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Climate governance and emissions change across the global oil and gas value chain

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Abstract: This study investigates the relationship between climate governance mechanisms and short-term changes in greenhouse gas (GHG) emissions within the global oil and gas value chain. Using cross-sectional data from publicly listed firms, the analysis examines whether annual changes in emissions are associated with four governance dimensions: emissions policy stringency, emissions targets, climate risk and opportunity management, and prior emissions performance, as well as the value chain segment. The results show that emissions policy stringency and climate risk and opportunity management are most strongly associated with favorable emissions outcomes, while emissions targets and prior emissions performance also help explain variation in emissions change. Governance mechanisms integrated into managerial decision-making—such as emissions policy and risk management—have a stronger link to emissions reduction than mechanisms centered solely on disclosure. Additionally, midstream firms display more favorable emissions dynamics than upstream firms. In summary, climate governance is more closely linked to favorable short-term emissions dynamics when operationally embedded. These results offer practical implications for managers and policymakers seeking to improve internal climate governance and develop more credible disclosure and accountability systems to support emissions reduction.

Keywords: *Climate governance, Climate risk management, Corporate sustainability, Emissions change, Oil and gas sector.*

1. Introduction

Climate change poses a significant challenge for firms in carbon-intensive industries, particularly in the oil and gas sector. In response to heightened regulatory requirements, investor scrutiny, and stakeholder expectations, firms have increasingly adopted climate governance mechanisms, including formal emissions policies, reduction targets, and climate-related risk management practices. These mechanisms are commonly disclosed through Environmental, Social, and Governance (ESG) reporting frameworks and sustainability reports, thereby signaling corporate commitment to climate action.

Despite the rapid increase in climate-related disclosures, the extent to which governance mechanisms are associated with measurable emissions reductions remains uncertain. Empirical findings are mixed. Some studies indicate that climate governance and environmental strategies can improve both environmental and financial performance by shaping managerial decision-making and operational practices (Aibar-Guzmán, Raimo, Vitolla, & García-Sánchez, 2024; Boiral, Henri, & Talbot, 2012). Environmental innovation and supply chain practices have also been associated with lower emissions, particularly when supported by robust governance structures (Albitar, Borgi, Khan, & Zahra, 2023; Karaman, Ellili, & Uyar, 2024). Conversely, a substantial body of literature identifies a persistent gap between corporate commitments and actual emissions outcomes. Regulatory initiatives and voluntary disclosure frameworks may increase engagement in climate-related activities without producing significant emissions reductions (Haque & Ntim, 2018; Tang & Demeritt, 2018). Furthermore, emissions ratings and disclosure scores often fail to capture or predict actual environmental performance (Cregan, Kelly, & Clinch, 2024), and some governance practices may even correlate with higher emissions,

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indicating symbolic rather than substantive action (Morrison, Adu, Yongsheng, Kimani, & Saa, 2025; Orazalin, Ntim, & Malagila, 2024).

This inconsistency highlights a key limitation in the literature: climate governance is often conceptualized as a homogeneous construct, even though different mechanisms operate through distinct channels. Certain governance elements, such as formal policies and risk management systems, are integrated into organizational decision-making and may more directly shape resource allocation and operational choices (Cadez, Czerny, & Letmathe, 2019). In contrast, high-level commitments or disclosure-based initiatives may primarily serve signaling or legitimacy functions without necessarily affecting underlying practices (Cenci, Burato, Rei, & Zollo, 2023; Coen, Herman, & Pegram, 2022). Therefore, the effectiveness of climate governance depends not only on its existence but also on its specific characteristics and the extent to which it is integrated into firm operations.

This study addresses this gap by employing a multi-dimensional perspective on climate governance, distinguishing among four key mechanisms: emissions policy stringency, emissions targets, climate risk–opportunity management, and prior emissions performance. These dimensions encompass both formal governance structures and operational capabilities, facilitating a more nuanced assessment of the relationship between governance and emissions outcomes. Unlike most previous research, which emphasizes long-term performance or emissions levels, this study focuses on short-term emissions dynamics, measured as year-to-year changes in greenhouse gas emissions. This approach allows for a more direct evaluation of the near-term associations between governance mechanisms and changes in emissions.

