive association between climate commitments and environmental resources need not arise solely because a public statement changes subsequent behavior. It may also reflect an existing orientation towards environmental activities. This consideration supports examining prior environmental status and interpreting the empirical estimates as conditional associations.

A general climate commitment identifies a firm-specific intention to address climate change even when it lacks detailed quantitative benchmarks. Relative to the absence of an identifiable commitment in an available report, such a statement may indicate greater managerial attention to climate issues and provide a basis for coordinating environmental activities. The absence of a detailed target does not prevent a firm from allocating resources to these activities. We therefore retain a positive expectation for general commitments relative to no identified commitment.

The empirical measures distinguish positive environmental records from their scale. Environmental expenses are annual flows, whereas capitalized environmental assets are closing balances. A positive asset record can persist across years and does not necessarily indicate a newly initiated project. The binary indicator, amount measures, and intensity measures therefore provide distinct evidence concerning the broader resource-allocation expectation. Support limited to the binary indicator would qualify, rather than establish in full, a general claim of greater green investment.

H1a. *General climate commitments are positively associated with green investment relative to no identifiable climate commitment.*

2.3. Commitment Specificity and Environmental Resource Allocation

Commitment specificity concerns the information attached to a stated climate objective. General commitments identify a direction of action, while quantified commitments provide attributes that make aspects of the objective more concrete. Target dates, intended reductions, and the scope of an objective can help stakeholders understand what the firm proposes to achieve. The classification used in this study concerns the specificity of reported commitments; it is distinct from external target validation or an assessment of alignment with a particular climate pathway.

More specific objectives may facilitate resource allocation through planning and evaluation. Management can use an identifiable target to consider the activities required, assess resource needs, and allocate responsibility. Directors and other stakeholders may then have a clearer basis for reviewing progress. Research on corporate climate targets links target characteristics to environmental performance [4], while evidence on target progress shows that target characteristics, time horizons, ambition, and climate-linked remuneration are associated with progress [5]. Participation in initiatives that support target setting has also been associated with lower emissions among participating firms [6]. These studies motivate examining whether more specific commitments are reflected in environmental resources.

There are reasons why this relationship may be incomplete or delayed. Corporate sustainability targets may differ in how closely they correspond to broader ecological requirements [29], and specific targets may still face weak accountability [1]. Targets extending to 2030 or 2050 also operate over a different horizon from annual expenditure and budgeting decisions. Implementation can involve successive investment stages, operational adjustments,

or resources committed before the report is published. A long-term target therefore need not be accompanied by an immediate increase in each annual resource measure.

The planning and evaluation arguments nevertheless provide a directional expectation: quantified objectives offer more concrete information for aligning environmental resources with stated intentions than general objectives. We examine this expectation across outcome measures and observation horizons.

H1b. *Quantified climate commitments have a stronger positive association with green investment than general climate commitments.*

2.4. The Moderating Role of Board Independence

Board independence may influence how climate objectives enter corporate decisions through monitoring and resource provision [14]. Independent directors can question managerial proposals, request information, and assess whether planned activities are consistent with the firm's objectives. Galbreath examines how firms address climate change through governance practices and documents variation across board structures and institutional settings [30]. De Villiers et al. connect environmental performance with board characteristics representing monitoring and resource provision [31], while Kock et al. examine the contributions of boards, managerial incentives, and external governance mechanisms [32]. This work supports treating board independence as one component of the governance arrangements surrounding environmental decisions.

The resources and expertise available to directors also affect their contribution. Ortiz-de-Mandojana et al. show that director interlocks can enable or inhibit proactive environmental strategies depending on the resources conveyed through those connections [33]. Asad et al. link board environmental expertise to stakeholder orientation and environmental performance [34]. Shaukat et al. examine the connections among board attributes, CSR strategy, and environmental and social performance [35], and Orazalin and Baydauletov consider how board gender diversity conditions the strategy–performance relationship [36]. Together, these studies motivate attention to the combination of oversight, knowledge, and strategy through which boards engage with environmental activities. Independence, expertise, and diversity capture distinct aspects of that engagement.

Governance relationships also vary with the setting and outcome. Research on EU firms considers board characteristics and environmental performance [37], while Agnese et al. explicitly examine industry differences in the governance–environmental performance relationship [38]. Kim et al. study board independence in relation to greenhouse gas emissions intensity [15]. Haque finds associations between board independence and carbon reduction initiatives without a corresponding relationship between the examined governance variables and greenhouse gas emissions [39]. These distinctions reinforce the importance of specifying whether the outcome concerns an initiative, a financial resource, or realized environmental performance.

The related literature examines environmental communication. Cong and Freedman distinguish governance relationships with pollution disclosure from those with pollution performance [40]. Liao et al. study board independence, gender diversity, and environmental committees in greenhouse gas disclosure [41]; Ben-Amar and McIlkenny examine board effectiveness and voluntary climate-change disclosure [42]; and Ben-Amar et al. analyze board gender diversity and participation in climate disclosure [43]. These studies establish the relevance of boards to corporate reporting, while leaving open how the specificity of reported commitments relates to resource allocation. Walls et al. emphasize interactions among owners, managers, and directors in understanding environmental performance [44], consistent with calls for a more integrated and outcome-specific approach to environmental governance [13].

For general commitments, the monitoring role is particularly relevant because broad objectives leave management discretion over which activities are presented as contributing to them. Independent directors may question a project's environmental purpose, costs, and consistency with corporate priorities. Studies of environmental risk disclosure and reporting tone examine how governance relates to the information communicated by firms [45,46]. Extending this reporting perspective to allocation decisions, we propose that directors can scrutinize the information used to justify environmental projects. Stronger oversight may therefore constrain poorly justified discretionary expenditure when commitments remain vague. This argument concerns the evaluation of proposed activities.

Quantified objectives may provide more usable benchmarks for evaluating proposals. A stated target can help directors assess how an activity contributes to the objective, whether the resources requested are proportionate, and what information is needed to monitor progress. Combined with the board's advisory and resource-provision functions, these benchmarks may improve the alignment between environmental objectives and allocation decisions. Target specificity thus provides a basis for a more positive moderating relationship than under general commitments, without requiring board independence to increase expenditure under both categories.

H2. *The moderating relationship of board independence is more positive for quantified climate commitments than for general climate commitments.*

2.5. Conceptual Framework

Figure 1 summarizes the proposed relationships. Commitment categories distinguish the presence of a general corporate climate objective from greater specificity in that objective. Board independence conditions the relationship between commitment categories and environmental resource allocation. The hypotheses concern associations; the timing of report publication, outcome measurement, and the empirical comparison of categories are specified in Section 3.

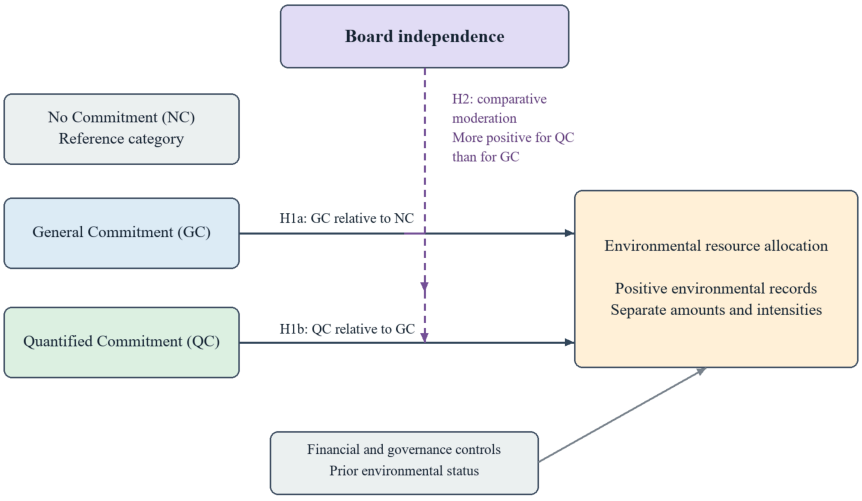


Figure 1. Conceptual framework. Notes: NC, GC, and QC denote No Commitment, General Commitment, and Quantified Commitment. Solid paths represent the proposed commitment–outcome associations. H1a compares GC with NC; H1b compares QC with GC. The dashed moderation path denotes H2, a more positive moderating relationship for QC than for GC. The outcome is examined through positive environmental records and separate amount and intensity measures; expenses are flows and capitalized assets are balances. Grey elements denote controls.

3. Research Design

3.1. Data Sources and Sample Construction

This study combines corporate-report texts with financial, governance, and environmental records to examine the relationship between climate commitments and environmental resource allocation among Chinese listed firms. The unit of analysis is the firm-year. Climate commitments are classified from reports covering year t, while board characteristics and control variables are measured for the same reporting year.

The initial archive contains 16,653 principal CSR, ESG, and sustainability reports covering reporting years 2010–2024. Reports are consolidated at the firm-year level to avoid duplicate observations. Financial and governance variables and environmental records originate from the China Stock Market and Accounting Research (CSMAR) database. The datasets are linked using six-digit stock codes and fiscal years. The matched climate-commitment panel contains 12,937 firm-year observations from 2268 firms for 2010–2023. Firm-years without available and readable report text remain unclassified rather than being assigned to No Commitment.

We distinguish the reporting period from the publication date. Reports in the local archive are matched to official CNINFO announcement metadata using stock code, report title, reporting period, and language. Dates embedded in filenames serve as matching clues rather than verified publication dates. The main timing sample requires a verified announcement date in calendar year t + 1 and excludes identified multi-period reports and nonannual documents. The date index records the announcement date, source link, and inclusion decision.

After applying the timing and variable-availability requirements, the main analytical sample contains 10,767 firm-year observations from 1864 firms. Reporting years range from 2010 to 2022, with environmental outcomes observed through 2023. Under the original commitment classification, the sample comprises 9942 No Commitment observations, 419 General Commitment observations, and 406 Quantified Commitment observations. The classification-sensitivity analysis retains these firm-year observations and applies the reconstructed classification described in Section 3.2.2. Of the reports included, 10,593, or 98.38%, were published in the first half of t + 1.

The commitment categories are unevenly represented: No Commitment accounts for 92.34% of observations, compared with 3.89% for General Commitment and 3.77% for Quantified Commitment. GC and QC observations are also concentrated in later reporting years and are sparsely represented in some industries (Appendix A, Tables A5 and A6). These relatively small groups may limit the precision of commitment comparisons and interaction estimates, particularly after sample restrictions. Results are therefore interpreted alongside the retained category counts and weighting diagnostics in Appendices C and E.

The primary outcome is measured in calendar year t + 1, the report's publication year. This specification examines annual associations surrounding publication; the outcome includes months preceding disclosure. The t + 2 analysis examines the first complete calendar year after publication. We compare the two horizons using identical firm–report-year observations and separately examine reports published by June 30 of t + 1. Leads and lags are assigned by calendar year, so gaps in the panel are not treated as consecutive observations.

Two environmental-data coverage conventions are examined. The full sample codes unmatched environmental records as zero, indicating the absence of a positive database record. The recorded sample requires original environmental-source coverage. Requiring coverage at t + 1 yields 4315 observations from 988 firms. Models additionally controlling for environmental status at t − 1 use 10,520 observations from 1810 firms under the full-sample convention and 3227 observations from 777 firms when source coverage is required at both

t + 1 and t − 1. Common-sample specifications separate changes associated with adding prior environmental status from those associated with sample restrictions. Appendix A documents sample construction and commitment distributions; additional estimation-specific restrictions are reported with the relevant results.

3.2. Variable Measurement

3.2.1. Environmental Outcomes

The primary outcome, denoted GI, is a binary indicator of a positive environmental expense or capitalized environmental asset record. It equals one when either component has a positive recorded amount in the relevant outcome year and zero otherwise under the full-sample coding convention.

Environmental expenses comprise environmental management and research expenses incurred during the year. Capitalized environmental assets comprise reported balances for environmental construction projects, fixed assets, and capitalized research and development expenditure. Expenses represent annual flows, whereas capitalized assets represent closing balances. Accordingly, GI measures the presence of a positive environmental record; it does not measure the initiation of a new project or the amount of new annual investment. Unmatched records coded zero do not establish that a firm's actual environmental expenditure or assets are zero.

We examine the components separately using EXP, an indicator of positive environmental expenses, and CAP, an indicator of a positive capitalized environmental asset balance. Binary classifications are based on monetary amounts rather than rounded intensity ratios. The combined indicator identifies a positive record in either component without adding expense flows to asset stocks.

Amount and intensity analyses assess whether the binary-outcome associations extend to the scale of recorded resources. These analyses use: (i) the natural logarithm of one plus the corresponding amount, measured in RMB yuan; (ii) environmental expenses divided by operating revenue and capitalized environmental asset balances divided by total assets; (iii) these intensity ratios after common winsorization; and (iv) the natural logarithm of the amount among strictly positive observations. Numerators and denominators are measured in the same outcome year. Appendix D provides the outcome-specific definitions and estimation samples.

Prior environmental status is measured at t − 1. Combined-outcome models use prior GI, while component and amount models use the corresponding prior EXP or CAP indicator. These variables capture persistence in positive environmental records and are binary indicators rather than lagged monetary amounts.

3.2.2. Climate-Commitment Specificity

The original climate-commitment classification follows a two-stage text protocol. Candidate passages are retrieved using expressions related to climate change, greenhouse gases, carbon emissions, carbon neutrality, carbon peaking, net zero, emissions-reduction targets, emissions scopes, and science-based targets. The retrieved text is then assessed against rules linking a firm-related subject to a forward-looking climate objective. National or regional policy targets, targets attributed solely to third parties, and historical emissions or achieved reductions qualify only when accompanied by a prospective commitment by the reporting firm.

The protocol assigns three mutually exclusive firm-year categories. No Commitment (NC) indicates that no qualifying commitment is identified in an available and readable report. General Commitment (GC) identifies a forward-looking corporate climate commitment without a qualifying quantitative attribute. Quantified Commitment (QC) identifies a commitment

with a verifiable attribute under the coding protocol, such as a target year, reduction percentage, baseline year, or quantified emissions boundary attached to the prospective objective. When several qualifying statements appear in a report, the firm-year receives the highest applicable category. NC is the regression reference category; the empirical comparisons distinguish GC relative to NC and QC relative to GC. Appendix A provides the retrieval expressions, classification criteria, illustrative passages, and category distributions.

A single-coder human audit evaluated the original stored classifications using a stratified random sample of 300 candidate passages associated with the main analytical sample, with 100 passages drawn from each original NC, GC, and QC stratum. One author independently assigned NC, GC, QC, or U (unresolved). The annotation workbook presented passages in randomized order and withheld the algorithm labels. Of the 259 resolved passages, 142 agreed with the original predictions, yielding agreement of 54.83% and Cohen's kappa of 0.323. Precision was 94.19% for NC, 22.09% for GC, and 48.28% for QC.

The initial audit informed the reconstruction of a classifier from the recovered report texts, addressing policy-target attribution, completed outcomes, and the attachment of quantitative attributes to corporate objectives. The reconstructed classifier was frozen as version CC-R2-candidate-20261019c before a separate evaluation sample was drawn. This sample contained 300 candidate text units from 273 reports in the main analytical sample, with 100 units sampled without replacement from each predicted category. Reports used in the initial human audit, the earlier AI-assisted review, or classifier development were excluded. Algorithm labels were withheld. The same author independently determined the categories before using AI solely to help organize the wording of the reasons. The first-pass category decisions were preserved for evaluation.

The separate evaluation yielded 290 resolved units and 10 unresolved units. Human–algorithm agreement was 69.66% (202/290), with Cohen's kappa of 0.545. Precision for NC, GC, and QC was 91.75%, 51.02%, and 66.32%, respectively; recall was 54.94%, 80.65%, and 95.45%. These unweighted estimates describe agreement among resolved units in the stratified audit samples. Appendix A reports the confusion matrices, sampling procedures, sampling-design-weighted estimates, and treatment of unresolved cases. The audits evaluate retrieved text units; full-report retrieval recall and final firm-year classification accuracy were not assessed. Results are reported separately because the two audits concern different classification procedures and sampling frames. The earlier AI-assisted review and subsequent assisted contextual checks are documented separately in Appendix A.

3.2.3. Board Independence

Board independence is initially measured as the percentage of independent directors on the board. All baseline and moderation regressions use the standardized variable:

$$BI^{z}_{it} = \left(BI^{pct}_{it} - 37.729839\right)/5.940123 \quad (1)$$

The reference mean and standard deviation are retained from the original standardization sample and held fixed across the analytical samples. They are not recalculated within coverage groups, timing subsamples, or heterogeneity groups. Thus, $BI^{z} = 0$ represents the reference mean, while $BI^{z} = 1$ represents an increase of 5.940123 percentage points in the proportion of independent directors.

Both GC × BI^{z} and QC × BI^{z} enter the moderation model. The descriptive statistics report the underlying percentage measure, while regression tables use the standardized measure. This distinction preserves interpretability without changing the scale across model comparisons.

3.2.4. Control Variables

The financial controls are firm size, leverage, return on assets, operating cash flow, revenue growth, and the fixed-asset ratio. Governance controls include board size, CEO–chair duality, largest-shareholder ownership, and firm age. Their definitions are summarized in Table 1.

Table 1. Variable definitions and measurement.

Role	Variable	Symbol	Definition and Measurement
Primary outcome	Combined positive environmental-record indicator	GI at t + 1	Equals one when recorded environmental expenses or capitalized environmental asset balances are positive at t + 1. Unmatched environmental records are coded zero in the full sample.
Alternative horizon	Combined indicator at t + 2	GI at t + 2	Corresponding binary indicator in the first complete calendar year after publication within the verified timing sample.
Component outcome	Positive environmental expense record	EXP	Equals one when annual environmental management or research expenses are positive.
Component outcome	Positive capitalized environmental asset record	CAP	Equals one when a positive balance is recorded for environmental construction projects, fixed assets, or capitalized research and development expenditure.
Amount outcomes	Log-transformed expenses and asset balances	$\ln(1 + A)$; $\ln(A)$	A is the corresponding amount in RMB yuan. The first specification retains zeros; the second uses strictly positive amounts.
Intensity outcomes	Expense and capitalized asset intensities	Expense intensity; capital intensity	Expenses divided by operating revenue; capitalized environmental asset balances divided by total assets. Both components of each ratio are measured at the outcome date.
Prior outcome	Prior positive environmental status	GI, EXP, or CAP at t − 1	Corresponding binary environmental-record indicator at t − 1.
Reference category	No Commitment	NC	No qualifying firm-level climate commitment is identified in an available and readable report.
Explanatory variable	General Commitment	GC	A qualifying forward-looking corporate climate commitment without a quantitative attribute under the classification protocol.
Explanatory variable	Quantified Commitment	QC	A qualifying forward-looking corporate climate commitment with a quantitative attribute under the classification protocol.
Moderator	Board independence	BI^z	Percentage of independent directors standardized using the fixed reference values in Equation (1).
Interaction	General Commitment × board independence	GC × BI^z	Product of GC and standardized board independence.
Interaction	Quantified Commitment × board independence	QC × BI^z	Product of QC and standardized board independence.
Control	Firm size	SIZE	Natural logarithm of total assets.
Control	Leverage	LEV	Total liabilities divided by total assets.
Control	Return on assets	ROA	CSMAR return-on-assets measure, using the ROAB field retained in the source control dataset.
Control	Operating cash flow	CFO	Net cash flow from operating activities divided by total assets.
Control	Revenue growth	GROWTH	Annual growth rate of operating revenue.
Control	Fixed-asset ratio	FIXED	Fixed assets divided by total assets.
Control	Board size	BOARD	Natural logarithm of the number of directors.
Control	CEO–chair duality	DUAL	Equals one when the chief executive officer also serves as board chair, and zero otherwise.

Table 1. *Cont.*

Role	Variable	Symbol	Definition and Measurement
Control	Largest-shareholder ownership	TOP1	Shares held by the largest shareholder divided by total shares, expressed as a fraction.
Control	Firm age	AGE	Natural logarithm of the reporting year minus the establishment year plus one.
Grouping variable	State ownership	SOE	State-owned enterprise indicator from the source control dataset.
Grouping variable	Heavily polluting industry	Polluting	Industry membership under the baseline source-data classification; the industry-code list is reported in Appendix F.

Notes: Commitment categories, BI, and controls are measured at t; environmental outcomes are measured at the stated horizon. NC, GC, and QC are mutually exclusive. Expense amounts are annual flows, and capitalized asset amounts are closing balances. Full and recorded samples follow Section 3.1. The financial controls retain the common winsorization treatment described above.

SIZE, LEV, ROA, CFO, GROWTH, and FIXED are winsorized at common first- and ninety-ninth-percentile thresholds calculated from a fixed reference sample of 9082 observations eligible for the t + 2 comparison before publication-date exclusions. The same thresholds are applied across all specifications. BI, binary variables, and the remaining governance controls receive no additional winsorization in this analysis.

The intensity outcomes in Appendix D use their own first- and ninety-ninth-percentile thresholds calculated from the same reference sample. Both unadjusted and winsorized intensity results are reported. This treatment keeps the reference cutoffs constant when estimation samples change.

3.3. Empirical Models

3.3.1. Baseline Model

The baseline specification relates climate-commitment categories to the probability of a positive environmental record:

$$GI_{i,t+1} = \alpha + \beta G\, GC_{it} + \beta Q\, QC_{it} + \theta\, BI^{z}_{it} + \rho\, GI_{i,t-1} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where i indexes firms and t indexes reporting years. X contains the financial and governance controls, μ_i denotes firm fixed effects, and λ_t denotes reporting-year fixed effects. Models are estimated as linear probability models, with standard errors clustered by firm.

The specification includes standardized board independence in both baseline and moderation analyses. Models without prior GI are also reported. On the sample with prior status available, the model is estimated both with and without GI at t − 1, allowing the contribution of the prior-status control to be assessed while holding observations constant.

With NC as the reference category, βG tests H1a. H1b is assessed using the formal contrast βQ − βG. A positive, statistically significant contrast is consistent with a stronger association for quantified commitments. Comparing whether the two coefficients are individually significant does not test this difference.

Linear probability coefficients are expressed in probability units; multiplying by 100 gives percentage-point differences. Firm fixed effects absorb time-invariant firm characteristics, while year effects capture common annual conditions. These controls and the prior-status indicator do not eliminate unobserved time-varying confounding, so estimates are interpreted as conditional associations.

3.3.2. Moderation Model

The moderation specification adds both commitment–board independence interactions:

$$\begin{aligned} GI_{i,t+1} = \alpha + \beta G\, GC_{it} + \beta Q\, QC_{it} + \theta\, BI^{z}{}_{it} \\ +\delta G(GC_{it} \times BI^{z}{}_{it}) + \delta Q(QC_{it} \times BI^{z}{}_{it}) \\ +\rho GI_{i,t-1} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned} \quad (3)$$

H2 concerns comparative moderation and is evaluated by:

$$H_0 : \delta Q - \delta G = 0 \quad (4)$$

A positive and statistically significant difference is consistent with a more positive moderating association for QC than for GC. This test does not require the individual QC × BI^z coefficient to be significantly positive.

At a given standardized board-independence value b, the conditional difference between QC and GC is:

$$\Delta(b) = (\beta Q - \beta G) + b(\delta Q - \delta G) \quad (5)$$

We report this contrast at b = −1, 0, and 1, using the joint coefficient covariance matrix to calculate standard errors. Figure 2 presents the conditional QC − GC difference and its pointwise 95% confidence interval over this range. In moderation models, the GC and QC coefficients describe comparisons with NC at the fixed reference mean of board independence.

