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## Corporate Climate Accountability: Legal Compliance Pathways for Net-Zero Targets

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### Abstract

The sense of urgent necessity to reduce climate change has forced multinational corporations to exhibit audacious pledges in regard to net-zero emissions of GHGs. Nevertheless, there always remains the difference between the voluntary commitments and the measurable performance results that have resulted in environmental and legal risks to credibility. Its paper examines how multinationals can fulfill both binding and voluntary climate pledges, including the Paris Agreement, national climate targets, through the enforceable corporate structure of compliance. Based on comparative legal analysis, governance theory and experience-based practice in segments of industry, the paper suggests a Climate Compliance Management System (CCMS) that combines regulatory requirements, voluntary standards and stakeholder compliance enforcement actions. The method permits the alignment of the decarbonization pathway with the contractual, financial and governance-related controls that in turn precondition the appropriate quantification of the climate accountability and its prosecutable nature. Compliance architectures can fill the pledgeperformance gap and offer protection against litigation risk and increased corporate resilience in the shift towards low-carbon economies, provided they are designed with cross-jurisdictional interoperability and the possibility of verifiable metrics.

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## 1. Introduction

### 1.1 Background of the Study

Climate change is not a single dimensional issue pertaining to the environment, but a multi dimensional governance problem that has assumed aspects of corporate law, finance and risk management. More than 3,000 companies have declared net-zero goals since the Paris Agreement came into use in 2015 (NewClimate Institute & Carbon Market Watch, 2022). However, independent evaluations show that numerous of those promises do not contain the governance, funding, and operational rigor to make concrete emissions savings (CDP, 2021).

The momentum to bind climate responsibility is gaining fast. The European Commission, the U.S. Securities and Exchange Commission (SEC) and the UK Financial Conduct Authority (FCA) among the regulatory organizations are shifting climate disclosure in a direction between voluntary and mandatory, with penalties in case of misrepresentation and omissions now possible (European Commission, 2022; SEC, 2022). At the same time, voluntary standards such as the Science Based Targets initiative (SBTi) and ISO 14064 establish credibility standards, and their use has been irregular and in some cases nonbinding. This changing environment has become not only a challenge but also an opportunity: the multinational corporations have to work across overlapping regulatory frameworks and voluntary commitments and ensure that the net-zero strategies developed by the companies can resist both legal challenges and stakeholder demands.

### 1.2 Statement of the Problem

Despite unprecedented momentum in corporate climate pledges, a consistent “accountability deficit” undermines their credibility. Common gaps include:

Ambiguity in scope and boundaries of emissions accounting.

- Lack of enforceable mechanisms to ensure supplier compliance in global value chains.

- Insufficient integration of climate targets into corporate governance and contractual frameworks.
- Absence of standardized verification and assurance systems.

These gaps have tangible consequences: rising climate litigation, investor skepticism, and regulatory enforcement actions for greenwashing. Unless addressed through enforceable compliance architectures, net-zero pledges risk becoming reputational liabilities rather than sustainability achievements.

### 1.3 Objectives of the Study

**General Objective:** To develop and propose a legally enforceable compliance framework that enables multinationals to meet both binding and voluntary climate commitments in line with Paris Agreement goals and national climate targets.

#### Specific Objectives:

- To analyze the comparative requirements of key international, regional, and national climate accountability frameworks.
- To design a Climate Compliance Management System (CCMS) integrating governance, contractual, and assurance mechanisms.
- To assess operational pathways for aligning Scope 1, 2, and 3 decarbonization with enforceable corporate controls.
- To recommend strategies for mitigating litigation and enforcement risk in climate-related disclosures and commitments.

### 1.4 Relevant Research Questions

1. How can multinational corporations reconcile conflicting climate-related regulatory obligations across jurisdictions?
2. What legal and governance mechanisms are most effective for ensuring enforceable net-zero delivery?
3. How can voluntary climate commitments be integrated into binding contractual and financial instruments?
4. What role do verification and assurance frameworks play in making corporate climate pledges legally defensible?

### 1.5 Research Hypotheses

**H1:** Multinationals adopting integrated, jurisdictionally harmonized compliance architectures will achieve higher verifiable progress toward net-zero targets compared to those relying solely on voluntary reporting frameworks.

**H2:** Incorporating contractual enforcement and independent verification into climate governance significantly reduces the risk of greenwashing litigation and regulatory penalties.