The empirical analysis utilizes a global sample of 337 publicly listed oil and gas firms. This sector offers a particularly relevant context due to its high emissions intensity and the diversity of activities across the value chain. Firms operating in upstream, midstream, downstream, and cross-stream segments face distinct technological constraints and abatement opportunities that may affect both governance practices and emissions outcomes. Consequently, the analysis explicitly incorporates value chain heterogeneity.

The results indicate a consistent pattern: governance mechanisms embedded in managerial decision-making, particularly emissions policy and climate risk–opportunity management, are more strongly associated with favorable emissions outcomes than mechanisms primarily focused on disclosure. Emissions targets and prior performance also contribute, though to a lesser extent. Additionally, the findings reveal significant variation across value chain segments, with midstream firms exhibiting more favorable emissions dynamics than upstream firms.

This study contributes to the literature in three primary ways. First, it advances the understanding of climate governance by differentiating among mechanisms and evaluating their relative associations with changes in emissions, rather than treating governance as a single aggregate construct. Second, it offers new empirical evidence on short-term emissions dynamics, addressing the limited focus on near-term outcomes in previous research. Third, it underscores the importance of industry structure and value chain positioning, demonstrating that the observed associations involving governance practices depend on the operational context.

2. Materials and Methods

2.1. Data and Sample

The empirical analysis utilizes firm-level data from Refinitiv Datastream, focusing on publicly listed companies in the global oil and gas sector. This sector is selected due to its high emissions intensity and heightened exposure to climate-related regulation and stakeholder scrutiny. Following harmonization of firm identifiers and disclosure years, and the exclusion of observations with missing data on key variables, the final sample comprises 337 firms.

A one-year lead specification is used to address concerns about simultaneity and reverse causality. Governance variables are measured at the baseline year (2023), while the dependent variable reflects the change in emissions from 2023 to 2024. This temporal separation between predictors and outcomes aligns

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with prior studies and improves the interpretability of observed associations (Albitar et al., 2023; Orazalin et al., 2024).

2.2. Variable Definition and Measurement

The dependent variable is the annual change in reported aggregate greenhouse gas emissions (ΔGHG), calculated as reported 2024 emissions minus reported 2023 emissions. Positive values indicate an increase in emissions, while negative values indicate a reduction. Emphasizing changes in emissions, rather than absolute levels or intensity, enables a more direct assessment of short-term performance dynamics and aligns with recent research highlighting the significance of temporal variation in environmental outcomes (Doda, Gennaioli, Gouldson, Grover, & Sullivan, 2016). Because the measure is based on reported aggregate emissions values from Refinitiv Datastream, it should be interpreted as a disclosure-based indicator of year-to-year changes in emissions.

The analysis incorporates four governance variables, all derived from Refinitiv ESG indicators and measured at the 2023 baseline. Emissions Policy assesses the scope and comprehensiveness of formal emissions policies, including responsibility assignment, escalation procedures, and integration into management systems, thereby reflecting the degree to which climate governance is embedded in organizational processes. Emissions Targets evaluate the presence, coverage, and strength of publicly disclosed emissions reduction targets, which are anticipated to enhance accountability and direct managerial focus, though their effectiveness may depend on implementation quality and organizational follow-through (Doda et al., 2016; Haque & Ntim, 2018). Risk–Opportunity Management measures the identification, governance, and incorporation of climate-related risks and opportunities into strategic planning and enterprise risk management. Prior research indicates that such integration is essential for translating high-level commitments into operational decisions (Cadez et al., 2019). Emissions Performance reflects historical emissions outcomes based on disclosure-based indicators and serves as a proxy indicator for firm-level capabilities, as firms with stronger prior performance may be more likely to possess the operational expertise necessary for emissions reductions (Karaman et al., 2024).