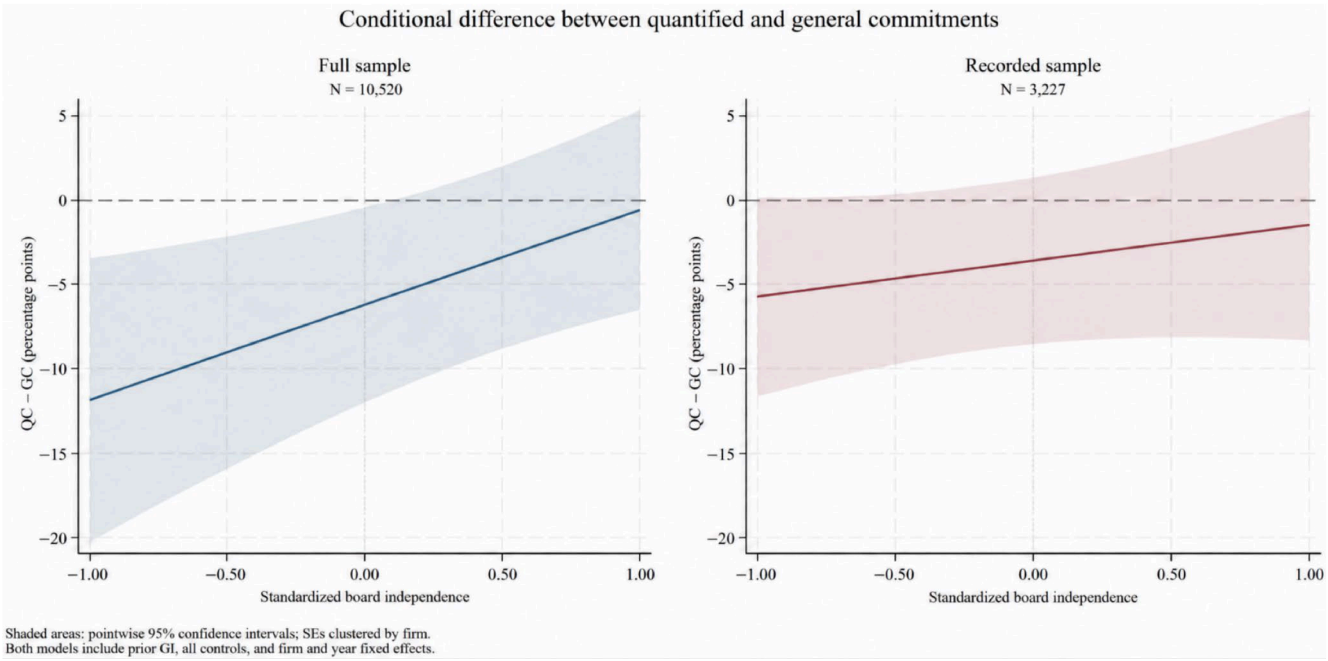


Figure 2. Conditional difference between quantified and general commitments across board independence. Notes: Solid lines show the estimated difference in the probability of a positive environmental expenditure or asset record at t + 1 between Quantified Commitment and General Commitment (QC–GC), expressed in percentage points. The full sample retains the convention of coding unmatched environmental records as zero; the recorded sample requires original environmental records at both t + 1 and t − 1. Both specifications include prior GI at t − 1, the full set of controls, and firm and year fixed effects. Shaded areas represent pointwise 95% confidence intervals based on firm-clustered standard errors. BI follows the fixed standardization defined in Section 3.2.3. The horizontal dashed line indicates no difference between QC and GC.

3.3.3. Multinomial Propensity-Score Weighting

Multinomial inverse-probability weighting examines sensitivity to observable differences across commitment categories. Propensity models are estimated separately for the full and recorded prior-status samples.

Let $D_{it} \in \{0, 1, 2\}$ denote NC, GC, and QC. A multinomial logit model estimates:

$$\hat{p}_{it}d = P\hat{r}\left(D_{it} = d \mid BI^{z}{}_{it}, X_{it}, GI_{i,t-1}, \text{year indicators}\right) \quad (6)$$

For an observation in category d, the stabilized weight is:

$$w_{it} = P\hat{r}(D = d)/\hat{p}_{it}d \quad (7)$$

where the numerator is the category's observed share in the corresponding estimation sample.

Weighted outcome models retain prior GI, the financial and governance controls, and firm and year fixed effects. Results are reported using both original stabilized weights and weights capped at the first and ninety-ninth percentiles within each estimation sample. Capping changes extreme weights without deleting observations.

Appendix C reports pairwise covariate balance, weight concentration, effective sample sizes, and capping rates. These diagnostics assess the comparability achieved by weighting. The approach addresses measured differences among commitment groups but does not recover unobserved environmental outcomes or remove selection on unmeasured time-varying characteristics.

3.3.4. Supplementary Analyses

Several supplementary analyses assess the scope and sensitivity of the findings. Separate expense and capitalized asset models distinguish the components of the combined binary indicator. Amount, intensity, and positive-amount models examine whether associations extend to the scale of recorded environmental resources. Conditional fixed-effects Logit models provide an alternative binary-outcome estimator. Because Logit retains firms with within-firm outcome variation, corresponding LPM models are re-estimated on exactly the Logit samples. Logit coefficients and interaction contrasts are interpreted on the log-odds scale.

Ownership and pollution-industry comparisons use joint models with group-specific slopes and firm-by-group and year-by-group fixed effects. Formal contrasts test differences between groups. Additional models replace common year effects with industry-by-year or province-by-year effects; each is accompanied by an original-specification estimate using the same retained observations.

Publication-centered event analyses examine outcomes around the first observed commitment publication. Events require a preceding report classified as NC, a verified publication date, and a balanced five-year outcome window. Comparisons use firms with no observed commitment in the report archive, with event year −1 as the reference period. These analyses report treatment-group support, pre-publication coefficients, and positive-record rates to assess pre-existing activity and possible ceiling effects.

(Classification sensitivity is assessed by re-estimating the six specifications for each outcome using the frozen reconstructed commitment categories.) Within each specification, the comparison holds the estimation sample, outcome definition, controls, fixed effects, board-independence standardization, and clustering procedure constant. The analysis compares the GC coefficient, the QC–GC contrast, and the difference between the QC and GC interaction coefficients. Section 4.9 summarizes the results, and Appendix I reports the estimates for both classification versions. The supplementary analyses in Appendices B–H retain the original classification.

All hypothesis and contrast tests are two-sided. Reported significance levels are unadjusted for multiple comparisons. The supplementary analyses are assessed for consistency across outcomes and samples, with detailed specifications and diagnostics provided in Appendices B–H.

4. Empirical Results

4.1. Descriptive Statistics

Table 2 reports descriptive statistics for the main t + 1 estimation sample, which contains 10,767 firm-year observations from 1864 Chinese listed firms. Commitment reporting years span 2010–2022, and the corresponding outcomes cover 2011–2023. The combined indicator of recorded environmental expenditure or assets (GI) has a mean of 0.3586. Positive environmental expenses (EXP) and positive closing capitalized environmental asset balances (CAP) are recorded for 15.97% and 26.17% of observations, respectively. The two component indicators can overlap within a firm-year.

No Commitment accounts for 92.34% of observations, while General Commitment and Quantified Commitment account for 3.89% and 3.77%, respectively. These categories are mutually exclusive and collectively exhaustive. Board Independence averages 37.73%, with a standard deviation of 5.94 percentage points and a median of 36.36%. Table 2 presents Board Independence in its original percentage units; the regressions use the standardized measure defined in Section 3.2.3.

Table 2. Descriptive statistics.

Variable	N	Mean	SD	Min	Median	Max
GI	10,767	0.3586	0.4796	0.0000	0.0000	1.0000
EXP	10,767	0.1597	0.3664	0.0000	0.0000	1.0000
CAP	10,767	0.2617	0.4396	0.0000	0.0000	1.0000
NC	10,767	0.9234	0.2660	0.0000	1.0000	1.0000
GC	10,767	0.0389	0.1934	0.0000	0.0000	1.0000
QC	10,767	0.0377	0.1905	0.0000	0.0000	1.0000
BI (%)	10,767	37.7272	5.9416	14.2900	36.3600	80.0000
SIZE	10,767	23.1915	1.4389	20.4475	23.0551	27.0793
LEV	10,767	0.4741	0.1971	0.0674	0.4859	0.8783
ROA	10,767	0.0473	0.0591	−0.1514	0.0401	0.2398
CFO	10,767	0.0558	0.0668	−0.1364	0.0533	0.2455
GROWTH	10,767	0.1554	0.3203	−0.4706	0.1077	1.7367
FIXED	10,767	0.2244	0.1764	0.0021	0.1821	0.7467
BOARD	10,767	2.1729	0.2074	1.3863	2.1972	2.8904
DUAL	10,767	0.2068	0.4051	0.0000	0.0000	1.0000
TOP1	10,767	0.3670	0.1610	0.0300	0.3539	0.8999
AGE	10,767	2.9747	0.3467	0.0000	2.9957	4.2905

Notes: Column (1). GI, EXP and CAP are measured at t + 1; commitments, Board Independence and controls are measured at t. GI equals one when EXP or CAP equals one. EXP denotes positive annual environmental expenses, whereas CAP denotes positive closing capitalized environmental asset balances. Unmatched environmental records are coded zero in this full-sample specification. NC, GC and QC denote No, General and Quantified Commitment. SIZE, LEV, ROA, CFO, GROWTH and FIXED retain the common 1st and 99th percentile cutoffs calculated from the 9082-observation reference sample described in Section 3.2.4. Board Independence is shown as a percentage and retains the fixed standardization reference for regression analysis. The remaining variable definitions follow Table 1.

The six continuous financial controls use the common winsorization cutoffs described in Section 3.2.4. Their mean values are 23.1915 for Firm Size, 0.4741 for Leverage, 0.0473 for Return on Assets, 0.0558 for Cash Flow, 0.1554 for Growth and 0.2244 for the Fixed-Asset Ratio. Table 2 also reports the distributions of the governance controls.

The full sample contains 3861 observations with positive original environmental amounts, 454 with original records showing zero in all five amount fields, and 6452 without a matched original environmental record. The latter group is coded zero under the convention in Section 3.2.1.

4.2. Correlation Analysis and Multicollinearity Diagnostics

Table 3 reports Pearson correlations and variance inflation factors (VIFs) for the 10,767 firm-year observations in the main t + 1 sample. General Commitment is positively correlated with the combined indicator of recorded environmental expenditure or assets ($r = 0.057$, $p < 0.001$). Quantified Commitment also has a positive correlation with this outcome ($r = 0.024$, $p = 0.0135$). General and Quantified Commitments are negatively correlated ($r = -0.040$, $p < 0.001$), consistent with their mutually exclusive classification. Board Independence is negatively correlated with the outcome ($r = -0.054$, $p < 0.001$) and weakly positively correlated with General Commitment ($r = 0.018$, $p = 0.0652$) and Quantified Commitment ($r = 0.019$, $p = 0.0442$). These are descriptive bivariate relationships; the hypotheses are evaluated using the subsequent fixed-effects regressions with standard errors clustered by firm.

Among the explanatory variables, the largest absolute pairwise correlation is between Firm Size and Leverage ($r = 0.525$), followed by Return on Assets and Cash Flow ($r = 0.484$) and Board Independence and Board Size ($r = -0.438$). In the pooled baseline diagnostic, VIFs range from 1.02 to 1.82, with a mean of 1.33. Return on Assets has the highest VIF of 1.82, followed by Leverage at 1.78 and Firm Size at 1.72.

We also assess collinearity after removing firm and year fixed effects from each variable. In the baseline specification, these within-model VIFs range from 1.01 to 1.46, with a mean of 1.15. Adding both commitment–board independence interactions leaves the maximum VIF at 1.46 and gives a mean VIF of 1.14. The VIFs for the General Commitment and Quantified Commitment interaction terms are 1.02 and 1.05, respectively. These diagnostics provide no indication of severe multicollinearity among the included regressors in either the baseline or moderation specification.

Table 3. Correlation matrix and variance inflation factors.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	VIF Pooled Baseline	VIF Within Baseline	VIF Within Moderation
1. GI	1.000														—	—	—
2. GC	0.057 ***	1.000													1.02	1.03	1.04
3. QC	0.024 **	−0.040 ***	1.000												1.04	1.03	1.05
4. BI	−0.054 ***	0.018 *	0.019 **	1.000											1.32	1.27	1.30
5. SIZE	0.064 ***	0.115 ***	0.145 ***	0.112 ***	1.000										1.72	1.18	1.18
6. LEV	0.061 ***	0.033 ***	0.023 **	0.047 ***	0.525 ***	1.000									1.78	1.35	1.35
7. ROA	−0.025 **	0.011	0.043 ***	−0.013	−0.069 ***	−0.411 ***	1.000								1.82	1.46	1.46
8. CFO	0.015	0.027 ***	0.054 ***	0.002	0.032 ***	−0.221 ***	0.484 ***	1.000							1.50	1.14	1.14
9. GROWTH	0.041 ***	0.028 ***	0.048 ***	−0.006	0.026 ***	0.022 **	0.284 ***	0.065 ***	1.000						1.14	1.14	1.14
10. FIXED	0.181 ***	0.024 **	0.007	−0.056 ***	0.090 ***	0.038 ***	−0.098 ***	0.239 ***	−0.048 ***	1.000					1.20	1.04	1.04
11. BOARD	0.057 ***	0.015	−0.001	−0.438 ***	0.205 ***	0.100 ***	−0.016 *	0.026 ***	−0.010	0.185 ***	1.000				1.40	1.29	1.29
12. DUAL	−0.049 ***	0.018 *	0.024 **	0.085 ***	−0.134 ***	−0.119 ***	0.091 ***	0.029 ***	0.054 ***	−0.102 ***	−0.168 ***	1.000			1.07	1.01	1.01
13. TOP1	0.035 ***	0.023 **	0.001	0.066 ***	0.242 ***	0.087 ***	0.060 ***	0.075 ***	−0.029 ***	0.113 ***	0.035 ***	−0.112 ***	1.000		1.15	1.02	1.02
14. AGE	0.042 ***	0.059 ***	0.065 ***	−0.061 ***	0.122 ***	0.114 ***	−0.099 ***	0.018 *	−0.088 ***	−0.051 ***	0.015	−0.040 ***	−0.179 ***	1.000	1.11	1.02	1.02
GC × BI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.02
QC × BI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.05
Mean VIF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.33	1.15	1.14

Notes: The lower triangle reports Pearson correlations for 10,767 firm-year observations from 1864 firms. *, ** and *** denote conventional two-sided, unadjusted $p < 0.10$, $p < 0.05$ and $p < 0.01$, respectively; correlation p values do not account for clustering within firms. Pooled baseline VIFs use the original regressors. Within VIFs use regressors residualized jointly on firm and year fixed effects. The moderation diagnostic includes both interactions, constructed before residualization. Blank cells omit the upper triangle; dashes denote entries not reported or not applicable. GI denotes the combined recorded environmental expenditure or assets indicator at t + 1, with unmatched records coded zero. Explanatory variables are measured at t. GC = General Commitment; QC = Quantified Commitment; BI = standardized Board Independence; SIZE = Firm Size; LEV = Leverage; ROA = Return on Assets; CFO = Cash Flow; GROWTH = revenue growth; FIXED = Fixed-Asset Ratio; BOARD = Board Size; DUAL = CEO–Chair Duality; TOP1 = Largest-Shareholder Ownership; AGE = Firm Age. NC is the omitted commitment category. Financial controls retain the common winsorization cutoffs described in Section 3.2.4.

4.3. Baseline Regression Results

Table 4 examines the association between climate commitments in year t and the combined indicator of recorded environmental expenditure or assets in year t + 1. All specifications include the full set of financial and governance controls, firm fixed effects, and year fixed effects, with standard errors clustered by firm. No Commitment (NC) is the reference category. Columns (1)–(3) use the full sample under the zero-coding convention defined in Section 3.2.1, while Columns (4)–(6) restrict the analysis to observations with original environmental records. Within each sample definition, we compare specifications with and without prior GI on identical observations to distinguish changes in sample composition from changes associated with including the prior outcome.

In Column (1), General Commitment (GC) is positively associated with GI at t + 1 ($\beta = 0.0592$, $p = 0.0208$). The estimate corresponds to a 5.92-percentage-point higher probability of a positive environmental expenditure or asset record relative to NC. Restricting the sample to observations with prior GI available yields a coefficient of 0.0673 ($p = 0.0098$) in Column (2). Adding GI at t − 1 on the same observations gives a GC coefficient of 0.0594 ($p = 0.0144$) in Column (3).

The recorded-sample comparisons qualify the strength of this evidence. The GC coefficient is 0.0553 ($p = 0.0075$) in Column (4). Requiring original environmental records at both t + 1 and t − 1 reduces the sample from 4315 to 3227 observations and the coefficient to 0.0354 ($p = 0.0517$) in Column (5). Including prior GI on these same observations leaves the estimate almost unchanged ($\beta = 0.0354$, $p = 0.0519$) in Column (6). The attenuation therefore occurs with the sample restriction, while adding the prior outcome produces little further change. These more restrictive estimates remain positive and significant at the 10% level, but not at the 5% level.

Quantified Commitment (QC) is not statistically distinguishable from NC in any of the six specifications. H1b concerns whether the QC coefficient exceeds the GC coefficient. The formal QC − GC contrast is negative in all six columns, equaling −0.0545 ($p = 0.0710$) in Column (1), −0.0550 ($p = 0.0578$) in Column (3), and −0.0346 ($p = 0.1800$) in Column (6). These estimates provide no support for H1b. Under the original classification, the evidence is consistent with H1a, with weaker statistical support in the sample requiring both current and prior environmental records. Section 4.4 examines comparative moderation by board independence, and Section 4.9 evaluates the sensitivity of the core findings to commitment classification.

Prior environmental status improves model fit in the full sample. Comparing Columns (2) and (3) of Table 4, which use the same 10,520 observations, adding GI at t − 1 increases within R^2 from 0.0198 to 0.0463. In the recorded sample, Columns (5) and (6) use the same 3227 observations, and within R^2 remains approximately 0.0250. Prior environmental status therefore contributes additional explanatory power in the full sample, with little improvement in the recorded sample. The models nevertheless explain a limited share of within-firm variation in positive environmental records. The estimated commitment coefficients describe conditional associations within this specification, while much of the variation in firms' recorded environmental resources remains unexplained.

Table 4. Climate commitments and subsequent recorded environmental expenditure or assets.

Variable	(1) Full	(2) Full, Prior Available	(3) Full, with Prior GI	(4) Recorded	(5) Recorded, Prior Available	(6) Recorded, with Prior GI
GC	0.0592 ** (0.0256)	0.0673 *** (0.0260)	0.0594 ** (0.0242)	0.0553 *** (0.0206)	0.0354 * (0.0182)	0.0354 * (0.0182)
QC	0.0048 (0.0210)	0.0013 (0.0213)	0.0044 (0.0198)	−0.0096 (0.0255)	0.0011 (0.0243)	0.0009 (0.0241)
BI	0.0002 (0.0078)	0.0005 (0.0079)	0.0020 (0.0074)	−0.0018 (0.0097)	−0.0009 (0.0117)	−0.0010 (0.0117)
SIZE	0.0499 ** (0.0215)	0.0481 ** (0.0218)	0.0350 * (0.0197)	0.0149 (0.0181)	0.0101 (0.0214)	0.0102 (0.0215)
LEV	−0.1422 * (0.0754)	−0.1394 * (0.0762)	−0.1337 * (0.0685)	−0.0410 (0.0897)	0.0012 (0.0984)	0.0021 (0.0983)
ROA	−0.0770 (0.1178)	−0.0755 (0.1194)	−0.0774 (0.1127)	0.0844 (0.1478)	0.2135 (0.1656)	0.2148 (0.1649)
CFO	−0.1433 * (0.0735)	−0.1615 ** (0.0738)	−0.1323 * (0.0730)	0.0658 (0.1081)	−0.0516 (0.1124)	−0.0521 (0.1119)
GROWTH	0.0338 *** (0.0128)	0.0340 *** (0.0128)	0.0375 *** (0.0127)	0.0363 * (0.0191)	0.0161 (0.0194)	0.0160 (0.0195)
FIXED	0.1108 (0.0916)	0.1172 (0.0929)	0.1008 (0.0855)	−0.0550 (0.0724)	−0.1027 (0.0810)	−0.1032 (0.0808)
BOARD	0.0418 (0.0569)	0.0398 (0.0574)	0.0387 (0.0518)	0.0826 (0.0533)	0.1118 * (0.0582)	0.1119 * (0.0582)
DUAL	0.0387 ** (0.0181)	0.0399 ** (0.0183)	0.0337 * (0.0176)	0.0246 (0.0206)	0.0162 (0.0188)	0.0165 (0.0189)
TOP1	0.0809 (0.1087)	0.0828 (0.1097)	0.0633 (0.1006)	0.0859 (0.0993)	0.0842 (0.1058)	0.0838 (0.1060)
AGE	0.1058 (0.0846)	0.1152 (0.0964)	0.1071 (0.0878)	0.3024 ** (0.1221)	0.3682 ** (0.1498)	0.3702 ** (0.1477)
GI at t − 1	—	—	0.1640 *** (0.0172)	—	—	−0.0061 (0.0362)
Constant	−1.2087 ** (0.5367)	−1.1925 ** (0.5604)	−0.8883 * (0.5066)	−0.3570 (0.5298)	−0.4749 (0.6539)	−0.4766 (0.6546)
QC − GC	−0.0545 * (0.0301)	−0.0660 ** (0.0308)	−0.0550 * (0.0290)	−0.0649 ** (0.0289)	−0.0344 (0.0259)	−0.0346 (0.0258)
p-value: GC = 0	0.0208	0.0098	0.0144	0.0075	0.0517	0.0519
p-value: QC − GC = 0	0.0710	0.0322	0.0578	0.0249	0.1858	0.1800
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0194	0.0198	0.0463	0.0208	0.0250	0.0250

Notes: The dependent variable is GI at t + 1, the combined indicator of recorded environmental expenditure or assets. All columns report firm and year fixed-effects linear probability models, with firm-clustered standard errors in parentheses. NC is the reference commitment category. Explanatory variables are measured at t, except prior GI, which is measured at t − 1. Columns (1)–(3) retain the full-sample convention of coding unmatched environmental records as zero; such zeros indicate no positive database record rather than verified zero investment. Column (4) requires an original environmental record at t + 1. Columns (2) and (3) use identical observations with prior GI available. Columns (5) and (6) use identical observations with original environmental records at both t + 1 and t − 1. Prior GI is included only in Columns (3) and (6). BI uses the fixed standardization in Section 3.2.3, and financial controls retain the common winsorization cutoffs in Section 3.2.4. QC − GC reports the estimated coefficient difference and its standard error. All *p*-values are two-sided; *, ** and *** indicate $p < 0.10$, $p < 0.05$ and $p < 0.01$. A dash denotes a regressor not included. Coefficients for individual year indicators are omitted from the table.

4.4. Moderating Role of Board Independence

Table 5 examines whether board independence moderates the association between climate-commitment type and subsequent recorded environmental expenditure or assets. Each specification includes GC × BI and QC × BI, the full set of financial and governance controls, and firm and year fixed effects. Standard errors are clustered by firm. The six columns retain the corresponding estimation samples from Table 4, with prior GI included in Columns (3) and (6). No Commitment (NC) is the reference category. H2 is assessed through the difference between the two interaction coefficients, QC × BI − GC × BI. A positive difference indicates that the association of QC relative to GC becomes more favorable as board independence increases.

Under the original classification, the full-sample interaction differences are positive and statistically significant. The interaction difference is 0.0593 ($p = 0.0085$) in Column (1) and 0.0616 ($p = 0.0079$) in Column (2). After including prior GI on the same observations, it remains positive and significant at 0.0564 ($p = 0.0121$) in Column (3). A one-unit increase in standardized BI therefore corresponds to a 5.64-percentage-point increase in the QC–GC probability difference in this specification. The GC × BI coefficient is negative and signifi-

cant ($\beta = -0.0399$, $p = 0.0164$), whereas QC × BI is positive but statistically insignificant ($\beta = 0.0165$, $p = 0.3694$).

The conditional contrasts clarify the substantive meaning of this result. In Column (3), QC is associated with an 11.86-percentage-point lower probability of a positive environmental expenditure or asset record than GC at BI = −1 ($p = 0.0056$). The difference narrows to −6.22 percentage points at BI = 0 ($p = 0.0344$) and −0.59 percentage points at BI = +1 ($p = 0.8461$). These values refer to the fixed BI standardization defined in Section 3.2.3. Thus, the negative QC–GC difference narrows as board independence increases, with no statistically detectable difference at BI = +1.

