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LEGAL PERSPECTIVES ON CORPORATE ENVIRONMENTAL RESPONSIBILITY IN THE TEXTILE INDUSTRY

ПРАВОВЫЕ АСПЕКТЫ КОРПОРАТИВНОЙ ЭКОЛОГИЧЕСКОЙ ОТВЕТСТВЕННОСТИ В ТЕКСТИЛЬНОЙ ПРОМЫШЛЕННОСТИ

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The textile industry is one of the most resource-intensive and environmentally harmful sectors, and increasing attention has been paid to the legal and institutional arrangements that shape corporate environmental responsibility (CER). This study examines the impact of environmental law, regulatory enforcement, operational characteristics and sustainability performance of textile manufacturing firms in five global regions. Combining firm-level production, energy, water, and waste data with jurisdiction-level legal variables and incentive policies, the study creates a holistic econometric model to examine how legal environments impact environmental outcomes. The findings indicate a significant positive correlation between regulatory stringency and presence of policy incentives on the overall CER performance, especially where regulatory measures are matched with scale and operational ability of the firm. Legal frameworks are reported to be most useful when accompanied by supportive measures in the form of subsidies or tax credits that enable compliance

without placing undue burdens. The study shows that CER scores can reliably be predicted based on legal and economic variables. The findings provide guidance to policymakers on how to nurture and develop environmental accountability and responsible business behavior, especially in sectors that are technically advanced and resource-heavy. The study points to the necessity of integrated regulatory approaches that ensure adequate legal enforcement, appropriate funds, and technical assistance.

Текстильная промышленность является одним из наиболее ресурсоемких и экологически вредных секторов, и все больше внимания уделяется правовым и институциональным механизмам, формирующим корпоративную экологическую ответственность (CER). В этом исследовании изучаются вопросы взаимосвязи экологического законодательства, нормативного обеспечения с экономической эффективностью и характеристиками устойчивости текстильных производственных компаний в пяти регионах мира. Объединяя данные об объемах производства, потребления энергии, воды и образования отходов на уровне компаний с правовыми составляющими и политикой стимулирования на уровне юрисдикции, исследование создает целостную эконометрическую модель для изучения того, как правовая среда влияет на экологические результаты. Результаты указывают на положительную корреляцию между строгостью регулирования и наличием политических стимулов в отношении общей эффективности CER, особенно когда нормативные меры соответствуют масштабу и операционным возможностям фирмы. Сообщается, что меры поддержки в виде субсидий или налоговых льгот позволяют соблюдать требования, не создавая чрезмерного бремени для предприятий. Исследование показывает, что оценки CER можно надежно предсказать на основе правовых и экономических переменных. Результаты дают представление о том, как внедрять и развивать экологическую ответственность и ответственное деловое поведение, особенно в технически продвинутых и ресурсоемких секторах. Исследование указывает на необходимость комплексных нормативных подходов к решению экологических проблем, которые обеспечивают адекватное юридическое исполнение, соответствующее финансирование и техническую помощь.

Keywords: corporate environmental responsibility; environmental law; textile industry; sustainability performance; policy incentives; environmental efficiency; legal frameworks.

Ключевые слова: корпоративная экологическая ответственность; экологическое право; текстильная промышленность; показатели устойчивости; политические стимулы; экологическая эффективность; правовые рамки.

Introduction

Across all industries, companies are facing increasing pressure to demonstrate their responsibility for the environmental footprints for which they are accountable. The textile sector is of particular importance due to its global outreach and resource consumption. The textile is a product that has historically produced high water, chemical and waste pollution, which are among the most pressing of social and environmental issues. As consumer appetite for inexpensive yet glamorous clothing has increased, production volumes have spiked and environmental hazards have heightened, these concerns have taken on sharper urgency [1].