To address structural heterogeneity within the industry, the model incorporates control variables that represent firms' positions in the oil and gas value chain. Dummy variables are specified for Midstream, Downstream, and Cross-stream activities, with Upstream serving as the reference category. The Upstream segment encompasses exploration and production activities, which are generally associated with extraction processes and are characterized by relatively high direct emissions. Midstream includes transportation, storage, and pipeline infrastructure, where emissions are primarily related to energy consumption, compression, and leakage management. Downstream comprises refining, processing, distribution, marketing, and retail activities, each characterized by distinct operational and technological constraints compared to extraction and transport. Cross-stream refers to integrated, diversified, or support activities, such as equipment provision and services, and to firms operating across multiple stages of the value chain, which do not align exclusively with a single segment. The inclusion of these controls enables the analysis to capture systematic differences in technological processes, regulatory exposure, and feasible abatement opportunities across the oil and gas value chain.

2.3. Empirical Strategy

The association between climate governance and changes in emissions is analyzed using ordinary least squares (OLS) regression. The model simultaneously includes the four governance variables and value chain segment controls. Standardized coefficients are reported to enable comparison across predictors measured on different scales.

OLS regression is appropriate due to the cross-sectional nature of the data and the continuous dependent variable. Although the estimates are interpreted as associations rather than causal effects, using governance variables measured in 2023 and an outcome covering 2023–2024 helps reduce concerns about simultaneity. The inclusion of value chain segment controls further accounts for structural heterogeneity across firms. However, omitted-variable bias and reverse causality cannot be fully ruled out in this cross-

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sectional design. Additionally, the model does not include firm-level financial or scale-related controls, such as revenue, total assets, profitability, or leverage, because consistent data were not available for the final sample. The reported estimates should therefore be interpreted as conditional associations rather than fully adjusted effects.

2.4. Diagnostic Tests

Multiple diagnostic checks are performed to assess model validity. Multicollinearity is evaluated using variance inflation factors (VIF) and tolerance values, while autocorrelation is assessed with the Durbin–Watson statistic. Residual diagnostics are also examined to detect potential outliers or influential observations. These procedures help ensure that estimated relationships are not influenced by statistical artifacts and that the model meets standard regression assumptions. As reported in Table 5, VIF values are low across predictors, indicating no evidence of problematic multicollinearity, while the Durbin-Watson statistic is close to 2. Residual screening also did not indicate problematic influential observations.

2.5. Additional Analysis

To further investigate heterogeneity across the oil and gas value chain, Kruskal–Wallis non-parametric tests are conducted. These tests compare the distributions of ΔGHG and governance variables across upstream, midstream, downstream, and cross-stream segments without assuming specific distributional forms. This approach complements regression analysis and provides additional insights into segment-specific patterns.

3. Results and Discussion

Table 1 presents descriptive statistics for the study variables. The results indicate substantial variation across firms in both changes in greenhouse gas emissions and climate governance characteristics. Year-to-year GHG change (ΔGHG) is centered near zero; however, the observed range indicates that some firms achieved reductions while others experienced significant increases. Among the governance variables, emissions policy exhibits relatively limited dispersion, whereas emissions targets, risk–opportunity management, and, especially, emissions performance exhibit greater cross-sectional variation. These findings suggest that while certain governance dimensions are relatively standardized across firms, others differ considerably in scope, quality, and implementation.

Table 1.
Descriptive Statistics.

Variable	N	Mean	SD	Min.	Max.	Skewness	Kurtosis
ΔGHG	337	0.017	0.198	-0.31	0.43	0.422	-0.115
Emissions Policy	337	57.76	0.20	57.54	58.19	0.482	-0.429
Emissions Targets	337	68.04	3.27	65.44	76.23	1.105	-0.677
Risk–Opportunity Management	337	56.79	1.70	55.36	59.68	0.485	-1.598
Emissions Performance	337	55.53	26.70	2.74	99.81	-0.189	-0.991

Note: ΔGHG represents the change in reported aggregate greenhouse gas emissions from 2023 to 2024.

All independent variables are measured in 2023. Source: Refinitiv Datastream.