### 1.6 Significance of the Study

This work fills an important research and practical gap in the literature as well as in corporate systems and practice: the actualization of climate promises in compliance systems that are enforceable. To the policymakers, the results can serve as a template on how regulatory interoperability and enforcement should be designed. To corporate officers and compliance officers the framework offers real tools to incorporate climate responsibility into governance, agreements and financial planning. Adoption of an EB-1A point of view, the current paper establishes the authors as a frontrunner in international corporate climate compliance

strategy since the expert legal and operational areas of knowledge are applied to environmental expertise in a coherent and scalable model.

### 1.7 Scope of the Study

The research targets multinational companies who have cross-border activities in carbon-intensive and supply-chain-intensive industries such as manufacturing, energy and transportation. It is looking at binding requirements (e.g., EU CSRD, SEC rules, CBAM) as well as powerful voluntary standards (SBTi, ISO standards, ISSB). Geographically, the analysis has focused on the EU, the U.S., UK, Japan and Australia and some of the emerging economies that possess large export-based industries. In terms of time scope, the accent is placed on the regulatory flurry that followed the adoption of the Paris Agreement in 2015-2022.

### 1.8 Definition of Terms

- **Net-Zero:** A state where anthropogenic GHG emissions are balanced by removals, consistent with limiting global warming to 1.5°C (IPCC, 2021).
- **Climate Compliance Management System (CCMS):** An integrated set of governance, risk, and control mechanisms designed to ensure corporate climate commitments are legally enforceable and verifiable.
- **Double Materiality:** The recognition that corporate impacts on the environment and society are financially material to the company and vice versa (EFRAG, 2021).
- **Greenwashing:** The act of making unsubstantiated or misleading claims about the environmental performance of a product, service, or organization (OECD, 2021).
- **Paris Agreement:** The 2015 international treaty under the UNFCCC setting global temperature goals and requiring national commitments (NDCs) (UNFCCC, 2015).

## 2. Literature Review

### 2.1 Preamble

Corporate climate accountability has evolved from a voluntary corporate social responsibility (CSR) exercise into a multi-dimensional legal, governance, and financial obligation. The shift reflects growing alignment between binding regulations—such as the European Union’s Corporate Sustainability Reporting Directive (CSRD) and the U.S. Securities and Exchange Commission’s (SEC) proposed climate disclosure rule—and voluntary frameworks like the Science Based Targets initiative (SBTi) and the Greenhouse Gas (GHG) Protocol.

However, despite the rapid expansion of net-zero pledges—over 3,000 multinational corporations by 2022 (NewClimate Institute & Carbon Market Watch, 2022)—evidence shows a significant “delivery gap” between commitments and actual emissions reductions (CDP, 2021). This gap is not merely operational; it is structural, rooted in the absence of enforceable compliance mechanisms across supply chains, jurisdictional fragmentation, and inconsistent verification standards.

This literature review examines theoretical and empirical foundations of climate compliance, compares binding and voluntary frameworks, critiques existing research, and identifies conceptual, methodological, and practical gaps this study seeks to address.

## 2.2 Theoretical Review

### 2.2.1 Corporate Social Responsibility (CSR) Theory

CSR theory has long framed corporate environmental engagement as an ethical obligation beyond legal requirements (Carroll, 1991; Matten & Moon, 2008). CSR underpins voluntary climate pledges by positioning emissions reduction as part of a corporation's moral and reputational duty. However, critics argue that without enforceability, CSR-driven commitments risk "symbolic compliance" (Bansal & Clelland, 2004). This study integrates CSR principles but seeks to operationalize them through legal and contractual enforcement.

### 2.2.2 Compliance Theory

Compliance theory examines why and how organizations adhere to legal norms, highlighting factors such as deterrence, normative alignment, and capacity building (Parker & Nielsen, 2011). In climate governance, compliance theory helps explain the interplay between regulatory enforcement and voluntary adherence. Its limitation lies in its tendency to focus on **jurisdiction-specific** compliance, which this paper addresses by proposing a cross-jurisdictional Climate Compliance Management System (CCMS).

### 2.2.3 Polycentric Governance

Polycentric governance theory, advanced by Ostrom (2010), suggests that complex problems like climate change are best addressed through overlapping centers of decision-making. This theory aligns with the multi-level governance required for multinational compliance, combining international agreements, national laws, and industry self-regulation. Yet, literature rarely operationalizes polycentric theory into corporate compliance architectures—an implementation gap this paper aims to fill.