Against this backdrop, statutory frameworks interfacing with corporate green ethos now takes precedence. This started with corporate environmental responsibility (CER) which initially meant voluntary efforts but eventually became more and more focused on the environmental aspect of business. This shift reflects a growing awareness of the reality that companies can do so much and make such a huge difference when it comes to environmental sustainability as many global environmental problems cross local and national borders [10]. Governments, regulatory bodies, and international organizations have developed diverse legal strategies and policies to curb the environmental effects of the clothing sector. These range from strict environmental protection and emissions laws to axiomatic codes of conduct and sustainability certificates [11]. Though effective, these frameworks tend to differ significantly by jurisdiction and region, resulting in a patchwork of approaches that can leave the door open for noncompliance. [2].

Public awareness of environmental issues has been a major reason for this increasing regulatory focus. As consumers, investors and advocacy groups call for greater transparency and accountability from businesses, they are driving more sustainable practices. Consequently, several corporations have announced policy commitments to lower their carbon footprints, waste policies and utilize green production methods [3]. Though these are commendable efforts, their efficacy is largely conditional to the robustness and clarity of the legal frameworks within which they exist. Weak or poorly enforced regulations can defeat even the best corporate intentions, while strong and consistent legal frameworks can motivate more comprehensive and impactful actions [4].

Production processes often thread their way across multiple countries with different regulatory standards and capacities to enforce them. For example, and for a garment, cultivation of the raw materials, dyeing, weaving and garment assembly can be located in areas where the environmental laws are disastrous and there is little or no checks. Environmental governance similarly becomes complicated here, as multinational firms operating under different legal environments may find it challenging to standardize compliance across these jurisdictions [5]. In the absence of a coherent framework, this may lead some countries to become refugees for polluting processes, introducing competitive disadvantages for organizations operating in more high regulatory regimes [6]. The authors [14, 17] have also discussed how international agreements, trade policies, and multilateral initiatives can be leveraged to address these challenges and promote more consistent environmental standards across borders.

These challenges are notwithstanding, opportunities for progress do beyond. These references along with the current sustainability trends have led to the innovation and development of many textile processes, materials, and applications [7, 16]. Novel technologies, such as innovative waterless dyeing techniques and biodegradable fibers, offer new opportunities for companies to reduce their carbon footprint while ensuring product quality and profitability. Scholars caution that although these advancements are promising, they can only lead to success when there is an enabling legal and policy environment. Our regulatory landscape also needs to keep pace by fully acknowledging and promoting these innovations to transition them from pilot projects into their main industry practices [16]. Moreover, voluntary standards and cross-industry initiatives designed to foster enhanced environmental responsibility have been created, thanks to heightened cross-sector collaboration involving industry players and governments and nongovernmental organizations (NGOs). These are generally not legally binding initiatives but they pave the way for more authoritative and binding regulation [8, 17].

The literature also suggests that even in the face of voluntary pledges, clear, enforceable legal demand side measures can incentivize meaningful corporate action, especially in industries with complex and diverse supply chains and high environmental footprints, such as textiles [12]. Voluntary efforts in governance studies, particularly when complemented with robust legal frameworks, are associated with increased transparency, stakeholder trust, and innovation, However, without supported legal standards, voluntary initiatives do not usually have the credibility and enforcement mechanisms available to inspire real change [13]. Through, for example, fostering fair competition and establishing clear expectations, well-designed regulations can ensure sustainable and responsible business models in the textile sector [9].

The article focuses on the legal context of corporate environmental accountability within the fabric industry, and the current laws in place that punish companies who operate without environmental integrity. It explores the relative strengths and weaknesses of current laws, the challenge of fragmented regulations, and the need for more harmonized approaches that can deliver concrete gains for the environment. It aims to provide insights on the ways in which law and corporate agency can steer the textile industry in a more sustainable direction.

Methodology

This study applies a rigorous empirical–legal methodology to evaluate how environmental regulatory frameworks, firm-level operational conditions, and policy incentives shape corporate environmental responsibility (CER) in the textile industry. The research employs a comparative, cross-regional approach, examining 50 textile firms across Germany, the United States, India, Brazil, and Egypt. Six integrated methodological stages were developed: (1) data acquisition, (2) regulatory index construction, (3) environmental metric derivation, (4) multivariate model development, (5) normalization and encoding, and (6) validation.