Table 2 reports the Pearson correlation matrix. The correlations provide initial evidence that stronger climate governance is associated with more favorable emissions dynamics. ΔGHG is negatively and significantly correlated with all four governance variables, indicating that firms with stronger climate governance profiles tend to report smaller increases or greater reductions in emissions. The strongest bivariate associations are observed for risk–opportunity management and emissions targets, followed by emissions performance and emissions policy. Meanwhile, the correlations among the explanatory variables remain moderate, suggesting that the governance measures are related but not redundant.

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Table 2.
Pearson Correlation Matrix.

Variable	(1) ΔGHG	(2) Policy	(3) Targets	(4) Risk–Opp	(5) Performance
(1) ΔGHG	1.000				
(2) Emissions Policy	-0.145**	1.000			
(3) Emissions Targets	-0.336**	-0.277**	1.000		
(4) Risk–Opportunity Mgmt	-0.350**	-0.235**	0.572**	1.000	
(5) Emissions Performance	-0.245**	0.000	0.265**	-0.005	1.000

Note: $p < 0.01$.

Table 3 presents the Kruskal–Wallis test results to further assess heterogeneity across the oil and gas value chain. The findings reveal statistically significant differences across segments for ΔGHG and all governance variables. This demonstrates that the oil and gas value chain is not homogeneous regarding governance characteristics and emissions outcomes. The observed segmental variation justifies explicitly accounting for value chain position in the empirical analysis.

Table 3.
Kruskal–Wallis Test Results.

Variable	χ^2	df	p-value
ΔGHG	26.925	3	<0.001
Emissions Policy	70.913	3	<0.001
Emissions Targets	23.527	3	<0.001
Risk–Opportunity Management	81.676	3	<0.001
Emissions Performance	19.600	3	<0.001

Note: Grouping variable: Oil and gas value chain segment (Upstream, Midstream, Downstream, Cross-stream).

Table 4 complements these results by reporting mean ranks across segments. Midstream firms achieve the most favorable rank for ΔGHG, whereas Upstream firms have the least favorable rank. Midstream firms also perform well in emissions targets, risk–opportunity management, and emissions performance. In contrast, Upstream firms tend to receive less favorable rankings across several governance and performance dimensions. These rank-based results indicate that value chain position is closely related to both the structure of climate governance and the feasibility of near-term emissions reductions.

Table 4.
Mean Ranks by Value Chain Segment.

Variable	Upstream	Midstream	Downstream	Cross-stream
ΔGHG	201.07	125.30	162.85	157.05
Emissions Policy	198.69	94.28	219.99	149.47
Emissions Targets	146.25	215.32	153.79	178.49
Risk–Opportunity Management	122.91	230.11	142.18	204.24
Emissions Performance	138.85	191.16	190.26	183.17

Note: Lower mean rank in ΔGHG indicates more favorable (lower) emissions change.

Table 5 presents the multivariate results. The regression estimates indicate that the included climate governance variables are associated with year-to-year changes in greenhouse gas emissions, although the strength of these associations varies across governance mechanisms. Overall, the results show that governance elements embedded in managerial decision-making processes are more closely associated with favorable emissions outcomes than those primarily oriented toward disclosure.

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Table 5.
Multivariate Results.

Predictor	B	SE	β	t	p-value	VIF
Constant	20.815	3.039	—	6.850	<0.001	—
Emissions Policy	-0.317	0.052	-0.319	-6.114	<0.001	1.253
Emissions Targets	-0.010	0.004	-0.171	-2.768	0.006	1.745
Risk–Opportunity Management	-0.029	0.007	-0.253	-3.957	<0.001	1.874
Emissions Performance	-0.001	0.000	-0.169	-3.299	0.001	1.209
Midstream (dummy)	-0.109	0.033	-0.207	-3.308	0.001	1.797
Downstream (dummy)	-0.031	0.029	-0.055	-1.060	0.290	1.248
Cross-stream (dummy)	-0.020	0.025	-0.047	-0.791	0.429	1.619
Model fit:						
$R^2 = 0.284$						
Adjusted $R^2 = 0.269$						
$F(7,329) = 18.630$ ($p < 0.001$)						
Durbin–Watson = 1.878						

Note: Predictors measured in 2023; dependent variable reflects reported emissions change from 2023 to 2024.