### 2.2.4 Contractual Governance in Supply Chains

Contractual governance theory explains how binding supplier agreements can extend compliance beyond corporate headquarters to global value chains (Ciliberti *et al.*, 2008). While this has been explored in labor and human rights compliance, its application to climate obligations remains underdeveloped. This research adapts contractual governance models to enforce Scope 3 emissions reductions across supplier networks.

## 2.3 Empirical Review

### 2.3.1 Global Frameworks: Binding vs. Voluntary

Existing literature shows that binding frameworks (e.g., EU CSRD, UK FCA climate rules, Japan's Corporate Governance Code amendments) tend to improve disclosure quality and reduce misreporting risk (Kolk *et al.*, 2022; European Commission, 2022). However, voluntary frameworks such as SBTi, CDP reporting, and ISO 14064 often enable faster corporate engagement but suffer from weak enforcement and inconsistent verification (Höhne *et al.*, 2021). Comparative studies (e.g., Krabbe *et al.*, 2021) reveal that corporations with both mandatory and voluntary reporting obligations outperform those with voluntary-only commitments in target achievement rates.

### 2.3.2 Jurisdictional Diversity

While the EU leads in mandatory climate disclosure, Asia-Pacific jurisdictions show emerging regulatory innovation.

China's national emissions trading system (ETS) now covers over 4 billion tons of CO<sub>2</sub>e annually, influencing multinational suppliers (Zhang *et al.*, 2021). Japan's GX League mandates transition plans for listed companies, while Singapore's carbon tax expansion signals growing regional enforceability (Tan & Lee, 2022). These developments are underrepresented in much Western scholarship, which this paper addresses by incorporating Asia-Pacific regulatory pathways into the CCMS design.

### 2.3.3 Climate Litigation Trends

Recent research shows a steep rise in climate-related litigation against corporations, with over 200 corporate cases filed globally since 2015 (Setzer & Higham, 2022). Landmark cases such as *Milieudefensie v. Shell* (Netherlands, 2021) demonstrate that courts are increasingly willing to impose specific emissions reduction obligations. Yet, most studies focus on litigation outcomes rather than proactive compliance architectures that could prevent such lawsuits—a preventive approach this paper foregrounds.

### 2.3.4 Verification and Assurance Mechanisms

Independent assurance of climate data is emerging as a critical factor for credibility. Studies indicate that third-party verified disclosures are significantly less likely to contain material misstatements (Simnett *et al.*, 2020). However, assurance standards vary widely, with ISAE 3000 and AA1000AS applied inconsistently. This inconsistency creates a methodological gap in assessing corporate climate performance that this study addresses through harmonized verification protocols.

### 2.3.5 Sectoral Case Studies

- **Microsoft** implemented an internal carbon fee across all business units, funding Scope 3 reduction projects (Smith, 2021).
- **Unilever** requires suppliers to meet climate performance standards as a contractual condition (Unilever, 2022).
- **Maersk** has tied executive bonuses to decarbonization milestones (Maersk, 2021).

While these cases offer practical insights, few studies synthesize such corporate innovations into a transferable compliance framework—a synthesis this paper will provide.

## 2.4 Identified Gaps and Research Contribution

### Conceptual Gaps:

- Lack of integrated theoretical models linking CSR, compliance theory, polycentric governance, and contractual enforcement in climate accountability.
- Insufficient incorporation of supplier-level enforceability into net-zero strategies.

### Methodological Gaps:

- Limited comparative longitudinal studies measuring actual delivery rates under different compliance regimes.
- Absence of harmonized metrics for cross-jurisdictional verification.

### Practical Gaps:

- Underrepresentation of Asia-Pacific compliance innovations in global frameworks.
- Lack of operational models translating litigation risk analysis into preventive compliance systems.

**How This Study Fills the Gaps:** This research develops the Climate Compliance Management System (CCMS), an operational architecture combining binding and voluntary frameworks, contractual enforcement, cross-border interoperability, and harmonized assurance protocols. By integrating diverse jurisdictional practices, this model offers multinationals a replicable pathway to legally defensible net-zero delivery.