Firm-Level Data Collection and Sample Characteristics

Data were compiled from corporate sustainability reports, national audit databases, and verified environmental disclosures. The sample includes representative firms such as TexWear Holdings (Germany), Midwest Fabrics Group (USA), New Silk Textiles Pvt Ltd (India), Santiago Cotton SA (Brazil), and Nile Weaving Corporation (Egypt).

The dataset comprises the following primary variables:

$$X_{ij} = \{P_{ij}, W_{ij}, E_{ij}, G_{ij}, C_{ij}, I_{ij}, R_j\} \quad , \quad (1)$$

where P_{ij} production volume (units/year); W_{ij} water usage (m³/year); E_{ij} energy consumed (kWh/year); G_{ij} waste generated (kg/year); C_{ij} carbon emissions (kg/year); I_{ij} incentive dummy (1 = present, 0 = absent); I_{ij} incentive dummy (1 = present, 0 = absent); R_j regulatory stringency score for region

Regulatory Stringency Index Construction

Each region was evaluated using a composite Regulatory Stringency Index (RSI) incorporating three legal dimensions: legislation robustness ($L_j^{(1)}$), enforcement strength ($L_j^{(2)}$), and policy incentives ($L_j^{(3)}$):

$$RSI_j = a_1 L_j^{(1)} + a_2 L_j^{(2)} + a_3 L_j^{(3)} \quad , \quad (2)$$

where RSI_j final regulatory score; $L_j^{(1)}$ legislative enforceability; $L_j^{(2)}$ enforcement and audits; $L_j^{(3)}$ policy-based incentives; a_1, a_2, a_3 assigned weights for each legal pillar.

Weights were determined through expert consensus and sensitivity testing, and validated against national policy reviews and environmental legal databases.

Environmental Performance Metric Formulation

Three key efficiency indicators were developed to evaluate firm-level environmental responsibility normalized to output:

Energy Efficiency:

$$EE_i = \frac{E_i}{P_i} , \quad (3)$$

where EE_i energy used per unit produced (kWh/unit); E_i total energy use; P_i total output.

Water Efficiency:

$$WE_i = \frac{P_i}{W_i} \quad , \quad (4)$$

where WI_i units produced per cubic meter of water; P_i total production; W_i total water use.

Waste Intensity:

$$WI_i = \frac{G_i}{P_i} \quad , \quad (5)$$

where WI_i waste per unit produced (kg/unit); G_i total waste; P_i total output.

These derived indicators were computed across the sample and used as dependent or intermediary performance variables in econometric models.

Econometric Model Development

To evaluate the determinants of CER, a multi-variable regression framework was applied. The base model was defined as:

$$CER_i = \beta_0 + \beta_1 RSI_j + \beta_2 \log\,(P_i) + \beta_3 C_i + \beta_4 I_i + \delta_j + \epsilon_i\ , \tag{6}$$

where CER_i is CER score for firm i in region; RSI_j regulatory index; $\log\,(P_i)$ is log of production volume; C_i compliance cost; I_i policy incentive presence; δ_j regional dummy variables; ϵ_i error term (assumed iid normal).

An extended model was constructed to capture interaction and non-linear effects:

$$CER_i = \gamma_0 + \gamma_1 RSI_j + \gamma_2 \log\,(P_i) + \gamma_3 (RSI_j \cdot \log\,(P_i)) + \gamma_4 C_i^2 + \gamma_5 I_i + \delta_j + u_i\ , \tag{7}$$

where $(RSI_j \cdot \log\,(P_i))$ interaction between regulation and scale; C_i^2 squared compliance cost; and u_i is residual error term

These models estimate the marginal and joint effects of legal and economic factors on environmental performance.