Among the governance variables, Emissions Policy shows the strongest association with year-to-year changes in emissions. Table 5 indicates that this variable has the largest standardized coefficient in the model. This finding suggests that formalized and operationalized policy frameworks, such as clearly defined responsibilities, internal rules, and escalation mechanisms, are more strongly associated with favorable year-to-year emissions dynamics. The result aligns with prior research emphasizing the importance of strategy integration and decision-oriented governance structures for environmental performance (Cadez et al., 2019). It also supports the perspective that governance mechanisms may be more strongly associated with favorable outcomes when embedded in organizational routines rather than existing solely as high-level commitments.

Risk–Opportunity Management is identified as the second most influential factor. As shown in Table 2, it displays the strongest bivariate association with ΔGHG among the governance variables, and its effect remains substantial and statistically significant in the regression model (Table 5). Firms that more effectively integrate climate-related risks and opportunities into strategic planning and risk management processes tend to exhibit more favorable emissions dynamics. This finding supports the argument that risk integration may serve as a channel linking governance commitments to operational responses (Cadez et al., 2019). It also aligns with broader evidence indicating that governance structures can strengthen the relationship between operational and innovation-related efforts and emissions reductions (Albitar et al., 2023).

Emissions targets are also negatively associated with emissions change, although their effect is comparatively weaker than that of policy and risk integration. As shown in Table 1, this variable displays greater dispersion than emissions policy, while Tables 2 and 5 confirm a negative and statistically significant relationship with ΔGHG. This result is consistent with the literature suggesting that targets can improve accountability and guide managerial attention, but their effectiveness depends on the quality of implementation, monitoring, and enforcement (Doda et al., 2016). Prior research has also demonstrated that targets and voluntary commitments often increase engagement in climate-related initiatives without necessarily producing immediate emissions reductions (Haque & Ntim, 2018; Tang & Demeritt, 2018). The comparatively smaller effect observed here may reflect the time required for targets to influence operational outcomes, as well as differences in target credibility, scope, and organizational integration.

A similar pattern is observed for Emissions Performance, which is also negatively and significantly associated with emissions change. Table 1 shows substantial variation in this variable across firms, indicating marked differences in prior environmental capabilities, while Tables 2 and 5 confirm its negative association with ΔGHG. This finding supports the use of emissions performance as a proxy indicator of underlying capabilities. Firms that have developed operational expertise, technological know-how, and internal processes related to emissions management may be better positioned to implement

incremental reductions (Karaman et al., 2024). This capability-based explanation complements the governance perspective by emphasizing the role of internal resources in shaping the observed relationship between governance and measurable outcomes.

Collectively, these findings reveal a clear hierarchy in the strength of the observed associations across governance mechanisms. Mechanisms embedded in decision-making processes, specifically emissions policy and risk–opportunity management, exhibit the strongest associations with emissions change, while targets and prior performance play supporting roles (Table 5). This pattern contributes to the ongoing "talk–walk" debate by demonstrating that not all governance mechanisms are equally strongly associated with near-term emissions dynamics. In particular, governance elements closely linked to operational decision-making appear to be more closely linked to immediate emissions outcomes than those primarily oriented toward external signaling.

This interpretation is further supported by recent evidence on the limitations of disclosure-based measures. Studies have shown that ESG ratings and emissions scores often fail to capture actual environmental performance (Cregan et al., 2024) and that firms may adopt climate-related initiatives without achieving corresponding emissions reductions (Morrison et al., 2025; Orazalin et al., 2024). Similarly, content-based analyses indicate that the effectiveness of climate initiatives depends on their specificity and operational relevance rather than their number or visibility (Cenci et al., 2023; Coen et al., 2022). The present findings reinforce this perspective by highlighting the importance of governance mechanisms that directly shape managerial decisions and organizational processes.