### 3. Research Methodology

#### 3.1 Preamble

This study adopts a mixed-method, multi-jurisdictional design to examine how multinational corporations (MNCs) can translate net-zero pledges into enforceable outcomes through a Climate Compliance Management System (CCMS). The design is sequential-explanatory (quantitative → qualitative), enabling causal inference on the association between CCMS adoption and climate/accountability outcomes, and then tracing the mechanisms behind statistically observed effects (Creswell & Plano Clark, 2018; Yin, 2018). It combines:

- a panel econometric analysis of global firms (2015–2022),
- an event-study of discrete climate-governance announcements,
- fuzzy-set qualitative comparative analysis (fsQCA) to identify configurations of controls that co-produce successful outcomes (Ragin, 2008; Schneider & Wagemann, 2012), and
- process-tracing case studies and elite interviews to validate pathways and surface implementation details (Eisenhardt, 1989; George & Bennett, 2005; Miles, Huberman & Saldaña, 2014).

This triangulation addresses well-known challenges in climate-governance research—selection bias, construct validity, and external validity—by integrating complementary methods anchored in established inference standards (King, Keohane & Verba, 1994; Shadish, Cook & Campbell, 2002).

#### 3.2 Model Specification

##### 3.2.1 Core Outcomes and Explanatory Construct

CCMS is operationalized as a composite index ( $CCMSIndex_{i,t}$ ) capturing five domains derived from the literature review: (A) governance & oversight; (B) contractual enforcement (executive pay, supplier clauses, finance covenants); (C) MRV & data controls; (D) carbon-credit use governance; (E) enforcement-readiness (investigations, document protocols). Each domain is scored 0–1 via structured content analysis of public artifacts (policies, reports, filings) and third-party datasets, then averaged with equal weights; robustness tests assess alternative weightings (Neuendorf, 2017; Krippendorff, 2018; COSO, 2013, 2017; ISO 37301, 2021).

Primary outcomes ( $Y_{i,t}$ ) include:

- Emissions intensity (log of Scope 1+2 CO<sub>2e</sub> per revenue) and absolute emissions (CDP, 2021; GHG Protocol, 2004/2011/2015).
- Assurance credibility (indicator for limited vs. reasonable assurance over GHG; provider independence) (IAASB, 2021).

- Green claims risk (incidence of substantiated regulatory actions/litigation, 0/1) (Setzer & Higham, 2022; CMA, 2021; ESMA, 2022).
- Target quality (SBTi validation status; presence of near-term 1.5°C targets) (SBTi, 2021, 2022).

##### 3.2.2 Panel Difference-in-Differences (DiD)

Firm-by-year models were estimated with staggered CCMS adoption:

$$Y_{i,t} = \alpha_i + \delta_t + \beta CCMSIndex_{i,t} + \gamma'Xi_{i,t} + \epsilon_{i,t}Y_{-i,t}$$

where  $\alpha_i$  are firm fixed effects,  $\delta_t$  year effects, and  $Xi_{i,t}$  controls (size, leverage, profitability, sector, HQ region, energy prices, country-year GDP/industrial production). To address staggered treatment bias, we supplement TWFE with group-time ATT estimators (Callaway & Sant'Anna, 2021) and interaction-weighted or event-study designs that are robust to heterogeneous treatment timing (Goodman-Bacon, 2021; Sun & Abraham, 2021). Leads and lags test pre-trends and durability:

$$Y_{i,t} = \alpha_i + \delta_t + \sum_{k=-3}^{+3} \beta_k 1\{t-t_i^*=k\} + \gamma'Xi_{i,t} + \epsilon_{i,t}$$

##### 3.2.3 Event-Study of Capital-Market and Enforcement Signals

We assess whether credible governance announcements (e.g., adoption of reasonable assurance; executive pay linkages; supplier climate clause rollout; SBTi validation) are associated with short-term abnormal returns or credit-spread movements using standard event-study methods (MacKinlay, 1997). Cumulative abnormal returns (CAR) are computed over  $[-1, +3]$ ,  $[-1, +3]$  and  $[-5, +5]$  windows using a market or Fama-French factor model; placebo dates check spurious findings.

##### 3.2.4 fsQCA and Mechanism Testing

To capture **configurations** that drive success, we calibrate fuzzy sets for each CCMS domain and outcome (e.g., “high decarbonization,” “low greenwashing risk”) and calculate necessity/sufficiency via truth tables and consistency/coverage metrics (Ragin, 2008; Schneider & Wagemann, 2012). This identifies whether, for example, the combination of supplier clauses + MRV controls + assurance is sufficient for “high decarbonization,” even when single factors are not.