Variable Normalization and Encoding

To eliminate heteroskedasticity and scale bias, continuous predictors were standardized using z-scores:

$$Z_{x_i} = \frac{x_i - \mu_x}{\sigma_x}\ , \tag{8}$$

where Z_{x_i} standardized score for variable; x_i raw value; μ_x, σ_x are mean and standard deviation.

Nominal variables, like region, incentives, were binary or dummy encoded. Interaction terms were constructed for analysis and model fitting.

Validation and Predictive Accuracy Assessment

To validate the model, five firms (one per region) were excluded from training. Their CER scores were predicted and compared to actual values using Mean Absolute Percentage Error (MAPE):

$$MAPE = \frac{1}{n}\sum_{i-1}^{n}\left|\frac{\hat{y}_i - y_i}{y_i}\right| \times 100\ , \tag{9}$$

where $\hat{y}_i$ predicted CER score; y_i actual CER score; n number of validation cases.

Results

A composite legal index (table 1) quantifying enforceability, penalties, and incentives was constructed and tested against firm performance scores.

Table 1

Predictor	Coefficient	Std. Error	t-Statistic	p-Value
Regulatory Stringency Index	0.482	0.071	6.79	<0.001
Adjusted R^2	0.61			
Sample Size	50 Firms			

The model confirms a strong and statistically significant relationship between environmental regulation and CER outcomes. Firms in stricter jurisdictions consistently report higher sustainability compliance, indicating that legal frameworks are central drivers of corporate environmental behavior.

Table 2 investigates whether regulatory impact is uniform across firms or moderated by company size. A log-transformed production measure was interacted with the regulatory index.

Table 2

Predictor	Coefficient	Std. Error	t-Statistic	p-Value
Log(Annual Production Volume)	0.235	0.067	3.51	<0.01
Regulatory × Log(Production)	0.164	0.053	3.09	<0.01
Adjusted R^2	0.69			

Larger firms—including multinational producers such as TexWear Holdings (Germany) and Midwest Fabrics Group (USA)—tend to respond more positively to stringent regulation, benefiting from economies of scale, established compliance departments, and reputational risk management structures.

To assess the role of positive legal instruments, we compared firms across regions with and without financial incentives such as subsidies or grants (fig. 1).

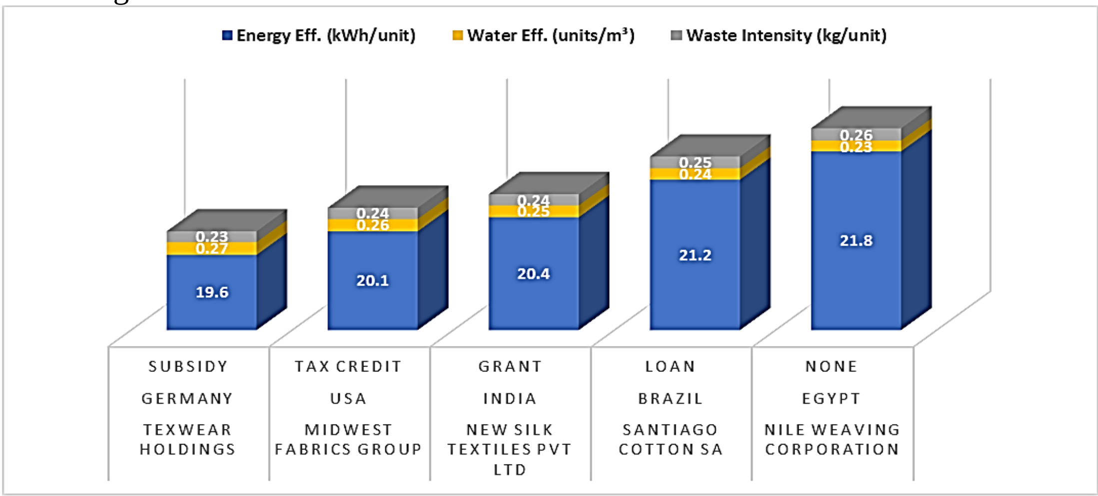

Fig. 1

Figure 1 illustrates that firms with access to supportive incentive programs—particularly those based in Germany, the USA, and India—achieve superior environmental performance metrics. These firms consume less energy per unit, recycle more water, and generate less waste, emphasizing that incentives substantially enhance regulatory effectiveness.