The recorded-sample estimates provide weaker evidence of moderation. The interaction difference is 0.0163 ($p = 0.5658$) in Column (4), 0.0213 ($p = 0.3005$) in Column (5), and 0.0213 ($p = 0.3010$) in Column (6). Adding prior GI on the same observations in Columns (5) and (6) leaves the estimate almost unchanged. Under the original classification, the full-sample interaction contrast is consistent with H2, whereas the recorded-sample estimates are statistically insignificant. Section 4.9 examines whether the comparative moderation result also holds under the reconstructed classification.

Figure 2 plots the conditional QC–GC difference across standardized BI values from −1 to +1, using Columns (3) and (6) of Table 5. In the full sample, the estimated difference rises toward zero, with the pointwise 95% confidence intervals excluding zero at BI = −1 and BI = 0 but including zero at BI = +1. The recorded-sample estimates also slope upward, although the formal interaction difference is statistically insignificant. The figure illustrates the narrowing QC–GC gap in the full sample and the weaker evidence of comparative moderation in the recorded sample.

Supplementary analyses distinguish environmental expenses from capitalized environmental asset balances (Appendix B, Tables A11 and A12). General Commitment is positively associated with the asset-record indicator in both sample definitions, whereas its association with the expense indicator is statistically insignificant. The comparative moderation found for the combined indicator is less consistently evident in the component models: the interaction difference reaches the 10% significance level only in the full-sample expense specification. These results indicate that the findings vary across outcome definitions and should not be generalized uniformly to both environmental expenses and asset balances.

The amount and intensity analyses in Appendix D (Tables A15–A18) qualify the interpretation of the binary-outcome results. General Commitment is positively associated with log-transformed capitalized environmental asset balances when zeros are included in the full sample, but negatively associated with log balances among positive-balance observations under both sample definitions. Its association with the ratio of capitalized environmental assets to total assets is also negative in the recorded sample, both before and after winsorization. Expense-based estimates show no statistically significant positive GC association in the baseline specifications. These results distinguish the presence of a positive environmental record from its scale: support for H1a is concentrated in the binary outcome and does not extend consistently to expenditure amounts or asset intensity. The amount and intensity analyses provide no support for H1b and limited evidence for H2. Comparisons across these specifications also reflect differences in outcomes and estimation samples.

Conditional fixed-effects Logit estimates preserve the positive GC association in the full sample, as does an LPM estimated on the same retained observations (Appendix E, Tables A19 and A20). The comparative moderation contrast remains positive but reaches only the 10% significance level in both models. In the recorded sample, the GC association and comparative moderation are statistically insignificant under both estimators after the sample restriction. These comparisons support the full-sample binary GC finding across

estimators, while showing that the moderation evidence and recorded-sample results remain sensitive to sample composition.

Ownership and pollution-industry comparisons provide no statistically significant between-group differences in the GC association, the QC − GC contrast, or comparative moderation (Appendix F, Tables A21–A23). Although some subgroup estimates are significant, direct tests do not establish that the relationships differ between SOEs and non-SOEs or between heavily polluting and other industries. This finding holds under both the full and recorded sample definitions.

Table 5. Moderating role of board independence.

Variable or Contrast	(1) Full	(2) Full, Prior Available	(3) Full, with Prior GI	(4) Recorded	(5) Recorded, Prior Available	(6) Recorded, with Prior GI
GC	0.0637 ** (0.0260)	0.0720 *** (0.0265)	0.0635 ** (0.0247)	0.0550 *** (0.0205)	0.0358 ** (0.0181)	0.0358 ** (0.0182)
QC	0.0021 (0.0209)	−0.0018 (0.0213)	0.0013 (0.0197)	−0.0108 (0.0246)	−0.0001 (0.0236)	−0.0003 (0.0235)
BI	0.0006 (0.0079)	0.0010 (0.0080)	0.0023 (0.0074)	−0.0018 (0.0099)	−0.0007 (0.0120)	−0.0007 (0.0120)
GC × BI	−0.0429 ** (0.0168)	−0.0460 *** (0.0178)	−0.0399 ** (0.0166)	−0.0095 (0.0178)	−0.0160 (0.0153)	−0.0160 (0.0153)
QC × BI	0.0164 (0.0189)	0.0156 (0.0193)	0.0165 (0.0184)	0.0068 (0.0241)	0.0053 (0.0177)	0.0053 (0.0176)
SIZE	0.0499 ** (0.0215)	0.0480 ** (0.0218)	0.0351 * (0.0198)	0.0152 (0.0182)	0.0103 (0.0215)	0.0104 (0.0216)
LEV	−0.1449 * (0.0752)	−0.1417 * (0.0760)	−0.1360 ** (0.0684)	−0.0426 (0.0901)	0.0000 (0.0987)	0.0009 (0.0985)
ROA	−0.0812 (0.1178)	−0.0785 (0.1194)	−0.0804 (0.1127)	0.0823 (0.1482)	0.2123 (0.1659)	0.2136 (0.1652)
CFO	−0.1431 * (0.0734)	−0.1611 ** (0.0737)	−0.1322 * (0.0730)	0.0661 (0.1083)	−0.0502 (0.1126)	−0.0507 (0.1121)
GROWTH	0.0338 *** (0.0128)	0.0338 *** (0.0128)	0.0374 *** (0.0127)	0.0362 * (0.0190)	0.0162 (0.0195)	0.0160 (0.0195)
FIXED	0.1108 (0.0916)	0.1172 (0.0929)	0.1009 (0.0855)	−0.0546 (0.0726)	−0.1033 (0.0817)	−0.1038 (0.0815)
BOARD	0.0416 (0.0568)	0.0396 (0.0572)	0.0385 (0.0517)	0.0826 (0.0533)	0.1121 * (0.0582)	0.1122 * (0.0582)
DUAL	0.0388 ** (0.0181)	0.0398 ** (0.0183)	0.0337 * (0.0176)	0.0246 (0.0206)	0.0163 (0.0188)	0.0165 (0.0189)
TOP1	0.0825 (0.1087)	0.0845 (0.1096)	0.0649 (0.1006)	0.0850 (0.0993)	0.0825 (0.1060)	0.0822 (0.1061)
AGE	0.1089 (0.0845)	0.1192 (0.0963)	0.1105 (0.0878)	0.3019 ** (0.1219)	0.3682 ** (0.1499)	0.3702 ** (0.1478)
GI at t − 1	—	—	0.1636 *** (0.0172)	—	—	−0.0061 (0.0362)
Constant	−1.2154 ** (0.5369)	−1.2008 ** (0.5606)	−0.8977 * (0.5071)	−0.3613 (0.5319)	−0.4791 (0.6558)	−0.4807 (0.6566)
QC × BI − GC × BI	0.0593 *** (0.0225)	0.0616 *** (0.0232)	0.0564 ** (0.0224)	0.0163 (0.0284)	0.0213 (0.0206)	0.0213 (0.0205)
p-value: interaction difference = 0	0.0085	0.0079	0.0121	0.5658	0.3005	0.3010
QC − GC at BI = −1	−0.1208 *** (0.0438)	−0.1354 *** (0.0453)	−0.1186 *** (0.0428)	−0.0822 ** (0.0407)	−0.0572 * (0.0301)	−0.0574 * (0.0300)
QC − GC at BI = 0	−0.0615 ** (0.0306)	−0.0738 ** (0.0313)	−0.0622 ** (0.0294)	−0.0658 ** (0.0282)	−0.0359 (0.0253)	−0.0361 (0.0251)
QC − GC at BI = +1	−0.0022 (0.0311)	−0.0122 (0.0314)	−0.0059 (0.0302)	−0.0495 (0.0394)	−0.0146 (0.0349)	−0.0148 (0.0348)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0202	0.0206	0.0469	0.0209	0.0251	0.0252

Notes: The dependent variable is GI at t + 1, the combined indicator of recorded environmental expenditure or assets. All specifications are firm and year fixed-effects linear probability models, with firm-clustered standard errors in parentheses. NC is the reference category. The six estimation samples are identical to the corresponding columns of Table 4. Columns (1)–(3) retain the convention of coding unmatched environmental records as zero, indicating no positive database record rather than verified zero investment. Column (4) requires an original environmental record at t + 1. Columns (2) and (3) use identical observations with prior GI available; Columns (5) and (6) use identical observations with original records at both t + 1 and t − 1. Prior GI is included only in Columns (3) and (6). Other explanatory variables are measured at t. BI uses the fixed reference mean and standard deviation defined in Section 3.2.3; BI = −1, 0 and +1 refer to this scale. GC and QC coefficients therefore describe comparisons with NC at BI = 0. The interaction difference is the formal test of H2; the three conditional contrasts report QC − GC at the specified BI levels. Financial controls retain the common winsorization cutoffs in Section 3.2.4. All *p*-values are two-sided. *, ** and *** denote $p < 0.10$, $p < 0.05$ and $p < 0.01$. A dash indicates an excluded regressor. Individual year coefficients are omitted.

4.5. Addressing Observable Selection Through Propensity-Score Weighting

Climate-commitment categories may differ systematically in observable financial characteristics, governance structures, and prior environmental activities. We therefore estimate propensity-score-weighted models as a sensitivity analysis. Within each sample definition, a multinomial logit model predicts membership in the NC, GC, and QC categories using board independence, the full set of financial and governance controls, prior GI at t − 1, and year indicators. Stabilized weights are calculated as the sample proportion of the observed commitment category divided by its predicted probability. We report estimates using both the original weights and weights capped at the first and ninety-ninth percentiles within each estimation sample. Capping changes the weights without removing observations.

Table 6 compares unweighted and weighted estimates on identical observations. Columns (1)–(3) use the full sample of 10,520 firm-year observations from 1810 firms, while Columns (4)–(6) use the recorded sample of 3227 observations from 777 firms. All outcome models include both commitment–board independence interactions, prior GI, the full set of controls, and firm and year fixed effects. Standard errors are clustered by firm. The same absorbed fixed-effects estimator is used for all six specifications to maintain a consistent comparison across weighting schemes.

The full-sample estimates retain a positive interaction-coefficient difference. The QC × BI − GC × BI contrast is 0.0564 ($p = 0.0224$) in the unweighted specification, 0.0815 ($p = 0.0678$) with the original stabilized weights, and 0.0804 ($p = 0.0419$) with capped weights. The weighted estimates therefore remain consistent with the direction predicted by H2, although their statistical significance varies with the weighting scheme. At BI = 0, the QC–GC contrast remains negative and statistically insignificant in both weighted specifications.

The recorded-sample results provide weaker evidence of comparative moderation. The interaction difference is 0.0213 ($p = 0.3680$) without weighting, 0.0333 ($p = 0.2445$) with the original weights, and 0.0354 ($p = 0.2281$) with capped weights. Thus, weighting does not yield statistically significant support for H2 in this sample.

Appendix C reports covariate-balance and weight diagnostics. Weighting reduces average imbalance, but substantial differences remain, particularly in the distribution of observation years. Capping reduces weight concentration and increases effective sample sizes, while affecting a larger proportion of GC and QC observations than the overall capping rate suggests. The weighted regressions consequently provide qualified sensitivity evidence for the full-sample moderation result rather than establishing that observable selection has been fully addressed. Reported standard errors treat the estimated weights as fixed and do not incorporate uncertainty from propensity-score estimation.

Stabilized weights are estimated separately within each sample using a multinomial logit model containing BI, all financial and governance controls, prior GI, and year indicators. Columns (2) and (5) use the original stabilized weights. Columns (3) and (6) cap these weights at their sample-specific first and ninety-ninth percentiles without deleting observations. The lower and upper cutoffs are 0.157900 and 2.049697 for the full sample, and 0.156553 and 2.297535 for the recorded sample. Appendix C reports balance and weight diagnostics.

BI follows the fixed standardization in Section 3.2.3, and financial controls retain the common winsorization cutoffs in Section 3.2.4. GC, QC and QC − GC are evaluated at BI = 0. QC × BI − GC × BI is the formal interaction-coefficient contrast for H2. The unweighted point estimates match the corresponding models in Table 5; standard errors differ because areg and xtreg apply different finite-sample adjustments to the clustered covariance estimator. Reported standard errors treat estimated weights as fixed. All p-values are two-sided; *, ** and *** denote $p < 0.10$, $p < 0.05$ and $p < 0.01$. Individual year coefficients are omitted.

Table 6. Propensity-score-weighted estimates of comparative moderation.

Variable	(1) Full: Unweighted	(2) Full: Original Weights	(3) Full: Capped Weights	(4) Recorded: Unweighted	(5) Recorded: Original Weights	(6) Recorded: Capped Weights
GC	0.0635 ** (0.0272)	0.0548 (0.0384)	0.0588 * (0.0353)	0.0358 * (0.0209)	0.0359 * (0.0211)	0.0364 * (0.0220)
QC	0.0013 (0.0217)	0.0195 (0.0412)	0.0080 (0.0292)	−0.0003 (0.0270)	0.0168 (0.0227)	0.0162 (0.0234)
BI	0.0023 (0.0082)	0.0041 (0.0083)	0.0040 (0.0083)	−0.0007 (0.0137)	−0.0021 (0.0139)	−0.0027 (0.0139)
GC × BI	−0.0399 ** (0.0182)	−0.0680 ** (0.0316)	−0.0581 ** (0.0281)	−0.0160 (0.0175)	−0.0255 (0.0224)	−0.0275 (0.0231)
QC × BI	0.0165 (0.0202)	0.0135 (0.0326)	0.0223 (0.0290)	0.0053 (0.0203)	0.0078 (0.0209)	0.0079 (0.0211)
SIZE	0.0351 (0.0217)	0.0389 * (0.0224)	0.0360 (0.0220)	0.0104 (0.0248)	0.0151 (0.0245)	0.0145 (0.0246)
LEV	−0.1360 * (0.0751)	−0.1507 * (0.0783)	−0.1367 * (0.0752)	0.0009 (0.1132)	−0.0090 (0.1108)	−0.0098 (0.1116)
ROA	−0.0804 (0.1239)	−0.1297 (0.1316)	−0.0957 (0.1272)	0.2136 (0.1898)	0.2020 (0.1927)	0.2016 (0.1936)
CFO	−0.1322 * (0.0802)	−0.1550 * (0.0822)	−0.1634 ** (0.0818)	−0.0507 (0.1288)	−0.0821 (0.1331)	−0.0838 (0.1332)
GROWTH	0.0374 *** (0.0139)	0.0434 *** (0.0144)	0.0393 *** (0.0140)	0.0160 (0.0224)	0.0154 (0.0225)	0.0157 (0.0226)
FIXED	0.1009 (0.0940)	0.0695 (0.0988)	0.0861 (0.0967)	−0.1038 (0.0936)	−0.0854 (0.0932)	−0.0869 (0.0934)
BOARD	0.0385 (0.0568)	0.0436 (0.0561)	0.0436 (0.0559)	0.1122 * (0.0669)	0.1044 (0.0639)	0.1040 (0.0641)
DUAL	0.0337 * (0.0193)	0.0337 * (0.0191)	0.0321 * (0.0190)	0.0165 (0.0217)	0.0128 (0.0224)	0.0128 (0.0225)
TOP1	0.0649 (0.1106)	0.0410 (0.1098)	0.0472 (0.1099)	0.0822 (0.1220)	0.0736 (0.1208)	0.0705 (0.1207)
AGE	0.1105 (0.0965)	0.0975 (0.1011)	0.1125 (0.0998)	0.3702 ** (0.1699)	0.3776 ** (0.1734)	0.3948 ** (0.1717)
GI at t − 1	0.1636 *** (0.0189)	0.1568 *** (0.0193)	0.1596 *** (0.0192)	−0.0061 (0.0416)	−0.0046 (0.0410)	−0.0033 (0.0410)
Constant	−0.8977 (0.5574)	−0.9383 (0.5736)	−0.9223 (0.5666)	−0.4807 (0.7545)	−0.5837 (0.7577)	−0.6143 (0.7576)
QC–GC at BI = 0	−0.0622 * (0.0323)	−0.0353 (0.0595)	−0.0508 (0.0473)	−0.0361 (0.0289)	−0.0191 (0.0282)	−0.0202 (0.0290)
QC × BI − GC × BI	0.0564 ** (0.0247)	0.0815 * (0.0446)	0.0804 ** (0.0395)	0.0213 (0.0236)	0.0333 (0.0286)	0.0354 (0.0294)
p-value: QC − GC = 0	0.0543	0.5524	0.2828	0.2119	0.4974	0.4862
p-value: interaction difference = 0	0.0224	0.0678	0.0419	0.3680	0.2445	0.2281
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,520	10,520	10,520	3227	3227	3227
Firms	1810	1810	1810	777	777	777

Notes: The dependent variable is GI at t + 1, the combined indicator of recorded environmental expenditure or assets. All columns report linear probability models estimated using the areg command in Stata 17, absorbing firm fixed effects and including year indicators. Firm-clustered standard errors are reported in parentheses. NC is the reference commitment category. Columns (1)–(3) use identical full-sample observations, retaining zero coding for unmatched environmental records. Columns (4)–(6) use identical recorded-sample observations, requiring original environmental records at both t + 1 and t − 1. All models include prior GI at t − 1; other explanatory variables are measured at t. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

4.6. Sensitivity to Disclosure Timing and Outcome Horizon

The timing of report publication affects the interpretation of the commitment–outcome association. In the verified timing sample, reports relating to year t are published during t + 1. Consequently, the annual outcome measured at t + 1 can include activity occurring before publication. We examine this issue through two complementary analyses. First, we restrict the t + 1 analysis to reports published by June 30 of t + 1. Second, we compare t + 1 and t + 2 outcomes using identical firm-year observations with both outcomes available. In this setting, t + 2 is the first complete calendar year following publication. The first restriction limits the pre-publication portion of the outcome year, while the second evaluates the association over a fully subsequent calendar year.

Table 7 reports the baseline estimates by disclosure timing and outcome horizon. Table 8 reports the corresponding estimates of the moderating role of board independence. In both tables, columns (1)–(3) present the full-sample results for first-half publication at t + 1, the paired sample at t + 1, and the same paired sample at t + 2, respectively. Columns (4)–(6) present the corresponding recorded-sample results. The full paired sample contains 9054 observations from 1489 firms. The recorded paired sample contains 3229 observations from 763 firms and requires original environmental records at both outcome horizons. All specifications include the financial and governance controls and firm and year fixed effects,

with standard errors clustered by firm. Prior GI is omitted consistently across these timing specifications; the prior-outcome comparisons are reported separately in Tables 4 and 5.

Restricting the analysis to first-half publication preserves the positive association between General Commitment and the t + 1 outcome. In Table 7, the GC coefficient is 0.0633 ($p = 0.0157$) in the full sample and 0.0564 ($p = 0.0070$) in the recorded sample. The QC–GC contrasts are negative in both samples: −0.0624 ($p = 0.0437$) and −0.0624 ($p = 0.0329$), respectively. These estimates support H1a within the first-half publication samples but do not support the positive contrast predicted by H1b.

Table 7. Baseline estimates by disclosure timing and outcome horizon.

Variable	(1) Full: First-Half t + 1	(2) Full: Paired t + 1	(3) Full: Paired t + 2	(4) Recorded: First-Half t + 1	(5) Recorded: Paired t + 1	(6) Recorded: Paired t + 2
GC	0.0633 ** (0.0262)	0.0451 (0.0348)	0.0358 (0.0332)	0.0564 *** (0.0209)	−0.0104 (0.0161)	0.0494 (0.0321)
QC	0.0010 (0.0214)	−0.0054 (0.0280)	0.0372 (0.0264)	−0.0060 (0.0256)	−0.0133 (0.0159)	0.0549 *** (0.0206)
BI	0.0004 (0.0079)	−0.0019 (0.0081)	0.0047 (0.0082)	−0.0017 (0.0098)	−0.0033 (0.0073)	−0.0050 (0.0108)
SIZE	0.0535 ** (0.0215)	0.0552 ** (0.0231)	0.0280 (0.0224)	0.0173 (0.0184)	−0.0012 (0.0134)	0.0012 (0.0213)
LEV	−0.1454 * (0.0756)	−0.1666 ** (0.0827)	−0.1655 ** (0.0751)	−0.0406 (0.0901)	0.1054 (0.0853)	0.1179 (0.0918)
ROA	−0.0777 (0.1197)	−0.0571 (0.1308)	−0.0738 (0.1180)	0.0966 (0.1500)	0.0867 (0.1280)	0.2672 (0.1842)
CFO	−0.1462 ** (0.0744)	−0.1183 (0.0813)	−0.0169 (0.0825)	0.0561 (0.1103)	0.0619 (0.0868)	0.3050 ** (0.1228)
GROWTH	0.0337 *** (0.0129)	0.0317 ** (0.0140)	0.0164 (0.0122)	0.0364 * (0.0193)	0.0173 (0.0140)	−0.0226 (0.0189)
FIXED	0.1067 (0.0929)	0.1184 (0.0956)	0.1944 ** (0.0906)	−0.0481 (0.0734)	−0.0142 (0.0439)	0.0073 (0.0797)
BOARD	0.0407 (0.0574)	0.0355 (0.0619)	0.0782 (0.0582)	0.0820 (0.0535)	0.0272 (0.0425)	0.0065 (0.0694)
DUAL	0.0401 ** (0.0182)	0.0356 * (0.0191)	0.0248 (0.0198)	0.0246 (0.0207)	−0.0014 (0.0143)	0.0169 (0.0241)
TOP1	0.0859 (0.1092)	0.0574 (0.1145)	0.1098 (0.1170)	0.0798 (0.0997)	−0.1166 (0.0950)	0.0203 (0.1270)
AGE	0.1104 (0.0846)	0.1016 (0.0897)	0.1314 (0.0879)	0.3004 ** (0.1223)	0.2233 * (0.1184)	0.2303 (0.1427)
Constant	−1.2984 ** (0.5349)	−1.2906 ** (0.5724)	−0.8456 (0.5576)	−0.4067 (0.5372)	0.3458 (0.4940)	0.2233 (0.6394)
QC − GC	−0.0624 ** (0.0309)	−0.0505 (0.0416)	0.0014 (0.0361)	−0.0624 ** (0.0292)	−0.0029 (0.0194)	0.0055 (0.0313)
p-value: GC = 0	0.0157	0.1948	0.2812	0.0070	0.5191	0.1238
p-value: QC − GC = 0	0.0437	0.2245	0.9690	0.0329	0.8800	0.8612
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,593	9054	9054	4254	3229	3229
Firms	1799	1489	1489	967	763	763
Within R^2	0.0199	0.0205	0.0167	0.0205	0.0126	0.0198
Report years (t)	2010–2022	2010–2021	2010–2021	2010–2022	2010–2021	2010–2021

Notes: The dependent variable is the combined indicator of positive recorded environmental expenditure or assets at the horizon specified in each column. All specifications are firm and year fixed-effects linear probability models, with firm-clustered standard errors in parentheses. NC is the reference commitment category. Explanatory variables are measured at t. Prior GI is omitted consistently across these timing specifications. "First-half" restricts the sample to reports with verified publication dates on or before June 30 of t + 1. "Paired" requires both t + 1 and t + 2 outcomes to be available. Columns (2) and (3) use identical observations, as do Columns (5) and (6). The full sample retains zero coding for unmatched environmental records. The recorded first-half sample requires an original environmental record at t + 1; the recorded paired sample requires original records at both t + 1 and t + 2. Reports in these samples were published during t + 1, making t + 2 the first complete calendar year after publication. The first-half restriction does not exclude all pre-publication activity from the annual t + 1 outcome. BI standardization and financial winsorization follow Sections 3.2.3 and 3.2.4. QC − GC reports the estimated coefficient difference and its standard error. All *p*-values are two-sided; *, ** and *** denote $p < 0.10$, $p < 0.05$ and $p < 0.01$. Individual year coefficients are omitted.

Table 8. Comparative moderation by disclosure timing and outcome horizon.