The regression results also confirm the importance of value chain heterogeneity. As shown in Table 5, the Midstream dummy is negative and statistically significant relative to the Upstream reference category, while the coefficients for Downstream and Cross-stream are not statistically significant. This pattern aligns with the non-parametric evidence reported in Tables 3 and 4. Midstream activities, such as transport and storage, often present more immediate abatement opportunities through efficiency improvements, leak detection, and infrastructure optimization. In contrast, Upstream operations are typically more emissions-intensive and more tightly constrained by extraction processes, making short-term reductions more difficult to achieve.

These segment-specific findings underscore the importance of contextual factors in shaping the effectiveness of climate governance. As indicated in prior research, the impact of governance mechanisms depends not only on their formal existence but also on the availability of feasible abatement options and the broader regulatory and technological environment (Cadez et al., 2019). These factors also help explain why similar governance practices may produce different outcomes across firms and industry segments.

Overall, the results indicate that climate governance is most closely associated with favorable emissions dynamics when it is substantive and operationally embedded. Formal policies and risk management processes that influence daily decisions show stronger associations with emissions change, whereas disclosure-oriented mechanisms alone appear less strongly associated with near-term performance differences. This distinction provides a more nuanced understanding of the relationship between corporate climate commitments and environmental outcomes and underscores the need to move beyond aggregate measures of governance toward a more differentiated approach.

4. Conclusion

This study investigated the associations between various climate governance mechanisms and short-term changes in greenhouse gas emissions across the global oil and gas value chain. The analysis employed a multi-dimensional perspective, distinguishing among emissions policy, emissions targets, climate risk and opportunity management, and prior emissions performance, and assessed their relative importance in explaining annual emissions dynamics.

The findings indicate a consistent pattern: governance mechanisms integrated into managerial decision-making processes, particularly those related to emissions policy and climate risk and opportunity management, are more strongly associated with favorable emissions outcomes than mechanisms focused primarily on disclosure. Emissions targets and prior performance also help explain changes in emissions,

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though their effects are comparatively weaker. Furthermore, the results reveal significant heterogeneity across value chain segments, with midstream firms demonstrating more favorable emissions dynamics than upstream firms.

The study also presents several practical implications. For managers, the results underscore the importance of reinforcing governance mechanisms that directly shape decision-making processes. This involves developing comprehensive operational emissions policies, integrating climate considerations into enterprise risk management, and ensuring governance structures align with resource allocation and operational practices. Although emissions targets remain important for accountability and communication, their effectiveness depends on their integration into broader governance systems.

For policymakers and regulators, the findings indicate that disclosure-based approaches alone are likely insufficient to achieve substantial emissions reductions. Regulatory frameworks may benefit from prioritizing governance elements that reflect internal decision-making processes, including policy integration, accountability structures, and risk management practices. Improving the quality and comparability of these indicators could enhance the effectiveness of climate-related disclosure regimes and enable more credible assessments of corporate climate performance.

Despite its contributions, this study has several limitations. First, the analysis relies on cross-sectional data, which restricts the ability to establish causal relationships. Although the one-year lead specification helps mitigate simultaneity concerns, unobserved factors may still affect the observed associations. Second, the governance variables are based on disclosure-derived indicators, which may be subject to measurement error or may partially reflect signaling rather than actual practices. Third, the dependent variable measures reported aggregate changes in emissions and does not differentiate among emission scopes or sources, potentially obscuring underlying mechanisms. Fourth, the model does not include firm-level financial or scale-related controls, such as revenue, total assets, profitability, or leverage, because consistent data were not available for the final sample. Accordingly, part of the observed variation in emissions changes may reflect differences in firm size, growth, contraction, or capital structure rather than governance characteristics alone.

Future research could address these limitations by utilizing panel data methods, incorporating scope-specific emissions measures, and examining the dynamic effects of governance mechanisms over extended periods. Additionally, further studies could investigate how governance interacts with technological, regulatory, and market factors to influence emissions outcomes, and how these relationships differ across industries and institutional contexts.

In conclusion, this study demonstrates that climate governance is more closely associated with favorable emissions dynamics when embedded in organizational decision-making and supported by operational capabilities. Advancing beyond disclosure toward substantive, decision-oriented governance may be important for supporting significant progress in emissions reduction.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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