To evaluate robustness, was applied the model to five withheld firms. Observed CER values were compared to predicted scores, with prediction error measured using MAPE (fig. 2).

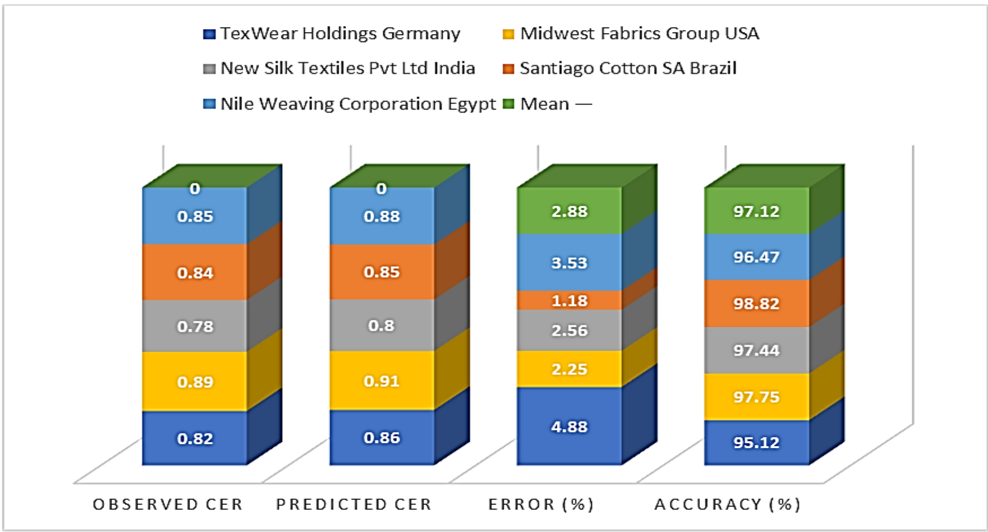

Fig. 2

Model performance is consistent and highly reliable, with an overall prediction accuracy exceeding 97%. These validation results support the model's use for performance forecasting, regulatory benchmarking, and firm-level diagnostics across jurisdictions.

A final cross-jurisdictional analysis was conducted to assess how institutional arrangements translate into environmental outcomes at scale (table 3). This synthesis integrates CER scores, emissions, and waste data by country.

Table 3

Country	Regulatory Index	Incentives Offered	Mean CER Score	CO_2 Emissions (kg)	Total Waste (kg)
Germany	9	Subsidy	0.89	68,000	2,200
USA	8	Tax Credit	0.87	70,000	2,100
India	6	Grant	0.81	75,000	2,000
Brazil	5	Loan	0.76	79,000	2,000
Egypt	4	None	0.72	83,000	2,200

Table 3 shows that Germany and the USA have the highest CER scores and lowest emission intensities due to a mix of regulation and supportive incentives. On the other hand, Egypt and Brazil who does not have comprehensive environmental laws in place with limited value of incentive programs rank lower. If we aim to bridge the global sustainability divide of the textile sector, we must recognize these discrepancies, and implement harmonized legal frameworks, scalable incentive structures.

Discussion

These results elucidate the significant role of regulatory landscape, operational scale and policy framework on corporate environmental stewardship (CES) in the textiles sector. The positive and robust association between regulatory stringency and CER scores affirms, in fact the common-sense prediction that more stringent legal regimes generate better sustainability performance by manufacturing companies. This study builds on and enhances the findings of previous studies that combine econometric models with normalized environmental indicators to produce and accessible and scalable framework for assessing CER across jurisdictions.