Variable	(1) Full: First-Half t + 1	(2) Full: Paired t + 1	(3) Full: Paired t + 2	(4) Recorded: First-Half t + 1	(5) Recorded: Paired t + 1	(6) Recorded: Paired t + 2
GC	0.0676 ** (0.0266)	0.0504 (0.0350)	0.0420 (0.0328)	0.0560 *** (0.0207)	−0.0098 (0.0161)	0.0460 (0.0315)
QC	−0.0016 (0.0213)	−0.0043 (0.0282)	0.0377 (0.0261)	−0.0087 (0.0249)	−0.0123 (0.0152)	0.0533 *** (0.0204)
BI	0.0007 (0.0080)	−0.0002 (0.0081)	0.0065 (0.0083)	−0.0021 (0.0100)	−0.0032 (0.0075)	−0.0045 (0.0111)
GC × BI	−0.0424 ** (0.0172)	−0.0660 ** (0.0258)	−0.0765 *** (0.0276)	−0.0085 (0.0179)	0.0076 (0.0098)	−0.0502 (0.0394)
QC × BI	0.0169 (0.0196)	−0.0176 (0.0220)	−0.0150 (0.0225)	0.0156 (0.0224)	−0.0072 (0.0099)	0.0043 (0.0164)
SIZE	0.0536 ** (0.0215)	0.0544 ** (0.0231)	0.0271 (0.0224)	0.0180 (0.0185)	−0.0015 (0.0135)	0.0011 (0.0214)
LEV	−0.1480 * (0.0754)	−0.1661 ** (0.0824)	−0.1653 ** (0.0747)	−0.0435 (0.0906)	0.1067 (0.0855)	0.1133 (0.0922)
ROA	−0.0812 (0.1196)	−0.0531 (0.1308)	−0.0698 (0.1180)	0.0912 (0.1503)	0.0878 (0.1282)	0.2689 (0.1847)
CFO	−0.1455 * (0.0743)	−0.1171 (0.0812)	−0.0158 (0.0826)	0.0556 (0.1104)	0.0629 (0.0869)	0.3029 ** (0.1228)
GROWTH	0.0337 *** (0.0129)	0.0317 ** (0.0140)	0.0164 (0.0122)	0.0362 * (0.0192)	0.0173 (0.0140)	−0.0224 (0.0189)
FIXED	0.1066 (0.0929)	0.1159 (0.0955)	0.1915 ** (0.0905)	−0.0471 (0.0735)	−0.0148 (0.0441)	0.0064 (0.0798)
BOARD	0.0402 (0.0573)	0.0355 (0.0617)	0.0783 (0.0582)	0.0820 (0.0535)	0.0273 (0.0425)	0.0049 (0.0690)
DUAL	0.0402 ** (0.0182)	0.0354 * (0.0191)	0.0246 (0.0197)	0.0248 (0.0207)	−0.0013 (0.0144)	0.0162 (0.0240)
TOP1	0.0876 (0.1091)	0.0585 (0.1143)	0.1113 (0.1167)	0.0790 (0.0997)	−0.1161 (0.0951)	0.0169 (0.1270)
AGE	0.1135 (0.0846)	0.1057 (0.0896)	0.1362 (0.0877)	0.3005 ** (0.1221)	0.2220 * (0.1182)	0.2364 * (0.1425)
Constant	−1.3059 ** (0.5352)	−1.2828 ** (0.5728)	−0.8389 (0.5580)	−0.4197 (0.5393)	0.3539 (0.4964)	0.2178 (0.6413)
QC − GC	−0.0692 ** (0.0314)	−0.0547 (0.0421)	−0.0042 (0.0361)	−0.0647 ** (0.0287)	−0.0025 (0.0189)	0.0073 (0.0307)
QC × BI − GC × BI	0.0594 ** (0.0231)	0.0484 (0.0306)	0.0615 ** (0.0297)	0.0241 (0.0274)	−0.0148 (0.0126)	0.0545 (0.0396)
p-value: GC = 0	0.0112	0.1500	0.2003	0.0071	0.5448	0.1452
p-value: QC − GC = 0	0.0274	0.1937	0.9065	0.0245	0.8932	0.8119
p-value: interaction difference = 0	0.0102	0.1134	0.0386	0.3807	0.2396	0.1684
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,593	9054	9054	4254	3229	3229
Firms	1799	1489	1489	967	763	763
Within R^2	0.0206	0.0215	0.0180	0.0206	0.0126	0.0205
Report years (t)	2010–2022	2010–2021	2010–2021	2010–2022	2010–2021	2010–2021

Notes: The dependent variable is the combined indicator of positive recorded environmental expenditure or assets at the horizon specified in each column. All specifications are firm and year fixed-effects linear probability models, with firm-clustered standard errors in parentheses. NC is the reference commitment category. All explanatory variables and interaction terms are measured at t. Prior GI is omitted consistently across these specifications. "First-half" restricts the sample to reports published by June 30 of t + 1. "Paired" requires both t + 1 and t + 2 outcomes to be available. Columns (2) and (3) use identical observations, as do Columns (5) and (6). Full-sample models retain zero coding for unmatched environmental records. Recorded-sample models require original records at t + 1 for the first-half analysis and at both t + 1 and t + 2 for the paired analysis. All included reports were published during t + 1. BI follows the fixed standardization in Section 3.2.3, and financial controls retain the common winsorization cutoffs in Section 3.2.4. GC, QC and QC − GC are evaluated at BI = 0. QC × BI − GC × BI is the formal interaction-coefficient contrast for H2. All *p*-values are two-sided; *, ** and *** denote $p < 0.10$, $p < 0.05$ and $p < 0.01$. Separate significance tests across columns do not constitute a formal test of coefficient differences between horizons. Individual year coefficients are omitted.

The matched-horizon comparison provides weaker evidence for H1a. In the full paired sample, the baseline GC coefficient is 0.0451 ($p = 0.1948$) at t + 1 and 0.0358 ($p = 0.2812$) at t + 2. In the recorded paired sample, the corresponding coefficients are −0.0104 ($p = 0.5191$) and 0.0494 ($p = 0.1238$). Because the GC association is already statistically insignificant at t + 1 after restricting the sample, its loss of significance relative to the main analysis cannot be attributed solely to extending the outcome horizon. At t + 2, QC is positively associated with the outcome relative to NC in the recorded sample ($\beta = 0.0549$, $p = 0.0079$), but the QC–GC contrast remains insignificant ($\beta = 0.0055$, $p = 0.8612$). This result does not establish the relative advantage predicted by H1b.

4.7. Commitment Transitions and Publication-Centered Dynamics

Within the main sample, 433 firms exhibit variation in commitment categories, including 421 that switch categories between consecutive calendar years. Publication-centered event analyses use verified dates of first observed commitments and balanced five-year outcome windows (Appendix G, Tables A24–A28). In the full event sample, post-publication coefficients are statistically insignificant at the 5% level across the combined, expense, and capitalized asset indicators.

The recorded event cohorts contain only seven GC firms and eleven QC firms. All have positive combined environmental records throughout the event window. Their positive relative coefficients at event year +2 reflect declining control-group record rates, rather than increased participation among treated firms. Pre-publication evidence is also limited: only one non-reference pre-period is available, and the recorded capitalized asset estimates show a negative pre-period difference at the 10% level. These diagnostics identify limitations of the binary outcome and event sample rather than establish a causal effect of publication.

4.8. Alternative Fixed Effects and Sample Comparisons

The full-sample findings persist after accounting for industry-by-year and province-by-year conditions (Appendix H, Tables A29–A33). The baseline GC coefficients remain positive and significant, while the comparative moderation contrasts are 0.0509 ($p = 0.0286$) and 0.0625 ($p = 0.0077$), respectively. Re-estimating the original specification on the same retained observations produces consistent full-sample findings.

Recorded-sample estimates remain less stable. The GC association weakens under province-by-year effects, and comparative moderation is insignificant under both alternative fixed-effect structures. Sample reductions are traced to missing identifiers and singleton removal, with common-sample comparisons reported separately. These comparisons assess sensitivity to fixed-effect specifications and sample coverage while holding the original commitment classification fixed. The next section examines sensitivity to the classification procedure.

4.9. Sensitivity to Commitment Classification

The frozen reconstructed classifier changes 946 of the 10,767 firm-year labels in the main analytical sample, yielding 9850 NC, 595 GC, and 322 QC observations. Appendix I compares the six specifications in each of Tables 4 and 5 under the original and reconstructed classifications. Each comparison retains the same observations, outcome definition, controls, fixed effects, board-independence standardization, and clustering procedure.

For the baseline specification corresponding to Table 4, Column (3), the GC coefficient changes from 0.0594 ($p = 0.0144$) under the original classification to 0.0010 ($p = 0.9602$) under the reconstructed classification. The QC − GC contrast changes from −0.0550 ($p = 0.0578$) to −0.0243 ($p = 0.3648$). For the moderation specification corresponding to Table 5, Column (3), the interaction difference changes from 0.0564 ($p = 0.0121$) to 0.0297 ($p = 0.2359$). Each of these Column (3) models uses 10,520 observations from 1810 firms. Under the reconstructed classification, the baseline GC coefficient and the comparative moderation contrast are statistically insignificant at the 10% level across all six corresponding specifications.

The statistical support for H1a and H2 therefore depends on the commitment classification. The human audit also identifies disagreement in the reconstructed GC and QC categories, so the alternative estimates serve as a measurement-sensitivity comparison rather than a corrected benchmark. Taken together, the two sets of estimates provide limited evidence of a stable GC association or comparative moderating relationship across classification procedures.

5. Discussion

The following discussion interprets the results obtained with the original commitment classification. As reported in Section 4.9 and Appendix I, the GC association and comparative moderation contrast are statistically insignificant when the core models use the reconstructed classification.

5.1. General Commitments and the Presence Versus Scale of Environmental Resources

The positive GC association in the main binary-outcome models concerns the presence of environmental records. General commitments may reflect managerial attention to climate issues or an organizational orientation also associated with environmental activities. Carbon-related information can enter accounting practices and capital-investment decisions [11], providing a basis for examining these statements alongside recorded environmental resources.

The monetary analyses narrow this interpretation. GC is positively associated with log-transformed capitalized environmental asset balances when zeros are included in the full sample, but negatively associated with log balances among positive-balance observations under both coverage conventions. Its association with capitalized asset intensity is also negative in the recorded sample. Baseline expense-based analyses provide no statistically significant positive GC association. These findings distinguish the presence of recorded resources from their monetary size and intensity.

Models that include zeros and models restricted to positive balances address different comparisons and use different samples. Capitalized environmental assets are closing balances, whereas environmental expenses are annual flows. A positive asset balance may therefore reflect resources accumulated before the commitment was disclosed. Project-level evidence would help determine how these patterns relate to the timing, scale, and composition of environmental activities.

Environmental-data coverage also shapes the comparison. In the full sample, an unmatched record is coded zero, indicating the absence of a positive database record rather than verified zero environmental activity. Restricting the analysis to source-covered observations changes both coverage and sample composition. Differences between these estimates therefore reflect sensitivity to the observation of environmental resources and the firms retained.

5.2. Commitment Specificity and the Timing of Resource Allocation

The results provide no consistent evidence that quantified commitments are associated with greater environmental resource allocation than general commitments. Quantified commitments may be associated with changes in the scale of environmental resource allocation even when the presence of a positive environmental record remains unchanged. Some binary-outcome contrasts are negative, while the baseline amount and intensity analyses show no statistically significant QC–GC difference. This financial-resource comparison is distinct from an assessment of the overall effectiveness of quantified and general climate strategies.

Specific objectives provide benchmarks whose use depends on how they enter organizational decisions. Research on corporate climate targets links target characteristics to environmental performance [4], while Bolay et al. identify associations between target progress and characteristics such as target type, time horizon, ambition, and climate-linked remuneration [5]. Evidence of lower emissions among SBTi participants also indicates that externally supported target-setting arrangements can accompany environmental improvements [6]. These studies examine target characteristics, implementation arrangements, and environmental outcomes. The present analysis focuses on statements in corporate reports

and their association with environmental expenses and asset balances. Evidence concerning validated targets and emissions therefore addresses a different relationship from the QC comparison examined here.

The temporal distance between long-term objectives and annual resource decisions offers one possible interpretation. Targets extending to 2030 or 2050 may involve staged implementation, operational adjustments, or resources committed before disclosure. The main t + 1 outcome covers the publication year, including months preceding publication, while t + 2 captures the first complete calendar year afterwards. The timing analyses indicate that the evidence varies with both the observation horizon and the observations retained. They leave unresolved whether target horizons explain the weaker QC association or whether additional expenditure occurs beyond the periods observed.

Partial integration of specific statements into organizational practice offers another interpretation, consistent with institutional decoupling [18]. Limited accountability for missed targets [1] and evidence concerning climate-related cheap talk [2] make this possibility relevant. Assessing this explanation requires direct evidence of implementation and target fulfillment alongside financial resource records, including information on the use of existing resources and other operational channels.

5.3. Board Independence and Comparative Oversight

The main full-sample moderation pattern is comparative: a negative GC interaction coexists with an individually insignificant QC interaction. The QC–GC difference becomes more favorable to QC as board independence increases, with weaker evidence in the source-covered sample. The result therefore concerns the relationship between the two commitment categories, rather than a statistically significant strengthening of the QC association considered alone.

Monitoring offers a possible interpretation. General commitments provide fewer explicit benchmarks for evaluating whether proposed environmental activities are necessary, appropriately scaled, or aligned with the firm's objectives. Independent scrutiny may demand stronger project justification or constrain discretionary expenditure. Quantified commitments provide more specific benchmarks that may help directors assess plans and request progress information. Under this interpretation, board oversight concerns the alignment and justification of environmental activities, with potentially different relationships across commitment categories.

Resource provision offers a complementary interpretation. Directors' expertise and external connections can support the evaluation of environmental activities [14]. Asad et al. link board environmental expertise to stakeholder orientation and environmental performance [34], suggesting that relevant knowledge can help translate environmental priorities into organizational decisions. Environmental expertise and independence are distinct board attributes. The present models assess independence and leave the relative roles of monitoring and advisory support unresolved. Evidence on project approvals and directors' interventions would be needed to assess whether either channel improves implementation or curbs greenwashing.

The outcome examined also matters. Haque reports associations between board independence and carbon reduction initiatives without a corresponding relationship between the examined governance variables and greenhouse gas emissions [39]. Cong and Freedman distinguish governance relationships with pollution disclosure from those with pollution performance [40]. These studies indicate that governance relationships vary across reporting, organizational activities, and environmental outcomes. The distinction between the presence and scale of recorded environmental resources provides a related perspective on environmental governance [13].

6. Conclusions and Implications

6.1. Conclusions

This study examines how the specificity of corporate climate commitments relates to environmental resource allocation and whether board independence conditions these relationships. Distinguishing No Commitment, General Commitment, and Quantified Commitment allows commitment adoption and target specificity to be examined separately.

Under the original classification, General Commitment is positively associated with positive environmental records in the main full-sample models. This association does not extend consistently to greater expenditure, larger asset balances, or higher resource intensity. Quantified Commitment shows no consistently stronger association than General Commitment. Greater board independence is associated with a more favorable QC–GC contrast in the full sample, with weaker evidence in the source-covered sample.

In the core comparisons, the GC association and comparative moderation contrast are statistically insignificant under the alternative reconstructed classification (Appendix I), indicating sensitivity to commitment measurement. The study connects climate-target research with environmental accounting records by distinguishing stated objectives from the presence and scale of recorded resources. These distinctions provide a basis for examining how climate commitments relate to observable corporate activity while accounting for differences in measurement and data coverage.

6.2. Implications

For firms and boards, climate objectives can be linked to implementation plans that specify responsibilities, interim milestones, expected resource requirements, and the contribution of proposed activities to the objective. Resource plans can distinguish the use of existing assets from new expenditure. Board scrutiny can assess the alignment between objectives, proposed activities, financial justification, and expected environmental contributions, placing the quality of resource allocation alongside its scale.

For investors and other stakeholders, commitment assessment can combine information about the stated objective with evidence of implementation. A target year or numerical attribute describes the objective, while expenditure, asset balances, progress disclosures, and emissions data capture different aspects of corporate activity. Considering these measures together provides a fuller basis for assessing the connection between climate commitments and implementation.

For policymakers and standard setters, clearer links between targets, implementation plans, and progress reporting could improve the interpretability of corporate climate disclosures. Consistent reporting of environmental operating expenses, new capital expenditure, and asset balances would help distinguish current spending from accumulated resources. Explicit coverage statements, including whether an unreported item represents zero activity or missing information, would also improve comparisons across firms and over time.

6.3. Limitations and Future Research

The human audits identify classification disagreement and rely on one author's judgments of retrieved candidate texts. Their scope leaves full-report retrieval recall and final firm-year classification accuracy unassessed. Further work could combine additional human coders with full-report contextual coding and examine commitments disclosed through other channels. Incorporating target ambition, interim milestones, emissions boundaries, and external validation would also help distinguish target specificity from credibility.

Environmental-data coverage also affects interpretation. Unmatched database records do not establish the absence of environmental activity, and restricting the analysis to source-covered observations changes sample composition. The binary outcome does not capture

changes in monetary amounts among firms with positive records, a margin through which quantified commitments may operate. Capitalized environmental asset balances measure accumulated stocks, whereas environmental expenses measure annual flows. Project-level information on expenditure, asset additions and retirements, completion dates, and environmental outcomes would help clarify how recorded resources relate to implementation and performance.

Annual observations limit the precision of the timing analysis. For reports covering year t and published in t + 1, the main t + 1 outcome includes activity occurring before publication, whereas t + 2 captures the first complete calendar year afterwards. These windows leave the sequence of individual commitment and resource-allocation decisions unresolved. The models also explain a limited share of within-firm variation in environmental records. Time-varying project schedules and environmental priorities may jointly influence commitments and resource allocation, leaving potential confounding after controls and fixed effects. Project dates, higher-frequency expenditure data, and credible sources of exogenous variation could strengthen temporal and causal identification. Information on directors' environmental expertise, committee participation, and actual interventions would further help distinguish monitoring from advice and resource provision.

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Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Definition
AI	Artificial intelligence
BI	Board independence
CAP	Positive capitalized environmental asset-record indicator
CFO	Cash flow
CSR	Corporate social responsibility
ESG	Environmental, social, and governance
ESS	Effective sample size
EXP	Positive environmental expense-record indicator
GC	General commitment
GHG	Greenhouse gas
GI	Combined positive environmental expense or asset-record indicator

IPW	Inverse probability weighting
LPM	Linear probability model
NC	No commitment
QC	Quantified commitment
RMB	Renminbi
ROA	Return on assets
SBTi	Science Based Targets initiative
SMD	Standardized mean difference
SOE	State-owned enterprise
VIF	Variance inflation factor

Appendix A. Sample Construction and Climate-Commitment Classification

Table A1 defines the analytical samples. Report year t identifies the period covered by the report; in the main timing sample, publication occurs in calendar year t + 1. Outcomes at t + 1 therefore measure annual environmental records surrounding publication. Missing or unreadable reports are not classified as NC. Calendar-year alignment is used for leads and lags, preserving gaps in the panel. Tables A2–A4 document the classification criteria and illustrative examples. Tables A5 and A6 summarize the original commitment classifications used in the main analyses. The subsequent tables report the earlier AI diagnostic review and the human audits of the original and reconstructed classifications.

Table A1. Sample Construction and Main Analytical Samples.

Sample	Definition	Firm-Year Observations	Firms
Initial report archive	Consolidated firm-year archive of principal CSR, ESG, or sustainability reports covering report years 2010–2024	16,653	—
Matched climate-commitment panel	Firm-year classifications linked to the financial, governance, and environmental-data panel for 2010–2023	12,937	2268
Main (t + 1) analytical sample	Observations satisfying the main variable-availability requirements and the verified publication-timing restriction; report years 2010–2022	10,767	1864
Full sample with prior environmental status	Main analytical sample additionally requiring the lagged combined environmental indicator in year (t − 1)	10,520	1810
Recorded sample with prior environmental status	Full sample with prior environmental status, additionally requiring original environmental-source coverage for the outcome year (t + 1) and the prior-status year (t − 1)	3227	777

Notes: Observations are firm-years. The full sample codes unmatched environmental records zero, indicating the absence of a positive database record rather than verified zero expenditure or assets. The recorded sample imposes source coverage in the stated periods. Additional estimation restrictions and sample counts are reported in the corresponding tables. A dash indicates an unreported archive firm count.

Table A2. Climate-Related Keyword Families and Representative Search Expressions.

Keyword Family	Representative Expressions
Climate change	气候变化 (climate change); 应对气候 (addressing climate issues); climate change
Greenhouse gases	温室气体 (greenhouse gases); greenhouse gas; GHG
Carbon emissions	碳排放 (carbon emissions); 二氧化碳排放 (carbon dioxide emissions); CO_2排放 (CO_2 emissions); CO_2 排放 (CO_2 emissions)
Carbon neutrality and peaking	碳中和 (carbon neutrality); 碳中性 (carbon neutrality); carbon neutral; carbon neutrality; 碳达峰 (carbon peaking); 达峰目标 (peaking targets)
Net zero	净零 (net zero); 净零排放 (net-zero emissions); net zero
Reduction targets	减排目标 (emission reduction targets); 减碳目标 (carbon reduction targets); 降碳目标 (carbon reduction targets); 碳减排目标 (carbon emission reduction targets); 温室气体减排目标 (greenhouse gas emission reduction targets)
Emissions boundary	Scope 1–3; 范围一至三 (Scopes 1–3); 范畴一至三 (Scopes 1–3)
Science-based targets	科学碳目标 (science-based carbon targets); 科学减碳目标 (science-based carbon reduction targets); 科学基础减排目标 (science-based emission reduction targets); SBTi; science-based target

Notes: These expressions summarize the stored retrieval dictionary, which also accommodates spacing, numeral, and wording variants through regular expressions. Keyword matches retrieve candidate passages; commitment categories depend on the textual conditions in Table A3.

Table A3. Commitment-Classification Criteria and Firm-Year Aggregation.

Classification Outcome	Required Textual Conditions	Main Exclusions	Final Classification
No Commitment	A complete report is available, but no sentence satisfies the criteria for a qualifying firm-level forward-looking climate commitment	Keyword mentions, policy background, current or historical emissions, and completed actions without a prospective firm-level commitment	NC = 1; GC = 0; QC = 0
General Commitment	A firm-related subject is linked to a forward-looking climate commitment, plan, target, or stated intention, with no verifiable quantitative attribute attached to the commitment	Statements referring only to national targets; targets attributable to customers, suppliers, governments, or other organizations; general green-development language without a qualifying firm-level climate commitment	NC = 0; GC = 1; QC = 0
Quantified Commitment	A qualifying firm-level forward-looking climate commitment contains at least one verifiable quantitative attribute, including a target year, reduction percentage, baseline year, or quantified emissions boundary	Historical numerical information or achieved reductions that are not attached to a prospective firm-level climate commitment	NC = 0; GC = 0; QC = 1
Excluded policy statement	The sentence describes national, regional, or sector-level carbon-peaking, carbon-neutrality, or related climate policy without establishing a target for the reporting firm	Not applicable	No firm-level commitment coded
Excluded emissions disclosure	The sentence reports current or historical emissions, energy use, or achieved reductions without a forward-looking firm-level commitment	Not applicable	No firm-level commitment coded
Excluded third-party target	The target is explicitly attributed to a customer, supplier, government body, or another organization	Not applicable	No firm-level commitment coded

Notes: Commitment statements require a firm-related subject and a prospective climate objective. Policy references, historical disclosures, and third-party targets do not qualify on their own. Qualifying statements are aggregated to the highest applicable firm-year category: QC takes precedence over GC, and NC is assigned when no qualifying commitment is identified in an available, readable report. In the passage-level audits below, NC denotes the absence of a qualifying commitment in the selected text unit.

Table A4. Representative Sentence-Level Classification Examples.

Classification Outcome	Source	Translated Report Excerpt	Classification Rationale
Excluded policy reference	Stock code 600135, 2023	"Against the background of the national carbon-peaking and carbon-neutrality goals, the company advances its energy transition and supports realization of the dual-carbon goals."	Refers to national climate objectives without establishing a firm-specific forward-looking climate commitment.
Excluded historical disclosure	Stock code 600962, 2023	"Photovoltaic generation supplied production facilities and reduced carbon dioxide emissions by 1129 tonnes."	Reports an achieved emissions reduction without a prospective firm-level climate commitment.
General Commitment	Stock code 000655, 2023	"The company formulated a three-year green-development action plan and established near-term and long-term carbon-management objectives."	Contains a firm-specific forward-looking climate objective without a verifiable quantitative attribute attached to that objective.
Quantified Commitment	Stock code 603259, 2021	"The company commits to reducing greenhouse-gas emissions intensity by 25% by 2030 relative to 2020."	Contains a firm-specific forward-looking target with a reduction percentage, target year, and baseline year.