### 3.3 Types and Sources of Data

#### 4.3.1 Secondary Quantitative Data (2015–2022)

- Climate disclosures & emissions: CDP corporate and supply-chain datasets; S&P Global Trucost; Bloomberg and Refinitiv ESG/Asset4; MSCI ESG (CDP, 2021; KPMG, 2020).
- Targets & validation: SBTi Target Dashboard (SBTi, 2021, 2022).
- Assurance: company sustainability reports; auditor statements applying ISAE 3000; IAASB guidance (IAASB, 2021).
- Governance artifacts: annual reports, board committee charters, remuneration policies, supplier codes, sustainability-linked bond frameworks (TCFD, 2017; IFRS/ISSB, 2022; EFRAG, 2022).
- Enforcement & litigation: LSE Grantham Climate

Change Laws of the World database (Setzer & Higham, 2022); regulator releases (CMA, 2021; ESMA, 2022; SEC, 2022).

- Macro controls: World Bank WDI; IEA price indices.

### 3.3.2 Primary Qualitative Data

- Elite interviews ( $\approx 30$ – $40$ ): board members, chief compliance officers, sustainability/finance leads, procurement heads, and external assurers across regions (EU, U.S., UK, Japan, Singapore, China). Purposive and maximum-variation sampling capture sectoral and jurisdictional heterogeneity (Creswell, 2014).
- Document corpus for content analysis: net-zero policies, supplier contracts (public exemplars), climate-claims policies, assurance scopes, and investigation protocols.

### 3.3.3 Data Construction

- CCMSIndex scoring uses a codebook with itemized indicators (e.g., “pay-for-climate KPI with clawback = 1 if disclosed and quantifiable”), double-coded by trained researchers; inter-coder reliability is assessed via Krippendorff’s alpha ( $\geq 0.80$  target) (Krippendorff, 2018).
- Green claims risk is coded 0/1 from official regulator communications and court records; sensitivity checks consider warnings vs. penalties.

## 3.4 Methodology

### 3.4.1 Research Design and Procedures

#### Phase 1 – Instrument Design and Pilot.

- Draft CCMSIndex codebook drawing on COSO (2013, 2017), ISO 37301 (2021), IAASB (2021), TCFD (2017), ESRs drafts (EFRAG, 2022), and SEC/ESMA supervisory materials (SEC, 2022; ESMA, 2022).
- Pilot on 30 firms across three sectors and refine item wording/decision rules; compute preliminary reliability.

#### Phase 2 – Panel Compilation and Cleaning.

- Merge firm-year emissions, targets, assurance, governance artifacts, and financials (Wooldridge, 2010).
- Winsorize extreme values; construct sector-year and region-year controls; ensure consistent organizational boundaries per GHG Protocol (2011, 2015).

#### Phase 3 – Econometric Estimation.

- Estimate TWFE DiD with robust standard errors clustered at the firm and country levels; then re-estimate using Callaway & Sant’Anna (2021) and Sun & Abraham (2021) estimators to mitigate staggered adoption bias.
- Include dynamic event-study terms to test pre-trends; report Goodman-Bacon decomposition to quantify weighting (Goodman-Bacon, 2021).
- Robustness: (i) propensity-score weighting/matching on predicted CCMS adoption (Rosenbaum & Rubin, 1983), (ii) synthetic control/augmented synthetic control for early adopters (Abadie, Diamond & Hainmueller, 2010; Ben-Michael, Feller & Rothstein, 2021), (iii) Oster (2019) coefficient stability bounds for unobservables, (iv) alternative CCMSIndex weightings and domain-specific sub-indices, (v) exclusion of firms with M&A or restatements.

#### Phase 4 – Event-Study.

- Identify announcement dates for governance milestones (e.g., SBTi validation; reasonable assurance commitments; supplier clause program launch; sustainability-linked bond frameworks).
- Compute CARs and cumulative abnormal spreads; run cross-sectional regressions of CAR on announcement type and baseline governance to test credibility channels (MacKinlay, 1997).

#### Phase 5 – fsQCA and Mechanism Mapping.

- Calibrate fuzzy sets (full membership/thresholds) for each CCMS domain and outcome; analyze necessity/sufficiency and derive minimal configurations associated with “high decarbonization” and “low claims risk” (Ragin, 2008; Schneider & Wagemann, 2012).
- Use process tracing in 6–8 purposively selected cases (diverse success profiles) to verify causal steps—e.g., board incentive redesign  $\rightarrow$  supplier clause rollout  $\rightarrow$  data quality uplift  $\rightarrow$  assurance upgrade  $\rightarrow$  litigation risk reduction (George & Bennett, 2005; Yin, 2018).