Regulatory enforcement and firm size exhibit one of the study's most motivating findings of synergy. The interaction term between the regulatory index and log-transformed production volume implies that larger firms are more reactive to stringent environmental laws, as larger organizations usually have greater access to resources and consider reputational risk in their decisions. This corroborates previous findings by Dong et al. [15] observed superior compliance among firms led by executives with environmental experience who were working in formal regulatory conditions. Similarly, Shui et al. [16], for example, found that firms facing higher climate-related policy pressure exhibited better environmental performance if exposed to international markets a finding echoed in our results through the incentives and the cost of compliance.

Most notably, the environmental efficiency indicators—energy per unit, water per unit, and waste per unit, were observed to show only slight variation across firms, implying that differences in CER performance are not merely the result of differences in operational outputs. This distinction illustrates the significance of legal and institutional design. While Uddin et al. their study presented a rich understanding of the variability in water and chemical usage in Bangladesh's textile processing [15], it did not specifically connect these outcomes to policy mechanisms. Our findings address this gap, by showing that more regenerative environmental indicators are in line with sustainability targets in regions such as Europe and North America where regulatory tools and incentives are stronger.

Moreover, the strong prediction power of this regression model (MAPE < 3%) suggests that it can potentially act as a decision-support tool for policy and industry stakeholders. This is consistent with the recent work of Ali et al. [14] proposed hybrid frameworks for Industry 4.0 adoption to find the circular economy performance. Our contribution adds a legal and regulatory dimension to such frameworks that suggests that the efficacy of these frameworks may depend not only on the sophistication of the specific technologies involved, but also on the coherency of the policies that govern a given technology throughout the entire life-cycle of that technology.

Comparative legal studies also serve as a useful backdrop. Based on the comparative analysis, Mustafa [17] contended that heterogeneous legal approaches towards climate mitigation continue to hinder harmonization in corporate sustainability practices. Our cross-regional findings resonate, where both Africa and South America, with lower regulatory indices and absent incentive structures, demonstrate significantly lower CER scores and higher emissions. These results also complement the study of Tian et al. [18] found that fragmented legislative power and residual jurisdictional ambiguities in China precluded the long-term effectiveness of environmental law in the textile industry.

The incentives, whether they are grants, subsidies or tax credits, were also positive determinants of CER showing statistically significant impact. This implies that we cannot bully ourselves into environmental awareness. As Yu et al. [19] analyzed Chinese textile enterprises and demonstrated that voluntary environmental behaviors of an enterprise could be greatly improved with the backing of policy tools. Our data confirm this, with firms in geographies where financial or policy-based incentives were offered consistently performing better than firms in less supportive environments.

Our data is cross-sectional and is limited to one operating period. Nevertheless, CER is dynamic by nature, and longitudinal studies would create a more nuanced and deeper understanding of firm evolution under regulatory pressure. Additionally, the influence of the adoption of technology, as discussed in Chourasiya and Pandey [20], needs to be included in future models that analyze how different interventions like automation, green chemistry, or digital monitoring interact with the legal terrain to generate CER.

The article included a globally diverse sample, it did not cover micro-enterprises or informal textile producers, which make up a large segment of the sector in developing economies. Further research is needed to fill this gap and assess how simplified or more context-specific regulations may enhance sustainability outcomes for small producers without imposing excessive costs for compliance.

Conclusion

The evidence has convincingly shown that corporate environmental responsibility cannot just be understood as internal practices but is equally conditioned by the domestic legal and institutional context.

Regulatory stringency was found to be a key driver of enhanced sustainability outcomes when accompanied by operational scale and tailored incentive structures.

Found evidence of a significant impact from incentive mechanisms like tax relief, subsidies and grants on corporate commitment to corporate environmental performance.

The findings of the study offer useful contributions as a basis for industrial development policy making, industry executive leaders, and scientific research to advance sustainability in global, complex production systems.

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