Notes: Excerpts are English translations of the Chinese-language examples reported in the manuscript. Classification concerns the original Chinese text and its report context.

Table A5. Distribution of Climate-Commitment Categories by Report Year.

Report Year	NC	GC	QC	Total	GC (%)	QC (%)
2010	433	9	1	443	2.03	0.23
2011	523	8	2	533	1.50	0.38
2012	580	11	1	592	1.86	0.17
2013	611	11	1	623	1.77	0.16
2014	638	9	1	648	1.39	0.15
2015	671	8	2	681	1.17	0.29
2016	711	8	3	722	1.11	0.42
2017	769	4	2	775	0.52	0.26
2018	829	9	2	840	1.07	0.24
2019	868	13	9	890	1.46	1.01
2020	892	38	73	1003	3.79	7.28
2021	1096	104	123	1323	7.86	9.30
2022	1321	187	186	1694	11.04	10.98
Total	9942	419	406	10,767	3.89	3.77

Notes: The main analytical sample contains 10,767 firm-years from 1864 firms. Counts use the original commitment classification. Categories are mutually exclusive. Percentages use row totals, and years identify reporting periods rather than publication dates.

Table A6. Distribution of Climate-Commitment Categories by Broad Industry Sector.

Industry Sector Code	NC	GC	QC	Total	GC (%)	QC (%)
A	129	0	4	133	0.00	3.01
B	384	26	32	442	5.88	7.24
C	5720	276	260	6256	4.41	4.16
D	553	24	17	594	4.04	2.86
E	285	9	5	299	3.01	1.67
F	511	8	14	533	1.50	2.63
G	526	30	24	580	5.17	4.14
H	21	2	0	23	8.70	0.00
I	613	11	22	646	1.70	3.41
J	1	0	0	1	0.00	0.00
K	545	11	13	569	1.93	2.28
L	129	5	1	135	3.70	0.74
M	73	5	7	85	5.88	8.24
N	132	9	7	148	6.08	4.73
P	11	0	0	11	0.00	0.00
Q	65	2	0	67	2.99	0.00
R	229	1	0	230	0.43	0.00
S	15	0	0	15	0.00	0.00
Total	9942	419	406	10,767	3.89	3.77

Notes: The sample and original commitment classification are identical to those in Table A5. Broad sectors use the first letter of the recorded industry code; percentages use row totals. This descriptive aggregation does not alter the detailed industry codes used in regressions or the pollution classification in Appendix F.

GC and QC become more prevalent in later report years. Because sample composition also changes over time, these distributions are complemented by the within-firm transition counts in Appendix G.

Earlier AI-Assisted Diagnostic Review

An earlier AI-assisted diagnostic review examined 500 candidate text passages, sampled from the original passage-level NC, GC, and QC categories in groups of 200, 150, and 150, respectively. The AI reviewer assessed the extracted passages without access to their original algorithm labels. Table A7 reports the outcomes.

Table A7. Outcomes of the Earlier AI-Assisted Diagnostic Review.

Review Outcome	Passages	Percentage of All Reviewed Passages (%)
Agreement with the original classification	286	57.2
Disagreement with the original classification	118	23.6
Inconclusive classification	96	19.2
Total	500	100.0

Notes: Counts and percentages describe the stratified review sample and are unweighted. Among the 404 passages receiving a conclusive AI classification, agreement with the original labels was 70.8% (286/404). These figures measure consistency between the original algorithm and the AI reviewer. The exercise used extracted passages and did not provide a human reference classification.

This diagnostic exercise identified disagreements and cases requiring additional context. Its records are retained separately from the human audits below. The empirical analyses in Tables A5 and A6 and Appendices B–H retain the original commitment labels.

Human Audits of the Original and Reconstructed Classifications

The original classifications were evaluated using a stratified random sample of 300 candidate passages associated with the main analytical sample. The eligible sampling frame

contained 33,412 passages: 32,032 classified as NC, 839 as GC, and 541 as QC. A sample of 100 passages was drawn without replacement from each original category using the NumPy PCG64 generator with seed 20261019. The combined sample was shuffled, and the annotation workbook withheld the algorithm labels. One author independently read each passage and assigned NC, GC, QC, or U, where U denotes an unresolved classification.

The initial audit informed the reconstruction of a classifier from the recovered report texts. Development focused on the attribution of policy targets, the distinction between completed outcomes and prospective commitments, and the attachment of quantitative attributes to a firm-level climate objective. The reconstructed classifier was frozen as version CC-R2-candidate-20261019c before a separate evaluation sample was drawn.

The separate evaluation excluded entire reports used in the original human audit, the earlier AI review, or development checks. After excluding 602 reports, the eligible frame contained 64,912 candidate units from reports in the main analytical sample: 64,059 classified as NC, 677 as GC, and 176 as QC. Using NumPy PCG64 with seed 2026101902, 100 units were drawn without replacement from each predicted category and then presented in randomized order. The resulting sample covered 273 reports.

The frozen classifier segments text at terminal punctuation and divides long units into 1800-character windows with 500-character overlap. Some candidate units therefore contain more than one sentence. The annotation protocol treats the selected unit as the object of classification. Accompanying context can clarify subjects and references; unrelated targets elsewhere in a report do not change the selected unit's category.

The same author completed the separate evaluation without access to the frozen classifier's predictions. Category decisions were made independently before AI was used to help organize the wording of the reasons. The submitted first-pass categories were preserved for evaluation. Table A8 reports the human–algorithm confusion matrices for the two audits.

Table A8. Human–Algorithm Confusion Matrices.

Panel A. Original classification				
Human classification	Algorithm NC	Algorithm GC	Algorithm QC	Total
NC	81	65	43	189
GC	3	19	2	24
QC	2	2	42	46
U	14	14	13	41
Total	100	100	100	300
Panel B. Frozen reconstructed classification				
Human classification	Algorithm NC	Algorithm GC	Algorithm QC	Total
NC	89	45	28	162
GC	8	50	4	62
QC	0	3	63	66
U	3	2	5	10
Total	100	100	100	300

Notes: Rows contain the author's first-pass classifications; columns contain the corresponding algorithm predictions. U denotes a case that remained unresolved from the supplied text and context. U cases are reported explicitly and excluded from the denominators used to calculate agreement, Cohen's κ, precision, recall, and F1. The matrices contain unweighted record counts.

Classification Metrics and Sampling Weights

The author's first-pass category serves as the reference for calculating classification metrics. For each category, precision is the diagonal count divided by the corresponding algorithm-column total, and recall is the diagonal count divided by the corresponding human-row total, after excluding U cases. F1 is the harmonic mean of precision and recall. Observed agreement is the proportion of resolved cases on the diagonal. Nominal Cohen's κ is calculated as $\kappa = (p_o - p_e)/(1 - p_e)$, where p_o is observed agreement and p_e is expected agreement from the human and algorithm marginal proportions. These statistics describe agreement between one human coder and the algorithm.

The audits deliberately sampled equal numbers from the three predicted categories. Unweighted estimates describe these balanced audit samples. Additional estimates apply sampling-design weights equal to the eligible stratum size divided by the number sampled from that stratum. The NC, GC, and QC weights are 320.32, 8.39, and 5.41 for the original audit and 640.59, 6.77, and 1.76 for the reconstructed-classifier audit. Weighted metrics are calculated from the weighted confusion matrix after excluding unresolved cases.

Table A9. Category-Specific Classification Metrics.

Panel A. Unweighted metrics				
Classification procedure	Category	Precision (%)	Recall (%)	F1 (%)
Original	NC	94.19	42.86	58.91
Original	GC	22.09	79.17	34.55
Original	QC	48.28	91.30	63.16
Frozen reconstructed	NC	91.75	54.94	68.73
Frozen reconstructed	GC	51.02	80.65	62.50
Frozen reconstructed	QC	66.32	95.45	78.26
Panel B. Sampling-design-weighted metrics				
Classification procedure	Category	Precision (%)	Recall (%)	F1 (%)
Original	NC	94.19	97.09	95.62
Original	GC	22.09	14.09	17.21
Original	QC	48.28	25.69	33.53
Frozen reconstructed	NC	91.75	99.38	95.42
Frozen reconstructed	GC	51.02	6.19	11.04
Frozen reconstructed	QC	66.32	84.52	74.32

Notes: Metrics use the human classification as the reference and are conditional on a resolved human decision. Precision is unchanged by design weighting because all observations within a predicted-category stratum receive the same weight. Recall and F1 change because human-reference categories contain observations drawn from different predicted strata. The two audits use different sampling frames and text units.

Table A10. Overall Agreement and Unresolved Cases.

Measure	Original Classification	Frozen Reconstructed Classification
Sampled text units	300	300
Resolved text units	259	290
Unresolved text units (U)	41	10
Unresolved share of the sample (%)	13.67	3.33
Agreements among resolved units	142	202
Unweighted agreement (%)	54.83	69.66
Unweighted Cohen's κ	0.323	0.545
Sampling-design-weighted agreement (%)	91.62	91.26
Sampling-design-weighted Cohen's κ	0.219	0.126

Notes: Agreement and κ are calculated on resolved cases. Sample sizes and unresolved shares are unweighted. Design-weighted estimates use the stratum weights stated above. Both κ estimates are nominal measures; design weighting adjusts for unequal sampling probabilities and does not assign ordinal weights to disagreements between categories.

The original audit yielded 142 agreements among 259 resolved passages, while the reconstructed-classifier audit yielded 202 agreements among 290 resolved units. The larger weighted agreement rates reflect the predominance of algorithm-predicted NC units in the eligible frames. Category-specific results show substantial disagreement in the positive commitment categories. In the reconstructed-classifier audit, eight units classified as NC by the algorithm received a human GC classification. Their large sampling weights contribute to the low design-weighted GC recall.

The two audits evaluate different classification procedures, text units, and sampling frames, so their scores are reported separately rather than interpreted as a controlled estimate of improvement. The estimates concern classification among retrieved candidate texts in the corresponding eligible frames, conditional on a resolved human decision. Full-report retrieval recall and final firm-year classification accuracy require separate evaluation. Section 4.9 and Appendix I examine how the core regression estimates change under the frozen reconstructed classification.

Assisted Contextual Follow-up

A separate AI-assisted contextual review examined 54 selected records from the original 300-passage audit. The author accepted 43 classification recommendations, while 11 cases remained unresolved. Applying this follow-up to the original audit records produced an assisted reference containing 289 resolved cases and 11 unresolved cases. Agreement with the original algorithm predictions was 53.29%, with Cohen's κ of 0.296.

This follow-up records the author's acceptance of AI-assisted recommendations. It is stored separately from the first-pass human classifications and is excluded from the independent-audit statistics in Tables A8–A10. The review materials preserve the original algorithm labels, first-pass human labels, assisted follow-up records, frozen reconstructed predictions, and separate evaluation records as distinct versions.

Reporting Conventions for Appendices B–H

The analyses in Appendices B–H use the original commitment classification. Appendix I reports the comparison with the frozen reconstructed classification.

Variable definitions follow Section 3.2. In commitment regressions, NC is the reference category. BI retains the fixed standardization in Section 3.2.3, and financial controls retain the common winsorization thresholds in Section 3.2.4. Base denotes the baseline specification; Mod. adds GC × BI and QC × BI. QC − GC is a linear coefficient contrast; in moderation models, this contrast and the GC and QC coefficients are evaluated at BI = 0. Comparative moderation is tested by QC × BI − GC × BI. Reported tests are two-sided and unadjusted for

multiple comparisons, and significance symbols use unrounded p values. Dashes denote terms or statistics not included or not applicable; the placement of group contrasts in Appendix F is explained separately.

Appendix B. Separate Analyses of Environmental Expenses and Capitalized Environmental Assets

EXP identifies positive environmental expenses, an annual flow; CAP identifies positive capitalized environmental asset balances, a closing-stock measure. Outcomes are measured at t + 1, explanatory variables at t, and the corresponding prior binary indicator at t − 1. All models include financial and governance controls and firm and year fixed effects. Columns (1)–(2) use the full prior-status sample and columns (3)–(4) the recorded prior-status sample defined in Table A1; columns (2) and (4) add both commitment–BI interactions.

Table A11. Climate Commitments, Board Independence, and Recorded Environmental Expenses.

Variable	(1) Full Baseline	(2) Full Moderation	(3) Recorded Baseline	(4) Recorded Moderation
GC	0.0196 (0.0165)	0.0210 (0.0170)	0.0233 (0.0201)	0.0242 (0.0202)
QC	−0.0015 (0.0148)	−0.0054 (0.0143)	0.0108 (0.0308)	−0.0016 (0.0270)
BI	0.0008 (0.0059)	0.0000 (0.0059)	−0.0083 (0.0158)	−0.0134 (0.0155)
GC × BI	—	−0.0107 (0.0143)	—	0.0332 (0.0393)
QC × BI	—	0.0229 (0.0193)	—	0.0875 * (0.0470)
SIZE	0.0018 (0.0137)	0.0022 (0.0137)	−0.0026 (0.0342)	−0.0001 (0.0339)
LEV	−0.0185 (0.0470)	−0.0204 (0.0470)	0.1864 (0.1336)	0.1739 (0.1333)
ROA	−0.0424 (0.0838)	−0.0460 (0.0838)	0.1558 (0.1995)	0.1320 (0.1992)
CFO	−0.0428 (0.0447)	−0.0435 (0.0447)	−0.0163 (0.1034)	−0.0239 (0.1033)
GROWTH	0.0180 ** (0.0087)	0.0179 ** (0.0087)	0.0085 (0.0174)	0.0083 (0.0176)
FIXED	−0.0086 (0.0643)	−0.0076 (0.0643)	−0.1686 (0.1360)	−0.1559 (0.1350)
BOARD	0.0258 (0.0350)	0.0259 (0.0349)	−0.0416 (0.0865)	−0.0428 (0.0864)
DUAL	0.0195 * (0.0110)	0.0194 * (0.0111)	0.0115 (0.0221)	0.0124 (0.0222)
TOP1	−0.0629 (0.0583)	−0.0620 (0.0583)	−0.2925 * (0.1704)	−0.2867 * (0.1713)
AGE	−0.0781 (0.0821)	−0.0776 (0.0824)	−0.0732 (0.2648)	−0.0692 (0.2629)
EXP at t − 1	0.3401 *** (0.0229)	0.3403 *** (0.0229)	0.3168 *** (0.0356)	0.3210 *** (0.0355)
Constant	0.2705 (0.3559)	0.2605 (0.3560)	0.7900 (0.8891)	0.7300 (0.8780)
QC − GC	−0.0211 (0.0208)	−0.0263 (0.0211)	−0.0125 (0.0321)	−0.0258 (0.0290)
QC × BI − GC × BI	—	0.0336 * (0.0200)	—	0.0543 (0.0468)
p-value: QC − GC = 0	0.3102	0.2114	0.6973	0.3744
p-value: interaction difference = 0	—	0.0935	—	0.2463
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	10,520	10,520	3227	3227
Firms	1810	1810	777	777
Within R^2	0.1338	0.1343	0.1243	0.1281

Notes: The dependent variable is EXP at t + 1, and the prior indicator is EXP at t − 1. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A12. Climate Commitments, Board Independence, and Recorded Capitalized Environmental Assets.

Variable	(1) Full Baseline	(2) Full Moderation	(3) Recorded Baseline	(4) Recorded Moderation
GC	0.0613 ** (0.0243)	0.0636 ** (0.0251)	0.0659 ** (0.0311)	0.0655 ** (0.0312)
QC	0.0290 (0.0202)	0.0259 (0.0193)	0.0636 (0.0393)	0.0666 * (0.0373)
BI	0.0012 (0.0068)	0.0010 (0.0069)	0.0052 (0.0174)	0.0057 (0.0177)
GC × BI	—	−0.0212 (0.0170)	—	0.0094 (0.0263)
QC × BI	—	0.0178 (0.0240)	—	−0.0178 (0.0547)
SIZE	0.0385 ** (0.0170)	0.0387 ** (0.0170)	0.0294 (0.0280)	0.0289 (0.0279)
LEV	−0.1203 * (0.0629)	−0.1222 * (0.0627)	−0.1228 (0.1226)	−0.1199 (0.1223)
ROA	0.1136 (0.1126)	0.1106 (0.1122)	0.2838 (0.2297)	0.2884 (0.2294)
CFO	−0.0897 (0.0697)	−0.0900 (0.0695)	−0.0174 (0.1405)	−0.0175 (0.1405)
GROWTH	0.0089 (0.0125)	0.0088 (0.0124)	−0.0301 (0.0295)	−0.0301 (0.0295)
FIXED	0.1186 (0.0791)	0.1192 (0.0791)	−0.0479 (0.1246)	−0.0491 (0.1244)
BOARD	0.0036 (0.0448)	0.0035 (0.0448)	0.0595 (0.0830)	0.0594 (0.0831)
DUAL	0.0142 (0.0174)	0.0142 (0.0173)	−0.0025 (0.0303)	−0.0027 (0.0303)
TOP1	0.0526 (0.0975)	0.0536 (0.0976)	0.2211 (0.1390)	0.2219 (0.1393)
AGE	0.1639 ** (0.0734)	0.1655 ** (0.0734)	0.4496 ** (0.1995)	0.4491 ** (0.1996)
CAP at t − 1	0.1115 *** (0.0173)	0.1113 *** (0.0173)	0.0610 ** (0.0284)	0.0607 ** (0.0283)
Constant	−1.1318 ** (0.4469)	−1.1404 ** (0.4465)	−1.3053 (0.8485)	−1.2931 (0.8461)
QC − GC	−0.0323 (0.0280)	−0.0377 (0.0281)	−0.0023 (0.0429)	0.0010 (0.0413)
QC × BI − GC × BI	—	0.0390 (0.0279)	—	−0.0272 (0.0587)
p-value: QC − GC = 0	0.2495	0.1795	0.9573	0.9799
p-value: interaction difference = 0	—	0.1615	—	0.6432
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	10,520	10,520	3227	3227
Firms	1810	1810	777	777
Within R^2	0.0308	0.0311	0.0209	0.0210

Notes: The dependent variable is CAP at t + 1, and the prior indicator is CAP at t − 1. CAP concerns closing balances rather than new annual investment. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Baseline GC coefficients are positive and significant for capitalized asset records under both sample definitions, but insignificant for expenses. QC − GC is insignificant in every component model. Comparative moderation reaches only the 10% level for full-sample expenses and is insignificant in the other component models. These estimates concern separate outcomes and do not constitute an additive decomposition of the combined-indicator coefficients.

Appendix C. Diagnostics for Propensity-Score Weighting

Propensity scores and stabilized weights are estimated separately for the full and recorded samples used in Section 4.5. Balance is assessed across all defined pairwise comparisons among NC, GC, and QC for BI, financial and governance controls, prior GI, and year indicators. Each SMD uses the square root of the average unweighted within-group variances as its denominator, held fixed across weighting schemes. One undefined comparison with a zero denominator is excluded from the summaries, without removing regression observations.

Table A13. Covariate Balance before and after Propensity-Score Weighting.

Sample	Weighting Scheme	Mean Absolute SMD	Maximum Absolute SMD
Full	Unweighted	0.2124	0.7750
Full	Original stabilized weights	0.1184	0.3716
Full	Capped stabilized weights	0.1386	0.4450
Recorded	Unweighted	0.2287	0.9643
Recorded	Original stabilized weights	0.2176	0.7799
Recorded	Capped stabilized weights	0.2063	0.6326

Notes: Absolute SMDs are summarized without weighting covariates or category pairs. Capped weights use the sample-specific first and ninety-ninth percentiles of the original stabilized weights.

Table A14. Weight Concentration, Effective Sample Sizes, and Capping Rates.

Sample	Category	Observations	ESS, Original Weights	ESS, Capped Weights	Maximum Original Weight	Maximum Capped Weight	Weights Capped (%)
Full	NC	9720	9486.8	9533.1	4.1939	2.0497	0.35
Full	GC	407	85.9	233.0	29.6216	2.0497	15.72
Full	QC	393	47.8	191.9	27.4261	2.0497	28.50
Full	All	10,520	7909.0	9947.1	29.6216	2.0497	2.00
Recorded	NC	2912	2799.7	2819.0	3.4983	2.2975	0.41
Recorded	GC	170	70.1	91.9	4.4514	2.2975	14.12
Recorded	QC	145	54.2	74.1	5.9466	2.2975	19.31
Recorded	All	3227	2874.0	2979.3	5.9466	2.2975	1.98

Notes: ESS = $(\Sigma w)^2/\Sigma w^2$, calculated from firm-year weights; it is not a count of independent firms. Overall ESS is calculated directly rather than summed across groups. Capping bounds are 0.157900–2.049697 for the full sample and 0.156553–2.297535 for the recorded sample. "Weights capped" is the percentage outside these bounds; capping removes no observations.

Weighting reduces average imbalance, but observable differences remain, particularly in the recorded sample. Capping limits weight concentration while producing less favorable aggregate balance than the original weights in the full sample. The weighted results should therefore be interpreted alongside these diagnostics.

Appendix D. Environmental Expenditure and Capitalized Asset Balances: Amount and Intensity Analyses

Environmental expenditure comprises annual environmental management and research expenses. Capitalized environmental assets comprise closing balances for environmental construction projects, fixed assets, and capitalized research and development expenditure. The two measures are analyzed separately. All outcomes are measured at $t + 1$; explanatory variables are measured at t. Models include the corresponding binary expense or asset indicator at $t - 1$, financial and governance controls, and firm and year fixed effects. The prior indicator is not a lagged monetary amount. Full and recorded samples follow Table A1, with additional positive-amount restrictions in Table A18.