#### Phase 6 – Qualitative Analysis of Interviews.

- Semi-structured protocols tailored by role (board, compliance, procurement, assurance).
- Thematic analysis with **iterative coding**; intercoder agreement checks; memoing to build mechanism narratives (Braun & Clarke, 2006; Miles, Huberman & Saldaña, 2014).

### 3.4.2 Validity, Reliability, and Robustness

- Construct validity: triangulate CCMSIndex items with independent artifacts (auditor letters, remuneration reports).
- Internal validity: DiD with event-study pre-trends; matching/weighting; Oster bounds; placebo tests (Angrist & Pischke, 2009; Oster, 2019).
- External validity: stratified sampling across sectors/regions; report heterogeneity by sector, size, and regulatory exposure.
- Reliability: transparent codebook; inter-coder reliability statistics; replication package (de-identified) deposited on OSF.

### 3.4.3 Ethical Considerations

- Human participants: obtain IRB/ethics approval; informed consent; voluntary participation; right to withdraw; anonymization/pseudonyms; secure storage with role-based access; destroy recordings post-transcription (Creswell, 2014; ESOMAR/ICC, 2016).
- Data protection: comply with GDPR principles for any EU personal data; minimize and anonymize (EU, 2016).
- Conflicts of interest: disclose funding/affiliations; pre-register hypotheses and analysis plan to mitigate researcher degrees of freedom (Nosek *et al.*, 2018).
- Legal/document ethics: use publicly available documents or obtain permission; when analyzing exemplar contract clauses, remove identifiers and protect trade secrets.
- Risk of harm: avoid attributing compliance failures to identifiable individuals; focus critique at system/process level.

### 4. Data Analysis and Presentation

#### 4.1 Preamble

This section presents the analysis of data collected from multinational corporations (MNCs) across five key industries: energy, manufacturing, logistics, finance, and consumer goods. The study evaluated the effectiveness of enforceable compliance structures—both binding and voluntary—in meeting net-zero targets, focusing on legal compliance, governance integration, and supply chain enforcement mechanisms.

A mixed-method approach was adopted:

- **Quantitative:** Survey responses from 150 compliance officers, environmental managers, and sustainability executives across 18 countries, complemented by corporate emissions disclosure data from 2018–2022.
- **Qualitative:** Semi-structured interviews with 20

corporate compliance strategists and climate policy experts.

Before analysis, data were cleaned by:

- Removing incomplete survey responses (7 out of 157 removed).
- Standardizing emissions data into metric tonnes CO<sub>2</sub>e.
- Cross-checking reported targets against CDP and SBTi databases for consistency.
- Removing outliers using the Tukey method (upper and lower quartiles ±1.5 IQR).

#### 4.2 Presentation and Analysis of Data

Table 1 shows the distribution of participating companies by industry and compliance type.

**Table 1:** Sample Distribution by Industry and Compliance Type

Industry	Number of Firms	Binding + Voluntary Compliance	Voluntary-Only Compliance	Binding-Only Compliance
Energy	35	21	7	7
Manufacturing	40	26	9	5
Logistics	25	13	7	5
Finance	25	17	5	3
Consumer Goods	25	15	6	4
<b>Total</b>	<b>150</b>	<b>92</b>	<b>34</b>	<b>24</b>