Table A15. Log-Transformed Environmental Expenditure and Capitalized Asset Balances, Including Zeros.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome	Expense	Expense	Expense	Expense	Capital	Capital	Capital	Capital
Sample	Full	Full	Recorded	Recorded	Full	Full	Recorded	Recorded
Specification	Base	Mod.	Base	Mod.	Base	Mod.	Base	Mod.
GC	0.3569 (0.2812)	0.3803 (0.2894)	0.3829 (0.3711)	0.3973 (0.3725)	0.9524 ** (0.4282)	0.9907 ** (0.4445)	0.8499 (0.5163)	0.8430 (0.5190)
QC	−0.0119 (0.2404)	−0.0752 (0.2338)	0.1652 (0.5263)	−0.0361 (0.4658)	0.4456 (0.3611)	0.3830 (0.3423)	0.8148 (0.7219)	0.8717 (0.6849)
BI	0.0516 (0.0965)	0.0397 (0.0967)	−0.0606 (0.2611)	−0.1425 (0.2549)	0.0060 (0.1199)	−0.0011 (0.1196)	0.0405 (0.3201)	0.0507 (0.3255)
GC × BI	—	−0.1926 (0.2477)	—	0.5323 (0.7016)	—	−0.3451 (0.3082)	—	0.1713 (0.4565)
QC × BI	—	0.3720 (0.3204)	—	1.4190 * (0.8166)	—	0.3587 (0.4495)	—	−0.3413 (1.0527)
SIZE	0.1203 (0.2046)	0.1270 (0.2042)	0.1431 (0.5437)	0.1825 (0.5379)	0.9000 *** (0.2964)	0.9052 *** (0.2961)	1.4413 *** (0.4951)	1.4311 *** (0.4939)
LEV	−0.4680 (0.7294)	−0.5005 (0.7280)	2.0216 (2.1219)	1.8182 (2.1183)	−2.2364 ** (1.0529)	−2.2720 ** (1.0495)	−2.6340 (2.1327)	−2.5780 (2.1291)
ROA	−0.3999 (1.2790)	−0.4585 (1.2784)	1.7616 (3.1092)	1.3767 (3.1053)	2.9534 (1.9046)	2.8945 (1.8957)	6.7420 * (3.9574)	6.8299 * (3.9573)
CFO	−0.5932 (0.6718)	−0.6043 (0.6719)	0.4002 (1.7054)	0.2786 (1.7022)	−1.7039 (1.1604)	−1.7115 (1.1581)	−1.1937 (2.3902)	−1.1951 (2.3897)
GROWTH	0.2537 * (0.1302)	0.2519 * (0.1302)	0.2278 (0.2693)	0.2239 (0.2717)	0.1370 (0.2122)	0.1348 (0.2118)	−0.4917 (0.5128)	−0.4919 (0.5130)
FIXED	−0.2466 (1.0316)	−0.2311 (1.0307)	−2.6611 (2.1656)	−2.4556 (2.1474)	1.4629 (1.3596)	1.4748 (1.3592)	−2.0845 (2.2857)	−2.1092 (2.2797)
BOARD	0.6056 (0.5657)	0.6056 (0.5647)	−0.4229 (1.4708)	−0.4421 (1.4723)	−0.0944 (0.7696)	−0.0953 (0.7687)	0.7496 (1.5489)	0.7488 (1.5516)
DUAL	0.3033 * (0.1716)	0.3029 * (0.1718)	0.1225 (0.3443)	0.1366 (0.3457)	0.1886 (0.2914)	0.1882 (0.2911)	−0.0163 (0.5485)	−0.0201 (0.5488)
TOP1	−1.0102 (0.9021)	−0.9952 (0.9024)	−4.4076 * (2.6197)	−4.3138 (2.6371)	1.5571 (1.6139)	1.5762 (1.6138)	6.0857 ** (2.4553)	6.1000 ** (2.4580)
AGE	−1.4155 (1.4272)	−1.4053 (1.4311)	−1.4364 (4.6513)	−1.3712 (4.6197)	2.8044 ** (1.2509)	2.8294 ** (1.2509)	8.2636 ** (3.3227)	8.2532 ** (3.3248)
Prior outcome indicator	5.3318 *** (0.3679)	5.3349 *** (0.3671)	4.8855 *** (0.5763)	4.9535 *** (0.5745)	2.1097 *** (0.2993)	2.1079 *** (0.2994)	1.3671 *** (0.4755)	1.3622 *** (0.4744)
Constant	2.3511 (5.4735)	2.1871 (5.4687)	8.9954 (14.6584)	8.0212 (14.4453)	−24.6829 *** (7.6927)	−24.8507 *** (7.6832)	−45.0735 *** (14.4181)	−44.8414 *** (14.3702)
QC − GC	−0.3689 (0.3469)	−0.4555 (0.3526)	−0.2177 (0.5623)	−0.4334 (0.5166)	−0.5068 (0.5007)	−0.6078 (0.5018)	−0.0351 (0.7553)	0.0286 (0.7219)
QC × BI − GC × BI	—	0.5646 * (0.3315)	—	0.8867 (0.8011)	—	0.7038 (0.5197)	—	−0.5126 (1.1452)
Observations	10,520	10,520	3227	3227	10,520	10,520	3227	3227
Firms	1810	1810	777	777	1810	1810	777	777
Within R^2	0.1378	0.1384	0.1191	0.1231	0.0394	0.0398	0.0302	0.0303
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Outcomes are ln(1 + expenditure) in columns (1)–(4) and ln(1 + capitalized asset balance) in columns (5)–(8), using RMB yuan. Zero observations are retained. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A16. Environmental Expenditure and Capitalized Asset Intensities before Winsorization.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome	Expense	Expense	Expense	Expense	Capital	Capital	Capital	Capital
Sample	Full	Full	Recorded	Recorded	Full	Full	Recorded	Recorded
Specification	Base	Mod.	Base	Mod.	Base	Mod.	Base	Mod.
GC	0.0019 (0.0090)	0.0018 (0.0092)	−0.0250 (0.0256)	−0.0252 (0.0257)	−0.1622 (0.1104)	−0.1534 (0.1123)	−0.6764 ** (0.2769)	−0.6730 ** (0.2766)
QC	−0.0055 (0.0077)	−0.0052 (0.0080)	−0.0305 (0.0256)	−0.0303 (0.0263)	−0.1193 (0.1717)	−0.1755 (0.1713)	−0.7184 (0.4659)	−0.7615 (0.5138)
BI	0.0025 (0.0040)	0.0025 (0.0040)	0.0056 (0.0160)	0.0051 (0.0163)	0.0314 (0.0283)	0.0170 (0.0250)	0.1317 (0.1130)	0.1183 (0.1193)
GC × BI	—	0.0005 (0.0060)	—	0.0160 (0.0169)	—	−0.0480 (0.0635)	—	0.0140 (0.1876)
QC × BI	—	−0.0018 (0.0049)	—	0.0011 (0.0141)	—	0.3373 (0.2595)	—	0.2821 (0.4034)
SIZE	−0.0125 (0.0141)	−0.0125 (0.0141)	−0.0617 (0.0630)	−0.0617 (0.0630)	0.0315 (0.1081)	0.0386 (0.1074)	0.1258 (0.4278)	0.1336 (0.4300)
LEV	−0.0128 (0.0268)	−0.0126 (0.0268)	0.0279 (0.0970)	0.0282 (0.0970)	0.0002 (0.3052)	−0.0261 (0.3072)	−0.7336 (1.0386)	−0.7753 (1.0218)
ROA	−0.2334 (0.1759)	−0.2331 (0.1756)	−0.8224 (0.6229)	−0.8229 (0.6229)	0.8995 (0.6326)	0.8476 (0.6088)	1.8324 (1.8794)	1.7577 (1.7918)
CFO	−0.0277 (0.0322)	−0.0276 (0.0321)	0.0610 (0.1020)	0.0592 (0.1021)	−0.3068 (0.3491)	−0.3199 (0.3469)	−1.1377 (1.0392)	−1.1535 (1.0477)
GROWTH	0.0081 (0.0142)	0.0081 (0.0143)	0.0298 (0.0544)	0.0298 (0.0544)	0.0244 (0.0748)	0.0231 (0.0746)	0.1480 (0.2108)	0.1477 (0.2112)
FIXED	0.0230 (0.0539)	0.0229 (0.0538)	0.0327 (0.1510)	0.0340 (0.1514)	−1.5082 *** (0.5037)	−1.4920 *** (0.5033)	−4.3902 *** (1.3149)	−4.3582 *** (1.3177)
BOARD	−0.0161 (0.0636)	−0.0161 (0.0636)	−0.1606 (0.2709)	−0.1609 (0.2711)	−0.0128 (0.1729)	−0.0121 (0.1721)	0.5230 (0.7085)	0.5208 (0.7075)
DUAL	0.0199 (0.0209)	0.0199 (0.0209)	0.0505 (0.0730)	0.0505 (0.0730)	0.0400 (0.0745)	0.0398 (0.0745)	0.0675 (0.2279)	0.0706 (0.2287)
TOP1	0.0129 (0.0194)	0.0128 (0.0194)	0.0239 (0.0699)	0.0257 (0.0700)	1.0117 ** (0.4364)	1.0214 ** (0.4361)	4.8628 *** (1.6005)	4.8675 *** (1.5949)
AGE	−0.0329 (0.0670)	−0.0329 (0.0671)	0.1701 (0.3072)	0.1704 (0.3072)	0.2422 (0.3226)	0.2392 (0.3252)	1.5081 (1.4204)	1.5198 (1.4166)
Prior outcome indicator	0.0457 *** (0.0134)	0.0457 *** (0.0133)	−0.0100 (0.0216)	−0.0098 (0.0216)	0.2663 *** (0.0876)	0.2672 *** (0.0876)	0.3952 *** (0.1292)	0.3987 *** (0.1293)
Constant	0.4503 (0.3368)	0.4510 (0.3374)	1.4490 (1.4832)	1.4488 (1.4835)	−0.9404 (2.4570)	−1.0832 (2.4271)	−6.6906 (9.5633)	−6.8778 (9.6149)
QC − GC	−0.0074 (0.0089)	−0.0070 (0.0094)	−0.0055 (0.0190)	−0.0051 (0.0202)	0.0429 (0.1921)	−0.0221 (0.1936)	−0.0420 (0.4875)	−0.0885 (0.5354)
QC × BI − GC × BI	—	−0.0023 (0.0069)	—	−0.0149 (0.0194)	—	0.3854 (0.2530)	—	0.2681 (0.3931)
Observations	10,520	10,520	3227	3227	10,520	10,520	3227	3227
Firms	1810	1810	777	777	1810	1810	777	777
Within R^2	0.0091	0.0091	0.0229	0.0230	0.0118	0.0138	0.0405	0.0410
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Expense intensity is expenditure/operating revenue; capital intensity is capitalized asset balance/total assets. Numerators and denominators are measured at t + 1. Outcomes are not winsorized. Coefficients, standard errors, and contrasts are multiplied by 100 and interpreted in percentage points. Firm-clustered standard errors are in parentheses. **, and *** denote $p < 0.05$, and $p < 0.01$, respectively.

Table A17. Environmental Expenditure and Capitalized Asset Intensities after Winsorization.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome	Expense	Expense	Expense	Expense	Capital	Capital	Capital	Capital
Sample	Full	Full	Recorded	Recorded	Full	Full	Recorded	Recorded
Specification	Base	Mod.	Base	Mod.	Base	Mod.	Base	Mod.
GC	0.0074 (0.0053)	0.0077 (0.0055)	0.0021 (0.0092)	0.0021 (0.0093)	−0.0705 (0.0691)	−0.0637 (0.0709)	−0.3369 ** (0.1588)	−0.3361 ** (0.1588)
QC	−0.0007 (0.0048)	−0.0006 (0.0051)	−0.0052 (0.0118)	−0.0053 (0.0126)	−0.0383 (0.0803)	−0.0586 (0.0797)	−0.2845 (0.2125)	−0.2880 (0.2288)
BI	0.0027 (0.0020)	0.0028 (0.0020)	0.0062 (0.0046)	0.0062 (0.0047)	0.0170 (0.0181)	0.0129 (0.0173)	0.0520 (0.0684)	0.0527 (0.0705)
GC × BI	—	−0.0026 (0.0040)	—	−0.0008 (0.0096)	—	−0.0545 (0.0435)	—	−0.0448 (0.1234)
QC × BI	—	−0.0004 (0.0034)	—	0.0002 (0.0104)	—	0.1196 (0.1086)	—	0.0159 (0.1763)
SIZE	−0.0001 (0.0035)	−0.0001 (0.0035)	0.0022 (0.0111)	0.0022 (0.0111)	0.0982 (0.0648)	0.1005 (0.0644)	0.3305 (0.2584)	0.3311 (0.2579)
LEV	−0.0095 (0.0147)	−0.0095 (0.0146)	−0.0135 (0.0464)	−0.0136 (0.0464)	−0.0796 (0.2041)	−0.0900 (0.2049)	−0.7740 (0.7175)	−0.7777 (0.7155)
ROA	−0.0388 * (0.0214)	−0.0388 * (0.0214)	−0.0835 (0.0579)	−0.0836 (0.0578)	0.5952 (0.3760)	0.5764 (0.3707)	0.8617 (0.9961)	0.8581 (0.9795)
CFO	−0.0029 (0.0146)	−0.0029 (0.0146)	0.0480 (0.0499)	0.0481 (0.0498)	−0.2395 (0.2207)	−0.2433 (0.2200)	−0.6346 (0.5857)	−0.6305 (0.5890)
GROWTH	−0.0027 (0.0023)	−0.0027 (0.0023)	−0.0107 * (0.0064)	−0.0107 * (0.0064)	0.0144 (0.0442)	0.0138 (0.0440)	0.0794 (0.1272)	0.0795 (0.1273)
FIXED	−0.0152 (0.0226)	−0.0153 (0.0227)	−0.0404 (0.0522)	−0.0404 (0.0525)	−0.8042 *** (0.3065)	−0.7992 *** (0.3062)	−2.4011 *** (0.8172)	−2.4027 *** (0.8175)
BOARD	0.0320 ** (0.0126)	0.0320 ** (0.0126)	0.0519 (0.0315)	0.0519 (0.0315)	0.0371 (0.1158)	0.0371 (0.1155)	0.3362 (0.3873)	0.3369 (0.3872)
DUAL	0.0034 (0.0032)	0.0034 (0.0032)	−0.0059 (0.0079)	−0.0058 (0.0079)	0.0026 (0.0545)	0.0026 (0.0545)	0.0349 (0.1726)	0.0351 (0.1727)
TOP1	0.0025 (0.0158)	0.0026 (0.0158)	0.0478 (0.0626)	0.0477 (0.0626)	0.6854 ** (0.2967)	0.6900 ** (0.2965)	3.6150 *** (1.0494)	3.6104 *** (1.0480)
AGE	−0.0609 (0.0388)	−0.0607 (0.0389)	−0.1161 (0.1462)	−0.1161 (0.1462)	0.3012 (0.2044)	0.3037 (0.2057)	1.6038 * (0.8269)	1.6036 * (0.8269)
Prior outcome indicator	0.0438 *** (0.0077)	0.0437 *** (0.0077)	0.0240 ** (0.0113)	0.0240 ** (0.0114)	0.1945 *** (0.0526)	0.1944 *** (0.0525)	0.2629 *** (0.0833)	0.2632 *** (0.0832)
Constant	0.1298 (0.1081)	0.1299 (0.1080)	0.2388 (0.3810)	0.2386 (0.3806)	−2.8429 * (1.5706)	−2.8955 * (1.5596)	−11.7215 * (6.0389)	−11.7334 * (6.0299)
QC − GC	−0.0081 (0.0061)	−0.0083 (0.0065)	−0.0073 (0.0125)	−0.0074 (0.0133)	0.0323 (0.0974)	0.0052 (0.0985)	0.0524 (0.2227)	0.0480 (0.2385)
QC × BI − GC × BI	—	0.0022 (0.0049)	—	0.0011 (0.0118)	—	0.1741 (0.1106)	—	0.0607 (0.1845)
Observations	10,520	10,520	3227	3227	10,520	10,520	3227	3227
Firms	1810	1810	777	777	1810	1810	777	777
Within R^2	0.0392	0.0392	0.0433	0.0433	0.0138	0.0146	0.0473	0.0473
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Definitions and percentage-point units follow Table A16. Common first- and ninety-ninth-percentile bounds are calculated from 9082 observations eligible for t + 2 analysis before publication-date restrictions. In ratio units, bounds are 0–0.0059815464 for expenses and 0–0.0911220235 for assets, applied unchanged to both samples. Firm-clustered standard errors are in parentheses. *, ** and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A18. Log-Transformed Environmental Expenditure and Capitalized Asset Balances among Positive Observations.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome	Expense	Expense	Expense	Expense	Capital	Capital	Capital	Capital
Sample	Full	Full	Recorded	Recorded	Full	Full	Recorded	Recorded
Specification	Base	Mod.	Base	Mod.	Base	Mod.	Base	Mod.
GC	0.0556 (0.1082)	0.0504 (0.1077)	0.0196 (0.1181)	0.0156 (0.1175)	−0.4204 ** (0.1837)	−0.4205 ** (0.1843)	−0.4405 ** (0.2080)	−0.4366 ** (0.2083)
QC	0.0664 (0.1202)	0.0844 (0.1228)	0.0651 (0.1266)	0.0811 (0.1295)	−0.2481 (0.2017)	−0.2884 (0.2015)	−0.2368 (0.1902)	−0.2448 (0.1873)
BI	0.0926 (0.0598)	0.0989 (0.0608)	0.1130 * (0.0598)	0.1229 ** (0.0611)	0.0370 (0.0785)	0.0178 (0.0778)	0.0198 (0.0816)	0.0136 (0.0807)
GC × BI	—	−0.0823 (0.1193)	—	−0.1460 (0.1244)	—	−0.0746 (0.1684)	—	−0.0426 (0.2164)
QC × BI	—	−0.0941 (0.0693)	—	−0.1287 (0.0920)	—	0.3906 * (0.2006)	—	0.1476 (0.2006)
SIZE	0.6369 *** (0.1434)	0.6345 *** (0.1437)	0.7357 *** (0.1452)	0.7357 *** (0.1444)	1.0343 *** (0.2115)	1.0481 *** (0.2087)	1.3248 *** (0.2440)	1.3264 *** (0.2439)
LEV	−0.4439 (0.5793)	−0.4274 (0.5807)	−1.0089 (0.6489)	−0.9849 (0.6504)	−0.7901 (0.7457)	−0.8307 (0.7442)	−0.6110 (0.8499)	−0.6207 (0.8517)
ROA	0.2292 (1.0529)	0.2564 (1.0506)	−1.4676 (1.0879)	−1.4399 (1.0840)	2.7241 * (1.4275)	2.5791 * (1.4035)	2.9750 ** (1.4511)	2.9454 ** (1.4442)
CFO	0.4738 (0.6661)	0.5021 (0.6700)	1.0762 (0.6862)	1.1242 (0.6905)	−1.0350 (0.9064)	−1.0018 (0.9059)	−1.3602 (0.9925)	−1.3478 (0.9918)
GROWTH	−0.0259 (0.0943)	−0.0227 (0.0944)	0.1332 (0.1005)	0.1374 (0.1006)	−0.0991 (0.1520)	−0.0916 (0.1521)	0.0051 (0.1844)	0.0088 (0.1852)
FIXED	0.2715 (0.5382)	0.2665 (0.5387)	0.7320 (0.6188)	0.7109 (0.6199)	−2.4093 *** (0.8637)	−2.3974 *** (0.8645)	−2.3216 *** (0.8466)	−2.3177 *** (0.8497)
BOARD	0.3557 (0.4299)	0.3636 (0.4299)	0.1228 (0.4572)	0.1311 (0.4565)	−0.3734 (0.5260)	−0.3846 (0.5257)	−0.2203 (0.5728)	−0.2263 (0.5704)
DUAL	−0.0521 (0.1331)	−0.0551 (0.1332)	−0.1239 (0.1364)	−0.1278 (0.1362)	−0.0014 (0.1934)	0.0042 (0.1933)	0.1341 (0.2216)	0.1360 (0.2219)
TOP1	−0.6234 (1.0257)	−0.6281 (1.0256)	−0.3549 (1.1769)	−0.3814 (1.1784)	1.9787 * (1.1920)	1.9707 * (1.1739)	3.0140 *** (1.1091)	3.0173 *** (1.1070)
AGE	−1.0053 (1.0014)	−0.9956 (1.0013)	−1.2868 (1.1374)	−1.2431 (1.1395)	0.9685 (0.8050)	0.9594 (0.8037)	0.3022 (1.0916)	0.2950 (1.0906)
Prior outcome indicator	0.0202 (0.1100)	0.0167 (0.1107)	−0.0748 (0.1772)	−0.0852 (0.1787)	0.0620 (0.1089)	0.0630 (0.1087)	0.0869 (0.1361)	0.0875 (0.1358)
Constant	3.5424 (4.6535)	3.5453 (4.6600)	2.8280 (4.8873)	2.6973 (4.8869)	−8.1309 (5.2097)	−8.3748 (5.1392)	−13.4323 ** (6.0752)	−13.4365 ** (6.0800)
QC − GC	0.0109 (0.1287)	0.0340 (0.1304)	0.0455 (0.1349)	0.0655 (0.1386)	0.1723 (0.2310)	0.1321 (0.2349)	0.2037 (0.2347)	0.1918 (0.2363)
QC × BI − GC × BI	—	−0.0118 (0.1115)	—	0.0172 (0.1168)	—	0.4652 * (0.2377)	—	0.1901 (0.2394)
Observations	1686	1686	1476	1476	2765	2765	2101	2101
Firms	386	386	356	356	751	751	573	573
Within R^2	0.0626	0.0631	0.0770	0.0782	0.0903	0.0922	0.1051	0.1054
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each model retains strictly positive amounts and uses ln(expenditure) or ln(capitalized asset balance), measured in RMB yuan before transformation. Full and Recorded denote the parent samples. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

GC is positively associated with log capitalized asset balances including zeros in the full-sample baseline model, but negatively associated with log balances among positive observations under both sample definitions. Recorded-sample asset intensity is also negatively associated with GC, and this association remains significant after applying the common winsorization thresholds. Baseline expense estimates provide no significant positive GC association. Positive-record probabilities and conditional amounts concern different outcomes and samples; the binary findings therefore do not establish a general increase in expenditure or asset scale.

All 16 baseline QC − GC contrasts are insignificant. Comparative moderation reaches only the 10% level for full-sample log expenditure including zeros ($p = 0.0888$) and positive capitalized asset balances ($p = 0.0507$); corresponding recorded-sample contrasts are insignificant.

Appendix E. Conditional Fixed-Effects Logit and Common-Sample Comparisons

Conditional fixed-effects Logit and LPM models use GI at t + 1, explanatory variables at t, Prior GI at t − 1, and year effects. Each table reports the original-sample LPM, conditional Logit, and an LPM estimated on exactly the corresponding Logit sample, separately for baseline and moderation specifications. Logit conditions out firm effects and retains firms whose outcomes vary over time. All four Logit models converged, with no further exclusions among firms exhibiting outcome variation.

LPM coefficients are on the probability scale; Logit coefficients and their linear contrasts are on the log-odds scale, not marginal effects. The Logit interaction contrast therefore tests comparative moderation on the log-odds scale. Within R^2 is reported only for LPM models. Category counts refer to firm-years.

Table A19. Conditional Fixed-Effects Logit and Common-Sample LPM Comparisons: Full Sample.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Estimator	LPM	FE Logit	LPM	LPM	FE Logit	LPM
Estimation sample	Original	Logit	Logit	Original	Logit	Logit
Specification	Baseline	Baseline	Baseline	Moderation	Moderation	Moderation
GC	0.0594 ** (0.0242)	0.6606 ** (0.2674)	0.1340 *** (0.0499)	0.0635 ** (0.0247)	0.6307 ** (0.2628)	0.1257 ** (0.0490)
QC	0.0044 (0.0198)	0.0723 (0.2348)	0.0180 (0.0469)	0.0013 (0.0197)	0.0234 (0.2369)	0.0090 (0.0476)
BI	0.0020 (0.0074)	0.0368 (0.0766)	0.0055 (0.0139)	0.0023 (0.0074)	0.0374 (0.0764)	0.0055 (0.0140)
GC × BI	—	—	—	−0.0399 ** (0.0166)	−0.3554 (0.2372)	−0.0670 (0.0467)
QC × BI	—	—	—	0.0165 (0.0184)	0.1763 (0.2181)	0.0309 (0.0375)
SIZE	0.0350 * (0.0197)	0.3092 * (0.1787)	0.0602 * (0.0343)	0.0351 * (0.0198)	0.3104 * (0.1800)	0.0602 * (0.0346)
LEV	−0.1337 * (0.0685)	−1.2101 * (0.6230)	−0.2310 ** (0.1144)	−0.1360 ** (0.0684)	−1.2306 ** (0.6242)	−0.2337 ** (0.1143)
ROA	−0.0774 (0.1127)	−0.8373 (1.1850)	−0.1577 (0.2210)	−0.0804 (0.1127)	−0.8742 (1.1887)	−0.1616 (0.2216)
CFO	−0.1323 * (0.0730)	−1.1609 (0.8220)	−0.2224 (0.1496)	−0.1322 * (0.0730)	−1.1678 (0.8215)	−0.2237 (0.1494)
GROWTH	0.0375 *** (0.0127)	0.3842 *** (0.1447)	0.0713 *** (0.0263)	0.0374 *** (0.0127)	0.3829 *** (0.1450)	0.0708 *** (0.0264)
FIXED	0.1008 (0.0855)	0.9877 (0.8032)	0.1917 (0.1462)	0.1009 (0.0855)	0.9930 (0.8029)	0.1932 (0.1460)
BOARD	0.0387 (0.0518)	0.4878 (0.5629)	0.0721 (0.1027)	0.0385 (0.0517)	0.4981 (0.5622)	0.0736 (0.1024)
DUAL	0.0337 * (0.0176)	0.3342 * (0.1935)	0.0594 * (0.0345)	0.0337 * (0.0176)	0.3321 * (0.1933)	0.0587 * (0.0345)
TOP1	0.0633 (0.1006)	0.3129 (0.9010)	0.1020 (0.1636)	0.0649 (0.1006)	0.3294 (0.9005)	0.1034 (0.1636)
AGE	0.1071 (0.0878)	1.3226 (1.1188)	0.2424 (0.1719)	0.1105 (0.0878)	1.3230 (1.1349)	0.2399 (0.1722)
Prior GI	0.1640 *** (0.0172)	0.7571 *** (0.0903)	0.1725 *** (0.0198)	0.1636 *** (0.0172)	0.7550 *** (0.0902)	0.1719 *** (0.0198)
Constant	−0.8883 * (0.5066)	—	−1.8570 ** (0.9093)	−0.8977 * (0.5071)	—	−1.8529 ** (0.9160)
QC − GC	−0.0550 * (0.0290)	−0.5883 * (0.3284)	−0.1160 * (0.0643)	−0.0622 ** (0.0294)	−0.6072 * (0.3236)	−0.1166 * (0.0640)
QC × BI − GC × BI	—	—	—	0.0564 ** (0.0224)	0.5318 * (0.2883)	0.0979 * (0.0542)
Observations	10,520	4846	4846	10,520	4846	4846
Firms	1810	497	497	1810	497	497
NC observations	9720	4566	4566	9720	4566	4566
GC observations	407	158	158	407	158	158
QC observations	393	122	122	393	122	122
Within R^2	0.0463	—	0.0614	0.0469	—	0.0621
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Full sample. Logit excludes 1313 firms with 5674 observations: 896 firms have exclusively zero outcomes and 417 exclusively positive outcomes. The retained sample contains 4846 observations from 497 firms. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A20. Conditional Fixed-Effects Logit and Common-Sample LPM Comparisons: Recorded Sample.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Estimator	LPM	FE Logit	LPM	LPM	FE Logit	LPM
Estimation sample	Original	Logit	Logit	Original	Logit	Logit
Specification	Baseline	Baseline	Baseline	Moderation	Moderation	Moderation
GC	0.0354 * (0.0182)	0.7385 (0.9506)	0.1119 (0.1119)	0.0358 ** (0.0182)	0.8948 (0.9379)	0.1122 (0.1128)
QC	0.0009 (0.0241)	−0.4179 (0.7178)	−0.0445 (0.1784)	−0.0003 (0.0235)	−0.4806 (0.7040)	−0.0573 (0.1758)
BI	−0.0010 (0.0117)	−0.0285 (0.2323)	−0.0151 (0.0390)	−0.0007 (0.0120)	−0.0288 (0.2305)	−0.0155 (0.0390)
GC × BI	—	—	—	−0.0160 (0.0153)	−0.9757 (0.6391)	−0.0923 (0.0985)
QC × BI	—	—	—	0.0053 (0.0176)	0.1701 (0.5162)	0.0460 (0.1232)
SIZE	0.0102 (0.0215)	0.0438 (0.4833)	0.0227 (0.0714)	0.0104 (0.0216)	0.0495 (0.4814)	0.0221 (0.0715)
LEV	0.0021 (0.0983)	−0.3069 (1.7639)	−0.0987 (0.2858)	0.0009 (0.0985)	−0.4323 (1.8149)	−0.1116 (0.2888)
ROA	0.2148 (0.1649)	4.3788 (2.8545)	0.7612 (0.4862)	0.2136 (0.1652)	4.2924 (2.8730)	0.7526 (0.4909)
CFO	−0.0521 (0.1119)	−1.0235 (2.1298)	−0.1312 (0.3483)	−0.0507 (0.1121)	−0.9811 (2.1434)	−0.1239 (0.3499)
GROWTH	0.0160 (0.0195)	0.3384 (0.4891)	0.0608 (0.0724)	0.0160 (0.0195)	0.3296 (0.5043)	0.0582 (0.0741)
FIXED	−0.1032 (0.0808)	−3.1901 * (1.9190)	−0.3977 (0.2791)	−0.1038 (0.0815)	−3.2342 * (1.9205)	−0.4001 (0.2824)
BOARD	0.1119 * (0.0582)	2.9559 ** (1.2568)	0.4225 ** (0.1771)	0.1122 * (0.0582)	2.9526 ** (1.2624)	0.4139 ** (0.1773)
DUAL	0.0165 (0.0189)	0.4248 (0.4224)	0.0781 (0.0685)	0.0165 (0.0189)	0.4698 (0.4303)	0.0800 (0.0684)
TOP1	0.0838 (0.1060)	4.4513 * (2.6721)	0.6116 (0.3719)	0.0822 (0.1061)	4.5145 * (2.7027)	0.6031 (0.3734)
AGE	0.3702 ** (0.1477)	8.2298 *** (2.6971)	1.2559 *** (0.4125)	0.3702 ** (0.1478)	8.1781 *** (2.7168)	1.2408 *** (0.4210)
Prior GI	−0.0061 (0.0362)	−0.1929 (0.2293)	−0.0293 (0.0436)	−0.0061 (0.0362)	−0.1898 (0.2283)	−0.0289 (0.0435)
Constant	−0.4766 (0.6546)	—	−3.9569 * (2.0120)	−0.4807 (0.6566)	—	−3.8776 * (2.0309)
QC − GC	−0.0346 (0.0258)	−1.1564 (1.1123)	−0.1564 (0.1983)	−0.0361 (0.0251)	−1.3754 (1.0906)	−0.1696 (0.1976)
QC × BI − GC × BI	—	—	—	0.0213 (0.0205)	1.1458 (0.8201)	0.1383 (0.1524)
Observations	3227	856	856	3227	856	856
Firms	777	161	161	777	161	161
NC observations	2912	824	824	2912	824	824
GC observations	170	21	21	170	21	21
QC observations	145	11	11	145	11	11
Within R^2	0.0250	—	0.0927	0.0252	—	0.0935
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Recorded sample. Logit excludes 616 firms with 2371 observations: 51 firms have exclusively zero outcomes and 565 exclusively positive outcomes. The retained sample contains 856 observations from 161 firms, including 21 GC and 11 QC firm-years. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

The positive baseline GC association persists in the full-sample Logit and common-sample LPM. Comparative moderation reaches only the 10% level in these restricted samples, and QC does not outperform GC. Recorded-sample GC and comparative moderation estimates are insignificant in both estimators, with limited commitment observations. The results indicate sensitivity to sample coverage as well as estimator choice.

Appendix F. Ownership and Pollution-Industry Heterogeneity

Ownership distinguishes SOEs from non-SOEs. The baseline pollution classification in the source dataset identifies industry codes B06, B07, B08, B09, C15, C17, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, and D44 as heavily polluting; all other codes form the comparison group. This list agrees with the provider's documentation and processing code.

The outcome is GI at $t + 1$, with explanatory variables at t and Prior GI at $t - 1$. Each adjacent pair of columns is estimated in one joint model allowing group-specific slopes for all regressors and absorbing firm-by-group and year-by-group fixed effects. Standard errors are clustered by original firm. Between-group contrasts use the joint covariance matrix and appear once, in the right-hand column of each pair; paired left-hand dashes avoid duplicate reporting. Within R^2 is repeated across each pair. Constants and absorbed coefficients are omitted.

Table A21. Ownership: Subgroup Estimates and Formal Differences.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Full	Full	Full	Full	Recorded	Recorded	Recorded	Recorded
Specification	Base	Base	Mod.	Mod.	Base	Base	Mod.	Mod.
Group	Non-SOE	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE	SOE
GC	0.0970 *** (0.0349)	0.0494 (0.0313)	0.1071 *** (0.0349)	0.0532 * (0.0320)	0.0392 (0.0357)	0.0341 (0.0215)	0.0428 (0.0338)	0.0345 (0.0215)
QC	−0.0127 (0.0343)	0.0198 (0.0245)	−0.0120 (0.0343)	0.0135 (0.0241)	−0.0196 (0.0484)	0.0022 (0.0289)	−0.0141 (0.0406)	−0.0023 (0.0297)
BI	−0.0033 (0.0136)	0.0060 (0.0086)	−0.0007 (0.0136)	0.0056 (0.0087)	0.0226 (0.0186)	−0.0133 (0.0142)	0.0253 (0.0188)	−0.0147 (0.0145)
GC × BI	—	—	−0.0776 ** (0.0306)	−0.0320 * (0.0190)	—	—	−0.0669 (0.0466)	0.0021 (0.0129)
QC × BI	—	—	−0.0078 (0.0363)	0.0232 (0.0212)	—	—	−0.0628 (0.0732)	0.0244 (0.0170)
SIZE	−0.0043 (0.0269)	0.0634 ** (0.0285)	−0.0032 (0.0269)	0.0637 ** (0.0286)	0.0462 (0.0293)	−0.0002 (0.0324)	0.0497 * (0.0295)	0.0012 (0.0326)
LEV	−0.0305 (0.0892)	−0.2238 ** (0.1023)	−0.0328 (0.0894)	−0.2263 ** (0.1020)	0.0611 (0.1414)	−0.0031 (0.1315)	0.0632 (0.1421)	−0.0087 (0.1317)
ROA	−0.1266 (0.1561)	0.0272 (0.1737)	−0.1271 (0.1559)	0.0198 (0.1733)	−0.0610 (0.2214)	0.3656 (0.2478)	−0.0515 (0.2221)	0.3559 (0.2475)
CFO	−0.0517 (0.0934)	−0.2465 ** (0.1109)	−0.0463 (0.0933)	−0.2475 ** (0.1109)	0.2269 (0.2026)	−0.2298 * (0.1308)	0.2320 (0.2023)	−0.2322 * (0.1314)
GROWTH	0.0366 ** (0.0170)	0.0351 * (0.0186)	0.0362 ** (0.0171)	0.0347 * (0.0186)	0.0320 (0.0300)	0.0028 (0.0274)	0.0301 (0.0303)	0.0023 (0.0275)
FIXED	0.1857 (0.1470)	0.0141 (0.1049)	0.1850 (0.1471)	0.0151 (0.1050)	−0.1911 (0.1644)	−0.0216 (0.0917)	−0.1980 (0.1665)	−0.0168 (0.0928)
BOARD	0.0735 (0.0983)	0.0509 (0.0602)	0.0735 (0.0979)	0.0511 (0.0600)	0.3278 *** (0.1074)	0.0502 (0.0675)	0.3271 *** (0.1068)	0.0495 (0.0677)
DUAL	−0.0009 (0.0249)	0.0455 * (0.0255)	−0.0010 (0.0249)	0.0456 * (0.0255)	−0.0149 (0.0327)	0.0278 (0.0210)	−0.0127 (0.0324)	0.0285 (0.0211)
TOP1	0.0339 (0.1647)	0.1044 (0.1268)	0.0384 (0.1637)	0.1064 (0.1269)	0.4727 ** (0.2139)	−0.1447 (0.1322)	0.4550 ** (0.2150)	−0.1455 (0.1325)
AGE	0.0762 (0.1932)	0.1171 (0.0977)	0.0668 (0.1944)	0.1217 (0.0976)	0.7819 * (0.4050)	0.2904 ** (0.1323)	0.7616 * (0.4124)	0.2911 ** (0.1324)
Prior GI	0.1243 *** (0.0287)	0.1865 *** (0.0222)	0.1236 *** (0.0286)	0.1858 *** (0.0222)	−0.0372 (0.0579)	0.0325 (0.0462)	−0.0395 (0.0576)	0.0326 (0.0462)
QC − GC	−0.1097 ** (0.0442)	−0.0297 (0.0370)	−0.1191 *** (0.0445)	−0.0397 (0.0377)	−0.0587 (0.0532)	−0.0319 (0.0296)	−0.0569 (0.0462)	−0.0368 (0.0304)
QC × BI − GC × BI	—	—	0.0698 (0.0439)	0.0553 ** (0.0257)	—	—	0.0041 (0.0828)	0.0223 (0.0178)
Between-group ΔGC	—	−0.0476 (0.0469)	—	−0.0539 (0.0474)	—	−0.0050 (0.0416)	—	−0.0083 (0.0401)
Between-group Δ(QC − GC)	—	0.0800 (0.0576)	—	0.0794 (0.0583)	—	0.0268 (0.0609)	—	0.0201 (0.0554)
Between-group Δ(interaction contrast)	—	—	—	−0.0145 (0.0509)	—	—	—	0.0182 (0.0847)
Group observations	4313	5508	4313	5508	1124	1797	1124	1797
Group firms	754	630	754	630	246	301	246	301

Table A21. *Cont.*

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Group GC observations	137	222	137	222	44	106	44	106
Group QC observations	177	164	177	164	51	62	51	62
Joint-model within R^2	0.0374	0.0374	0.0384	0.0384	0.0246	0.0246	0.0256	0.0256

Notes: Differences are SOE minus non-SOE. Subgroup firm counts may overlap when ownership changes; unique model firm counts appear in Table A23. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A22. Heavily Polluting versus Other Industries: Subgroup Estimates and Formal Differences.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Full	Full	Full	Full	Recorded	Recorded	Recorded	Recorded
Specification	Base	Base	Mod.	Mod.	Base	Base	Mod.	Mod.
Group	Other	Polluting	Other	Polluting	Other	Polluting	Other	Polluting
GC	0.0488 * (0.0290)	0.0727 * (0.0395)	0.0511 * (0.0305)	0.0715 * (0.0378)	0.0428 ** (0.0209)	0.0262 (0.0270)	0.0430 ** (0.0204)	0.0256 (0.0267)
QC	−0.0143 (0.0241)	0.0352 (0.0330)	−0.0166 (0.0242)	0.0331 (0.0329)	0.0132 (0.0351)	−0.0192 (0.0322)	0.0163 (0.0349)	−0.0147 (0.0278)
BI	−0.0027 (0.0085)	0.0117 (0.0135)	−0.0034 (0.0086)	0.0159 (0.0136)	−0.0044 (0.0251)	0.0031 (0.0118)	−0.0068 (0.0254)	0.0055 (0.0122)
GC × BI	—	—	−0.0095 (0.0187)	−0.1084 *** (0.0356)	—	—	0.0253 (0.0165)	−0.0395 (0.0241)
QC × BI	—	—	0.0260 (0.0233)	−0.0044 (0.0300)	—	—	0.0514 * (0.0267)	−0.0179 (0.0230)
SIZE	0.0153 (0.0236)	0.0709 ** (0.0355)	0.0156 (0.0236)	0.0704 ** (0.0356)	0.0128 (0.0407)	0.0062 (0.0235)	0.0142 (0.0407)	0.0061 (0.0236)
LEV	−0.0649 (0.0772)	−0.2711 ** (0.1285)	−0.0660 (0.0771)	−0.2645 ** (0.1274)	0.1167 (0.1834)	−0.0340 (0.0953)	0.1169 (0.1839)	−0.0296 (0.0960)
ROA	−0.0856 (0.1304)	0.0094 (0.2129)	−0.0904 (0.1299)	0.0206 (0.2132)	0.0936 (0.2973)	0.3147 * (0.1827)	0.0885 (0.2984)	0.3222 * (0.1842)
CFO	−0.0900 (0.0812)	−0.2584 * (0.1545)	−0.0905 (0.0811)	−0.2543 * (0.1544)	0.1010 (0.1898)	−0.2123 (0.1367)	0.1022 (0.1905)	−0.2062 (0.1375)
GROWTH	0.0381 *** (0.0143)	0.0374 (0.0250)	0.0382 *** (0.0143)	0.0352 (0.0250)	0.0171 (0.0299)	0.0215 (0.0247)	0.0169 (0.0301)	0.0209 (0.0246)
FIXED	0.1984 * (0.1098)	0.0580 (0.1285)	0.1987 * (0.1100)	0.0637 (0.1282)	−0.1151 (0.1498)	−0.0632 (0.0952)	−0.1121 (0.1503)	−0.0686 (0.0967)
BOARD	−0.0104 (0.0586)	0.1307 (0.0921)	−0.0090 (0.0585)	0.1322 (0.0915)	0.1051 (0.1216)	0.1067 (0.0668)	0.1080 (0.1219)	0.1075 (0.0665)
DUAL	0.0338 (0.0206)	0.0326 (0.0321)	0.0341 * (0.0206)	0.0313 (0.0320)	0.0162 (0.0310)	0.0130 (0.0230)	0.0169 (0.0311)	0.0125 (0.0229)
TOP1	0.0386 (0.1142)	0.1436 (0.1799)	0.0391 (0.1144)	0.1429 (0.1798)	0.2362 (0.1594)	−0.0404 (0.1530)	0.2391 (0.1600)	−0.0445 (0.1532)
AGE	0.1512 * (0.0891)	−0.0691 (0.2398)	0.1516 * (0.0890)	−0.0754 (0.2401)	0.4950 * (0.2573)	0.2269 * (0.1298)	0.4960 * (0.2579)	0.2242 * (0.1313)
Prior GI	0.1455 *** (0.0225)	0.1879 *** (0.0268)	0.1454 *** (0.0225)	0.1874 *** (0.0267)	−0.0681 (0.0492)	0.0655 (0.0516)	−0.0676 (0.0490)	0.0652 (0.0514)
QC − GC	−0.0631 * (0.0364)	−0.0375 (0.0456)	−0.0676 * (0.0375)	−0.0384 (0.0451)	−0.0296 (0.0305)	−0.0453 (0.0387)	−0.0266 (0.0301)	−0.0403 (0.0350)

Table A22. *Cont.*

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QC × BI − GC × BI	—	—	0.0355 (0.0286)	0.1039 *** (0.0380)	—	—	0.0262 (0.0297)	0.0216 (0.0260)
Between-group ΔGC	—	0.0238 (0.0490)	—	0.0205 (0.0485)	—	−0.0167 (0.0341)	—	−0.0174 (0.0336)
Between-group Δ(QC − GC)	—	0.0257 (0.0583)	—	0.0292 (0.0586)	—	−0.0157 (0.0492)	—	−0.0136 (0.0461)
Between-group Δ(interaction contrast)	—	—	—	0.0684 (0.0476)	—	—	—	−0.0046 (0.0395)
Group observations	6572	3510	6572	3510	1470	1525	1470	1525
Group firms	923	449	923	449	299	246	299	246
Group GC observations	203	162	203	162	63	87	63	87
Group QC observations	226	131	226	131	64	52	64	52
Joint-model within R^2	0.0379	0.0379	0.0392	0.0392	0.0169	0.0169	0.0180	0.0180

Notes: Differences are heavily polluting minus other industries, using the classification stated above. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A23. Sample Construction for the Heterogeneity Models.

Sample	Grouping	Parent Observations	Missing Grouping Variable	Eligible Observations	Singleton Observations Removed	Estimation Observations	Unique Firms
Full	Ownership	10,520	243	10,277	456	9821	1344
Full	Pollution industry	10,520	0	10,520	438	10,082	1372
Recorded	Ownership	3227	68	3159	238	2921	535
Recorded	Pollution industry	3227	0	3227	232	2995	545

Notes: Baseline and moderation models use identical samples within each row. Missing group identifiers are excluded before singleton removal. Unique firms use original identifiers; ownership subgroup counts may overlap.

Formal between-group tests for GC, QC − GC, and comparative moderation do not reach the 10% level under either sample definition. Comparative moderation is significant within the full-sample SOE and heavily polluting groups, but the corresponding between-group differences are insignificant. The results therefore do not establish systematic heterogeneity by ownership or pollution status.

Appendix G. Commitment Transitions and Publication-Centered Event Analyses

Table A24 distinguishes category variation across observed years from changes between consecutive calendar years. These measures describe observed classification transitions rather than the date of a firm's first-ever commitment.

Table A24. Firms with Changes in Climate-Commitment Categories.

Sample	Observations	Firms	Firms with Observed Category Variation	Firms Switching Between Consecutive Years	Consecutive Firm-Year Pairs	Pairs with a Category Change
Main sample	10,767	1864	433	421	8708	687
Full sample with Prior GI	10,520	1810	412	402	8526	663
Recorded sample with Prior GI	3227	777	160	148	2281	214

Notes: Category variation includes observations separated by gaps; consecutive-year switching requires adjacent years. Pair counts refer to adjacent-year comparisons rather than unique firms.

Events are the first observed GC or QC classifications in the full frozen report archive, requiring an NC report in the preceding year and a verified publication date consistent with the reporting sequence. Event year 0 is the publication year: for report year t, event years 0, +1, and +2 correspond to t + 1, t + 2, and t + 3. Calendar-year outcomes at event 0 include activity before publication.

Firms are drawn from the full or recorded prior-GI samples and must have a separate balanced outcome window from −2 through +2. The recorded branch requires source coverage in all five years. Controls have no observed commitment in the archive. Cohorts require at least five treated and twenty control firms. GC and QC are stacked separately; treated observations receive weight 1 and controls the within-cohort treated/control firm ratio. Models absorb stack-by-firm and stack-by-year effects, with original-firm clustering and no additional time-varying controls. Event −1 is the reference, and firms retain their initial event category despite later changes.

Table A25. Cohort Support for the Balanced Event Analyses.

Sample	Initial Category	Publication Year	Treated Firms	Control Firms
Full	GC	2014	7	225
Full	GC	2016	5	252
Full	GC	2019	7	310
Full	GC	2020	8	348
Full	GC	2021	18	381
Full	QC	2021	41	381
Recorded	GC	2021	7	96
Recorded	QC	2021	11	96

Notes: Only cohorts meeting the balanced-window and support requirements are reported. Controls may enter multiple stacks. These diagnostic samples differ from the main regression samples.

Table A26. Combined Positive Environmental-Record Rates around Publication.

Sample	Initial Category	Series	Year −2	Year −1	Year 0	Year +1	Year +2
Full	GC	Treated	42.22%	46.67%	51.11%	55.56%	55.56%
Full	GC	Controls	30.66%	31.37%	32.69%	34.49%	34.73%
Full	QC	Treated	31.71%	39.02%	34.15%	39.02%	41.46%
Full	QC	Controls	31.23%	32.28%	33.60%	37.27%	33.07%
Recorded	GC	Treated	100.00%	100.00%	100.00%	100.00%	100.00%
Recorded	GC	Controls	96.88%	95.83%	93.75%	96.88%	88.54%
Recorded	QC	Treated	100.00%	100.00%	100.00%	100.00%	100.00%
Recorded	QC	Controls	96.88%	95.83%	93.75%	96.88%	88.54%

Notes: Entries are weighted descriptive positive-record rates using the stated stack weights. Each cohort retains the same firms throughout the window. The recorded GC and QC analyses share the same control cohort.

Table A27. Publication-Centered Event Estimates: Full Sample.

Event Year	Combined: GC	Combined: QC	Expense: GC	Expense: QC	Capital: GC	Capital: QC
−2	−0.0374 (0.0529)	−0.0627 (0.0554)	0.0070 (0.0303)	−0.0296 (0.0250)	−0.0451 (0.0441)	−0.0488 (0.0506)
−1	0 [reference]	0 [reference]	0 [reference]	0 [reference]	0 [reference]	0 [reference]
0	0.0312 (0.0430)	−0.0619 (0.0619)	0.0200 (0.0370)	−0.0270 (0.0429)	0.0333 (0.0314)	−0.0244 (0.0457)
+1	0.0576 (0.0524)	−0.0499 (0.0635)	0.0221 (0.0387)	−0.0218 (0.0433)	0.0580 (0.0526)	−0.0360 (0.0473)
+2	0.0552 (0.0507)	0.0165 (0.0766)	0.0855 (0.0528)	−0.0218 (0.0437)	−0.0093 (0.0572)	0.0357 (0.0638)
Stacked observations	7805	2110	7805	2110	7805	2110
Unique firms	479	422	479	422	479	422
Treated firms	45	41	45	41	45	41
Stack × firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Stack × year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Outcomes are contemporaneous calendar-year combined, expense, and asset-record indicators. Coefficients measure treated–control differences relative to −1; reference coefficients are normalized to zero. Stacked observations include controls repeated across cohorts. Firm-clustered standard errors are in parentheses.

Table A28. Publication-Centered Event Estimates: Recorded Sample.