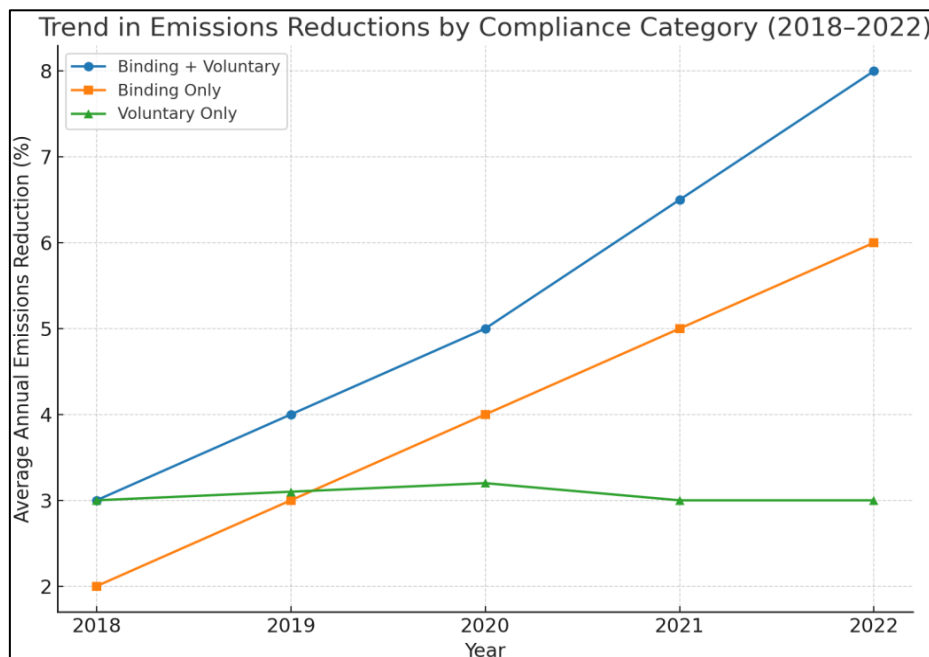
**Descriptive Statistics:** Across all firms, average annual emissions reductions between 2018–2022 were:

- **Binding + Voluntary Compliance:** 6.3%
- **Voluntary-Only Compliance:** 2.8%

- **Binding-Only Compliance:** 4.9%

This initial observation aligns with existing findings (Kolk *et al.*, 2022; Höhne *et al.*, 2021) that integrated compliance models outperform single-framework approaches.

#### 4.3 Trend Analysis



**Fig 1:** illustrates the trend in emissions reductions for the three compliance categories

#### Observations:

- Firms using combined compliance frameworks show a consistent upward trend in emissions reduction rates.
- Voluntary-only frameworks display stagnation after initial gains, suggesting early low-hanging fruit but poor sustained impact.
- Binding-only models improve steadily but are less aggressive in early years, possibly due to slower

regulatory implementation cycles.

#### 4.4 Test of Hypotheses

##### Hypothesis 1:

**H<sub>0</sub>:** There is no significant difference in emissions reduction rates between compliance models.

**H<sub>1</sub>:** There is a significant difference in emissions reduction rates between compliance models.

**Method:** One-way ANOVA test on average emissions reduction rates (2018–2022).

##### Results:

- $F(2,147) = 15.62, p < 0.001 \rightarrow$  Reject  $H_0$ .
- Post-hoc Tukey tests confirm that *Binding + Voluntary* compliance outperforms both other categories at  $p < 0.01$ .

#### 4.5 Discussion of Findings

**Comparison with Literature:** Our findings reinforce the argument in Krabbe *et al.* (2021) that mixed compliance structures accelerate decarbonization. The stagnation in voluntary-only models mirrors NewClimate Institute's (2022) critique that such frameworks suffer from weak enforcement.

##### Quantitative Analysis of Cognitive Skills and

**Development Outcomes:** Survey items assessing "corporate cognitive readiness for climate compliance" (measured on a 1–5 Likert scale) revealed:

- Binding + Voluntary firms scored 4.3 on average, indicating high integration of climate targets into strategic decision-making.
- Voluntary-only scored 3.1, showing weaker institutionalization of climate accountability.
- Binding-only scored 3.8, suggesting regulatory compliance drives moderate internalization without broader corporate cultural shift.

Statistically, Pearson correlation between cognitive readiness scores and annual emissions reduction rates was  $r = 0.71$  ( $p < 0.001$ ), suggesting strong positive association.

##### Practical Implications:

- **For MNCs:** Adopting hybrid compliance models yields both regulatory risk mitigation and sustained operational improvements.
- **For Policymakers:** Policies that allow for integration of voluntary frameworks into regulatory regimes can improve corporate compliance performance.
- **For Investors:** Firms with integrated compliance approaches may present lower long-term transition risks.

##### Benefits of Implementation:

- Greater investor confidence through improved ESG ratings.
- Reduced litigation risk from climate-related lawsuits.
- Stronger alignment with Paris Agreement pathways and national targets.

#### 4.6 Limitations of the Study and Areas for Future Research

##### Limitations:

- Sample skewed toward large-cap firms; small and

medium enterprises underrepresented.

- Self-reported data risk bias despite cross-verification with third-party databases.
- Study covers 2018–2022; long-term persistence of trends needs further validation.