Event Year	Combined: GC	Combined: QC	Expense: GC	Expense: QC	Capital: GC	Capital: QC
−2	−0.0104 (0.0236)	−0.0104 (0.0236)	−0.0104 (0.0105)	−0.0104 (0.0105)	−0.0521 * (0.0312)	−0.0521 * (0.0312)
−1	0 [reference]	0 [reference]	0 [reference]	0 [reference]	0 [reference]	0 [reference]
0	0.0208 (0.0258)	0.0208 (0.0257)	0.0104 (0.0182)	0.0104 (0.0182)	0.1949 (0.1391)	0.0521 (0.0376)
+1	−0.0104 (0.0279)	−0.0104 (0.0279)	0.0104 (0.2060)	0.0104 (0.0236)	0.0908 (0.1407)	−0.0521 (0.0431)
+2	0.0729 ** (0.0342)	0.0729 ** (0.0342)	0.0208 (0.2073)	0.0208 (0.0333)	0.2054 (0.1434)	0.0625 (0.0513)
Observations	515	535	515	535	515	535
Unique firms	103	107	103	107	103	107
Treated firms	7	11	7	11	7	11
Stack × firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Stack × year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Outcome and estimation conventions follow Table A27, with source coverage required throughout the window. Firm-clustered standard errors are in parentheses. * and **, denote $p < 0.10$, $p < 0.05$, respectively.

Full-sample post-publication coefficients are insignificant at the 5% level. In the recorded event samples, all seven GC firms and eleven QC firms have positive combined records throughout the window. Their positive relative coefficients at +2 reflect a control-rate decline from 95.83% to 88.54%, rather than increased treated-firm participation. This ceiling is specific to those event cohorts: prior positive-record rates in the full regression sample are 38.93% for QC, 46.68% for GC, and 32.66% for NC.

Only one non-reference pre-publication coefficient is available. Recorded-sample capital coefficients at −2 are negative and reach the 10% level for GC and QC. Small treated cohorts and the short pre-period limit trend assessment; the event analyses provide descriptive diagnostics rather than causal identification.

Appendix H. Alternative Fixed Effects and Common-Sample Comparisons

All models use GI at t + 1, explanatory variables at t, Prior GI at t − 1, and firm fixed effects. Columns (1), (3), and (5) include common year effects; columns (2) and (4) instead absorb industry-by-year and province-by-year effects. Columns (3) and (5) re-estimate the original specification on exactly the observations retained in columns (2) and (4), respectively, separating sample changes from fixed-effect changes.

Original and common-sample models use the within estimator; the other models use high-dimensional fixed-effect absorption. Each estimator applies its finite-sample adjustment to clustered standard errors. Constants depend on normalization, and within R^2 reflects variation remaining after each model's fixed effects, so neither is directly compared across different fixed-effect structures.

Table A29. Alternative Fixed Effects: Full-Sample Baseline Models.

Variable	(1) Original	(2) Industry × Year	(3) Same Sample as (2)	(4) Province × Year	(5) Same Sample as (4)
GC	0.0594 ** (0.0242)	0.0565 ** (0.0240)	0.0587 ** (0.0243)	0.0595 ** (0.0241)	0.0595 ** (0.0243)
QC	0.0044 (0.0198)	0.0106 (0.0214)	0.0013 (0.0197)	0.0064 (0.0210)	0.0043 (0.0199)
BI	0.0020 (0.0074)	0.0003 (0.0073)	0.0018 (0.0075)	0.0018 (0.0075)	0.0019 (0.0074)
SIZE	0.0350 * (0.0197)	0.0273 (0.0220)	0.0334 * (0.0202)	0.0338 * (0.0203)	0.0350 * (0.0197)
LEV	−0.1337 * (0.0685)	−0.1234 * (0.0705)	−0.1244 * (0.0695)	−0.1115 (0.0691)	−0.1338 * (0.0685)
ROA	−0.0774 (0.1127)	−0.0964 (0.1224)	−0.0676 (0.1144)	−0.0642 (0.1131)	−0.0775 (0.1128)
CFO	−0.1323 * (0.0730)	−0.1559 ** (0.0787)	−0.1215 (0.0739)	−0.1215 (0.0743)	−0.1324 * (0.0730)
GROWTH	0.0375 *** (0.0127)	0.0404 *** (0.0134)	0.0370 *** (0.0129)	0.0362 *** (0.0129)	0.0375 *** (0.0127)
FIXED	0.1008 (0.0855)	0.1217 (0.0931)	0.1087 (0.0869)	0.1472 * (0.0855)	0.1008 (0.0855)
BOARD	0.0387 (0.0518)	0.0170 (0.0499)	0.0424 (0.0528)	0.0444 (0.0532)	0.0386 (0.0518)
DUAL	0.0337 * (0.0176)	0.0396 ** (0.0185)	0.0346 * (0.0178)	0.0312 * (0.0174)	0.0337 * (0.0176)
TOP1	0.0633 (0.1006)	0.0953 (0.1051)	0.0721 (0.1007)	0.0797 (0.0983)	0.0632 (0.1006)
AGE	0.1071 (0.0878)	0.1066 (0.0893)	0.1155 (0.0879)	0.0525 (0.0975)	0.1063 (0.0885)
Prior GI	0.1640 *** (0.0172)	0.1528 *** (0.0177)	0.1609 *** (0.0174)	0.1575 *** (0.0171)	0.1640 *** (0.0172)
Constant	−0.8883 * (0.5066)	−0.6867 (0.5814)	−0.8889 * (0.5161)	−0.7449 (0.5634)	−0.8865 * (0.5086)
QC − GC	−0.0550 * (0.0290)	−0.0459 (0.0303)	−0.0573 ** (0.0290)	−0.0532 * (0.0297)	−0.0552 * (0.0291)
Observations	10,520	9943	9943	10,080	10,080
Firms	1810	1363	1363	1372	1372
Within R^2	0.0463	0.0307	0.0447	0.0322	0.0462

Notes: Full-sample baseline models. Column definitions follow the opening paragraph of Appendix H. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A30. Alternative Fixed Effects: Full-Sample Moderation Models.

Variable	(1) Original	(2) Industry × Year	(3) Same Sample as (2)	(4) Province × Year	(5) Same Sample as (4)
GC	0.0635 ** (0.0247)	0.0604 ** (0.0244)	0.0628 ** (0.0248)	0.0640 *** (0.0247)	0.0637 ** (0.0248)
QC	0.0013 (0.0197)	0.0095 (0.0216)	−0.0011 (0.0197)	0.0018 (0.0210)	0.0010 (0.0198)
BI	0.0023 (0.0074)	0.0011 (0.0074)	0.0024 (0.0075)	0.0016 (0.0075)	0.0023 (0.0074)
GC × BI	−0.0399 ** (0.0166)	−0.0430 ** (0.0172)	−0.0399 ** (0.0166)	−0.0373 ** (0.0171)	−0.0401 ** (0.0166)
QC × BI	0.0165 (0.0184)	0.0080 (0.0190)	0.0125 (0.0183)	0.0252 (0.0191)	0.0166 (0.0184)
SIZE	0.0351 * (0.0198)	0.0269 (0.0220)	0.0333 * (0.0202)	0.0341 * (0.0204)	0.0351 * (0.0198)
LEV	−0.1360 ** (0.0684)	−0.1244 * (0.0703)	−0.1264 * (0.0694)	−0.1139 * (0.0690)	−0.1360 ** (0.0684)
ROA	−0.0804 (0.1127)	−0.0975 (0.1223)	−0.0701 (0.1143)	−0.0680 (0.1131)	−0.0806 (0.1127)
CFO	−0.1322 * (0.0730)	−0.1546 ** (0.0786)	−0.1212 (0.0739)	−0.1217 (0.0742)	−0.1323 * (0.0730)
GROWTH	0.0374 *** (0.0127)	0.0402 *** (0.0134)	0.0368 *** (0.0129)	0.0361 *** (0.0129)	0.0374 *** (0.0127)
FIXED	0.1009 (0.0855)	0.1217 (0.0930)	0.1086 (0.0870)	0.1474 * (0.0856)	0.1010 (0.0855)
BOARD	0.0385 (0.0517)	0.0171 (0.0498)	0.0422 (0.0527)	0.0443 (0.0531)	0.0384 (0.0517)
DUAL	0.0337 * (0.0176)	0.0397 ** (0.0185)	0.0345 * (0.0177)	0.0311 * (0.0174)	0.0337 * (0.0176)
TOP1	0.0649 (0.1006)	0.0972 (0.1050)	0.0735 (0.1007)	0.0813 (0.0983)	0.0649 (0.1006)
AGE	0.1105 (0.0878)	0.1086 (0.0892)	0.1189 (0.0879)	0.0549 (0.0975)	0.1097 (0.0885)
Prior GI	0.1636 *** (0.0172)	0.1522 *** (0.0176)	0.1604 *** (0.0174)	0.1571 *** (0.0171)	0.1636 *** (0.0172)
Constant	−0.8977 * (0.5071)	−0.6820 (0.5805)	−0.8957 * (0.5164)	−0.7574 (0.5634)	−0.8957 * (0.5090)
QC − GC	−0.0622 ** (0.0294)	−0.0510 * (0.0307)	−0.0638 ** (0.0295)	−0.0622 ** (0.0302)	−0.0627 ** (0.0296)
QC × BI − GC × BI	0.0564 ** (0.0224)	0.0509 ** (0.0233)	0.0524 ** (0.0224)	0.0625 *** (0.0234)	0.0567 ** (0.0225)
Observations	10,520	9943	9943	10,080	10,080
Firms	1810	1363	1363	1372	1372
Within R^2	0.0469	0.0314	0.0453	0.0330	0.0469

Notes: Full-sample moderation models. Column definitions follow the opening paragraph of Appendix H. Firm-clustered standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table A31. Alternative Fixed Effects: Recorded-Sample Baseline Models.

Variable	(1) Original	(2) Industry × Year	(3) Same Sample as (2)	(4) Province × Year	(5) Same Sample as (4)
GC	0.0354 * (0.0182)	0.0383 * (0.0212)	0.0380 ** (0.0186)	0.0194 (0.0171)	0.0343 * (0.0182)
QC	0.0009 (0.0241)	0.0187 (0.0273)	0.0030 (0.0245)	−0.0108 (0.0271)	−0.0017 (0.0242)
BI	−0.0010 (0.0117)	−0.0032 (0.0124)	0.0013 (0.0121)	−0.0079 (0.0127)	−0.0018 (0.0119)
SIZE	0.0102 (0.0215)	0.0448 * (0.0254)	0.0224 (0.0217)	0.0178 (0.0208)	0.0143 (0.0211)
LEV	0.0021 (0.0983)	−0.1795 * (0.1042)	−0.0141 (0.0978)	−0.0404 (0.0999)	0.0057 (0.1030)
ROA	0.2148 (0.1649)	−0.0804 (0.1922)	0.2002 (0.1740)	0.2025 (0.1818)	0.2125 (0.1669)
CFO	−0.0521 (0.1119)	−0.0012 (0.1223)	−0.0456 (0.1169)	−0.0857 (0.1254)	−0.0640 (0.1146)
GROWTH	0.0160 (0.0195)	0.0262 (0.0210)	0.0133 (0.0205)	0.0256 (0.0215)	0.0166 (0.0198)
FIXED	−0.1032 (0.0808)	−0.1304 (0.1007)	−0.1011 (0.0841)	−0.0906 (0.0911)	−0.0922 (0.0809)
BOARD	0.1119 * (0.0582)	0.0956 (0.0703)	0.1191 * (0.0628)	0.0780 (0.0691)	0.1034 * (0.0610)
DUAL	0.0165 (0.0189)	0.0217 (0.0218)	0.0163 (0.0198)	0.0171 (0.0224)	0.0178 (0.0190)
TOP1	0.0838 (0.1060)	0.1569 (0.1120)	0.0622 (0.1075)	0.0311 (0.1362)	0.0788 (0.1137)
AGE	0.3702 ** (0.1477)	0.2132 ** (0.1060)	0.3069 ** (0.1491)	0.3883 ** (0.1826)	0.3776 ** (0.1549)
Prior GI	−0.0061 (0.0362)	−0.0102 (0.0354)	−0.0087 (0.0371)	−0.0197 (0.0377)	−0.0007 (0.0366)
Constant	−0.4766 (0.6546)	−0.9095 (0.7317)	−0.5721 (0.6960)	−0.7947 (0.7922)	−0.5793 (0.6647)
QC − GC	−0.0346 (0.0258)	−0.0196 (0.0317)	−0.0350 (0.0263)	−0.0302 (0.0269)	−0.0360 (0.0261)
Observations	3227	2821	2821	2949	2949
Firms	777	528	528	544	544
Within R^2	0.0250	0.0110	0.0220	0.0115	0.0263

Notes: Recorded-sample baseline models. Column definitions follow the opening paragraph of Appendix H. Firm-clustered standard errors are in parentheses. * and ** denote $p < 0.10$, $p < 0.05$, respectively.

Table A32. Alternative Fixed Effects: Recorded-Sample Moderation Models.

Variable	(1) Original	(2) Industry × Year	(3) Same Sample as (2)	(4) Province × Year	(5) Same Sample as (4)
GC	0.0358 ** (0.0182)	0.0397 * (0.0209)	0.0385 ** (0.0186)	0.0193 (0.0170)	0.0345 * (0.0182)
QC	−0.0003 (0.0235)	0.0201 (0.0272)	0.0018 (0.0239)	−0.0100 (0.0266)	−0.0017 (0.0237)
BI	−0.0007 (0.0120)	−0.0009 (0.0127)	0.0017 (0.0124)	−0.0076 (0.0129)	−0.0011 (0.0122)
GC × BI	−0.0160 (0.0153)	−0.0478 ** (0.0202)	−0.0182 (0.0154)	0.0007 (0.0204)	−0.0163 (0.0155)
QC × BI	0.0053 (0.0176)	−0.0146 (0.0211)	0.0044 (0.0178)	−0.0068 (0.0208)	−0.0039 (0.0173)
SIZE	0.0104 (0.0216)	0.0455 * (0.0254)	0.0226 (0.0218)	0.0177 (0.0209)	0.0143 (0.0212)
LEV	0.0009 (0.0985)	−0.1769 * (0.1039)	−0.0152 (0.0980)	−0.0401 (0.1000)	0.0054 (0.1031)
ROA	0.2136 (0.1652)	−0.0733 (0.1932)	0.1993 (0.1744)	0.2033 (0.1820)	0.2132 (0.1673)
CFO	−0.0507 (0.1121)	0.0066 (0.1229)	−0.0435 (0.1172)	−0.0858 (0.1254)	−0.0622 (0.1147)
GROWTH	0.0160 (0.0195)	0.0259 (0.0210)	0.0134 (0.0206)	0.0255 (0.0216)	0.0166 (0.0198)
FIXED	−0.1038 (0.0815)	−0.1334 (0.1011)	−0.1018 (0.0848)	−0.0909 (0.0916)	−0.0938 (0.0815)
BOARD	0.1122 * (0.0582)	0.0956 (0.0702)	0.1194 * (0.0628)	0.0780 (0.0691)	0.1036 * (0.0610)
DUAL	0.0165 (0.0189)	0.0219 (0.0217)	0.0164 (0.0198)	0.0172 (0.0224)	0.0178 (0.0190)
TOP1	0.0822 (0.1061)	0.1534 (0.1121)	0.0602 (0.1076)	0.0310 (0.1363)	0.0770 (0.1138)
AGE	0.3702 ** (0.1478)	0.2095 ** (0.1060)	0.3068 ** (0.1493)	0.3886 ** (0.1826)	0.3771 ** (0.1550)
Prior GI	−0.0061 (0.0362)	−0.0107 (0.0352)	−0.0087 (0.0371)	−0.0199 (0.0377)	−0.0008 (0.0366)
Constant	−0.4807 (0.6566)	−0.9132 (0.7280)	−0.5764 (0.6978)	−0.7932 (0.7930)	−0.5779 (0.6663)
QC − GC	−0.0361 (0.0251)	−0.0196 (0.0315)	−0.0367 (0.0256)	−0.0293 (0.0261)	−0.0363 (0.0255)
QC × BI − GC × BI	0.0213 (0.0205)	0.0332 (0.0254)	0.0226 (0.0206)	−0.0075 (0.0232)	0.0124 (0.0200)
Observations	3227	2821	2821	2949	2949
Firms	777	528	528	544	544
Within R^2	0.0252	0.0123	0.0222	0.0115	0.0265

Notes: Recorded-sample moderation models. Column definitions follow the opening paragraph of Appendix H. Firm-clustered standard errors are in parentheses. * and ** denote $p < 0.10$, $p < 0.05$, respectively.

Table A33. Sample Attrition under Alternative Fixed Effects.

Sample	Additional Fixed Effects	Parent Observations	Missing Fixed-Effect Identifier	Eligible Observations	Singleton Observations Removed	Final Observations	Final Firms
Full	Industry × year	10,520	0	10,520	577	9943	1363
Full	Province × year	10,520	1	10,519	439	10,080	1372
Recorded	Industry × year	3227	0	3227	406	2821	528
Recorded	Province × year	3227	0	3227	278	2949	544

Notes: Baseline and moderation models have identical counts within each row. Singleton removal follows the absorbed fixed-effect structure. Common-sample models retain exactly the final observations in their corresponding comparison models.

Full-sample GC and comparative moderation remain positive and significant under both alternative fixed-effect structures and in the common-sample comparisons. QC − GC does not become significantly positive. Recorded-sample GC evidence weakens, and comparative moderation is insignificant under both alternatives. Table A33 attributes sample reductions to missing identifiers and singleton removal; common-sample comparisons show that the attenuation of recorded-sample GC under province-by-year effects is not solely due to sample loss.

Appendix I. Sensitivity to Commitment Classification

This appendix compares the core regression estimates obtained from the original commitment classification with those obtained from the frozen reconstructed classifier, CC-R2-candidate-20261019c. The comparison re-estimates all six specifications in each of Tables 4 and 5. Within each specification, sample membership, outcome definitions, financial and governance controls, firm and year fixed effects, and firm-level clustering remain unchanged. Board Independence retains the fixed standardization in Section 3.2.3, and financial controls retain the common winsorization thresholds in Section 3.2.4.

For the same 10,767 firm-year observations in the main analytical sample, the original classification contains 9942 NC, 419 GC, and 406 QC observations. The reconstructed classification contains 9850 NC, 595 GC, and 322 QC observations, with 946 firm-year labels differing between the two versions. Appendix A reports the classification rules and the separate human audits.

Table A34. Baseline Estimates under the Original and Reconstructed Commitment Classifications.

Panel A. Original classification						
Variable or statistic	(1)	(2)	(3)	(4)	(5)	(6)
GC	0.0592 (0.0208)	0.0673 (0.0098)	0.0594 (0.0144)	0.0553 (0.0075)	0.0354 (0.0517)	0.0354 (0.0519)
QC	0.0048 (0.8210)	0.0013 (0.9531)	0.0044 (0.8248)	−0.0096 (0.7070)	0.0011 (0.9641)	0.0009 (0.9718)
QC − GC	−0.0545 (0.0710)	−0.0660 (0.0322)	−0.0550 (0.0578)	−0.0649 (0.0249)	−0.0344 (0.1858)	−0.0346 (0.1800)
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0194	0.0198	0.0463	0.0208	0.0250	0.0250
Panel B. Frozen reconstructed classification						
Variable or statistic	(1)	(2)	(3)	(4)	(5)	(6)
GC	0.0014 (0.9434)	0.0033 (0.8684)	0.0010 (0.9602)	−0.0148 (0.5284)	−0.0089 (0.6996)	−0.0089 (0.6997)
QC	−0.0274 (0.2831)	−0.0239 (0.3638)	−0.0234 (0.3510)	−0.0389 (0.1734)	−0.0345 (0.2460)	−0.0347 (0.2413)
QC − GC	−0.0288 (0.2781)	−0.0272 (0.3227)	−0.0243 (0.3648)	−0.0241 (0.4614)	−0.0255 (0.4649)	−0.0258 (0.4590)
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0185	0.0186	0.0454	0.0197	0.0246	0.0246

Notes: The dependent variable is GI at t + 1, the combined indicator of recorded environmental expenditure or assets. All columns report firm and year fixed-effects linear probability models with the financial and governance controls specified in Table 4. NC is the reference category. Parentheses contain two-sided p values calculated using firm-clustered standard errors. Columns (1)–(6) correspond to the respective columns of Table 4. Columns (1)–(3) use the full-sample convention of coding unmatched environmental records as zero. Columns (2) and (3) use identical observations with prior GI available. Column (4) requires original environmental-source coverage at t + 1; Columns (5) and (6) require coverage at both t + 1 and t − 1. Prior GI, measured at t − 1, is included only in Columns (3) and (6). QC − GC is the within-model difference between the two commitment coefficients. Contrasts are calculated from unrounded estimates. Reported p values test the coefficients or contrasts against zero and are unadjusted for multiple comparisons.

The positive GC association under the original classification is statistically insignificant under the reconstructed classification in all six specifications. In Column (3), which includes prior environmental status and uses 10,520 observations from 1810 firms, the GC coefficient changes from 0.0594 ($p = 0.0144$) to 0.0010 ($p = 0.9602$). The QC − GC contrast remains negative, changing from −0.0550 ($p = 0.0578$) to −0.0243 ($p = 0.3648$). Under the reconstructed classification, neither the QC coefficient nor the QC − GC contrast is statistically significant at the 10% level in any specification.

Table A35. Moderation Estimates under the Original and Reconstructed Commitment Classifications.

Panel A. Original classification						
Variable or statistic	(1)	(2)	(3)	(4)	(5)	(6)
GC × BI	−0.0429 (0.0107)	−0.0460 (0.0098)	−0.0399 (0.0164)	−0.0095 (0.5913)	−0.0160 (0.2946)	−0.0160 (0.2944)
QC × BI	0.0164 (0.3865)	0.0156 (0.4174)	0.0165 (0.3694)	0.0068 (0.7785)	0.0053 (0.7642)	0.0053 (0.7657)
QC × BI − GC × BI	0.0593 (0.0085)	0.0616 (0.0079)	0.0564 (0.0121)	0.0163 (0.5658)	0.0213 (0.3005)	0.0213 (0.3010)
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0202	0.0206	0.0469	0.0209	0.0251	0.0252
Panel B. Frozen reconstructed classification						
Variable or statistic	(1)	(2)	(3)	(4)	(5)	(6)
GC × BI	−0.0188 (0.2249)	−0.0235 (0.1214)	−0.0209 (0.1926)	−0.0293 (0.3094)	−0.0321 (0.1442)	−0.0320 (0.1453)
QC × BI	0.0122 (0.5836)	0.0096 (0.6714)	0.0088 (0.6904)	0.0143 (0.4421)	0.0118 (0.5726)	0.0117 (0.5744)
QC × BI − GC × BI	0.0309 (0.2109)	0.0331 (0.1853)	0.0297 (0.2359)	0.0437 (0.1764)	0.0439 (0.1183)	0.0438 (0.1188)
Observations	10,767	10,520	10,520	4315	3227	3227
Firms	1864	1810	1810	988	777	777
Within R^2	0.0187	0.0189	0.0456	0.0203	0.0256	0.0257

Notes: The dependent variable is GI at t + 1. Columns (1)–(6) correspond to the respective columns of Table 5 and use the sample definitions described in Table A34. All models include GC, QC, BI, both commitment–BI interactions, the financial and governance controls, and firm and year fixed effects. Prior GI is included only in Columns (3) and (6). NC is the reference commitment category. BI retains its fixed standardization across classification versions. Parentheses contain two-sided *p* values calculated using firm-clustered standard errors. QC × BI − GC × BI is the within-model difference between the interaction coefficients and provides the comparative moderation test. Contrasts are calculated from unrounded estimates. Reported *p* values test the coefficients or contrasts against zero and are unadjusted for multiple comparisons.

The comparative moderation contrast remains positive under the reconstructed classification but is statistically insignificant at the 10% level in all six specifications. In Column (3), the contrast changes from 0.0564 ($p = 0.0121$) under the original classification to 0.0297 ($p = 0.2359$) under the reconstructed classification. The GC × BI coefficient changes from −0.0399 ($p = 0.0164$) to −0.0209 ($p = 0.1926$), while QC × BI changes from 0.0165 ($p = 0.3694$) to 0.0088 ($p = 0.6904$).

The comparison shows that statistical support for the original GC association and comparative moderation depends on the commitment classification. The human audits in Appendix A also identify disagreement in the positive commitment categories under both procedures. The reconstructed classification therefore provides an alternative operationalization for assessing measurement sensitivity. Its estimates qualify the interpretation of the original associations without establishing either classification as a definitive benchmark.

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