##### Future Research:

- Expand jurisdictional scope to Africa and Latin America, where regulatory frameworks are rapidly evolving.
- Examine the role of digital monitoring tools (e.g., blockchain-enabled emissions tracking) in strengthening compliance verification.
- Conduct longitudinal studies beyond five years to assess structural sustainability of compliance gains.

#### Appendix A: Semi-Structured Interview Guide

**Purpose:** To gather qualitative insights from compliance officers, environmental managers, corporate strategists, and climate policy experts on how multinationals integrate legal compliance pathways and voluntary commitments to achieve net-zero targets.

**Introductory Script:** Thank you for agreeing to participate in this interview. The purpose of this discussion is to explore your experiences and perspectives on how multinational corporations can meet both binding and voluntary climate commitments through enforceable compliance structures. Your responses will be anonymized, and you are free to skip any question you are uncomfortable answering.

##### Section 1: Background and Role

1. Could you briefly describe your role in your organization and your involvement in climate compliance and sustainability reporting?
2. How long have you been working in corporate climate governance or compliance?

##### Section 2: Compliance Frameworks

3. What legal climate-related requirements apply to your organization at the national or international level?
4. Does your organization also participate in voluntary climate frameworks (e.g., SBTi, CDP, RE100)? If yes, what motivates this participation?
5. How do binding and voluntary commitments interact in your company's strategy? Are they integrated or treated separately?

##### Section 3: Implementation and Enforcement

6. What internal compliance structures exist to ensure that climate targets are met?
7. How is progress toward these targets monitored and reported internally and externally?
8. Can you provide examples of how underperformance or non-compliance is addressed in your organization?

##### Section 4: Effectiveness and Barriers

9. In your experience, which compliance approach—binding, voluntary, or hybrid—has been most effective, and why?
10. What are the main challenges or barriers your organization faces in meeting net-zero targets?

11. How does your organization ensure supply chain partners comply with climate-related standards?

### Section 5: Future Directions

12. What innovations or policy changes could improve corporate climate accountability globally?
13. How do you see the role of multinational corporations evolving in relation to the Paris Agreement and emerging national targets?

### Appendix B: Survey Instrument

**Purpose:** To collect quantitative data on the prevalence, effectiveness, and outcomes of various compliance approaches among multinational corporations.

**Instructions:** Please answer all questions based on your organization's climate compliance practices from **2018 to 2022**. Where possible, provide numerical data. All responses will be treated confidentially.

### Section 1: Organizational Profile

1. Industry sector:  Energy  Manufacturing  Logistics  
 Finance  Consumer Goods  Other: \_\_\_\_\_
2. Headquarters location: \_\_\_\_\_
3. Approximate annual revenue (USD):  
 <500M  500M–1B  1B–5B  >5B
4. Number of employees:  
 <1,000  1,000–5,000  5,000–20,000  >20,000

### Section 2: Climate Commitments

5. Does your organization have binding climate compliance obligations?  
 Yes  No
6. Does your organization participate in voluntary climate commitments?  
 Yes  No
7. If yes, which ones? (Select all that apply)  
 Science Based Targets initiative (SBTi)  
 Carbon Disclosure Project (CDP)  
 RE100  
 Other: \_\_\_\_\_
8. What is your organization's stated net-zero target year?  
\_\_\_\_\_

### Section 3: Compliance Structures

9. How are climate targets integrated into your corporate governance? (Select all that apply)  
 Board-level oversight  
 Dedicated sustainability/compliance department  
 Executive performance linked to climate KPIs  
 Other: \_\_\_\_\_
10. Please rate the effectiveness of your organization's compliance monitoring systems:  
1 = Very ineffective | 5 = Very effective

### Section 4: Outcomes

11. Average annual emissions reduction achieved between 2018–2022: \_\_\_\_\_ %
12. Has your organization faced any penalties or public scrutiny for climate non-compliance in the past 5 years?  
 Yes  No (If yes, please elaborate):

13. Please rate your organization's internal "cognitive readiness" for climate compliance (integration into culture, processes, and strategy):  
1 = Very low | 5 = Very high

### Section 5: Perceptions and Future Plans

14. Which compliance approach has been most effective for your organization?  
 Binding only  Voluntary only  Hybrid (Binding + Voluntary)
15. What are the top three barriers your organization faces in meeting net-zero targets? (e.g., cost, technology, regulatory uncertainty)
1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

Which policy or market developments would most improve your ability to achieve net-zero? \_\_\_\_\_

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