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Original Article

Taxing India's Way to a Greener Future: A Progressive Regime

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Abstract: *In response to increasing environmental challenges, this paper proposes a progressive green tax policy that targets producers to enable a reduction in carbon emissions while maintaining production incentives. Carbon pricing is widely discussed as one of the most cost-efficient mechanisms for internalising environmental externalities. The paper addresses a persistent gap in existing frameworks by integrating firms' revenue levels into the emission tax structure, ensuring that tax burdens scale with financial capacity rather than being applied uniformly. The tax is designed to create proportional financial disincentives for both large and small firms. The framework adjusts tax incidence based on firms' relative revenue positions within an industry and thereby aligns environmental responsibility with economic capacity. This approach is evaluated through an illustrative calibration using firm-level data from the Indian cement industry, comparing tax incidence under the proposed regime with that under existing flat-rate levies. The study identifies and seeks to mitigate shortcomings of prior tax regimes, and it examines implementation considerations specific to the Indian context. By integrating theory, mathematics, and empirical illustrations, this paper seeks to contribute to the creation of an environmental tax policy which is not only efficient but also equitable and administratively feasible.*

Keywords: *Ability-To-Pay, Carbon Border Adjustment Mechanism, Carbon Pricing, Cement Industry, Emission Intensity, Environmental Taxation, Green Tax, India, Pigouvian Taxation, Progressive Taxation, Revenue Normalisation.*

I. INTRODUCTION

The global urgency to mitigate climate change has driven policymakers to explore various mechanisms for reducing greenhouse gas emissions. Among these, environmental taxes, or green taxes, have emerged as a crucial tool for reducing carbon emissions and addressing climate change (Intergovernmental Panel on Climate Change [IPCC], 2022; Stern, 2006; World Bank, 2023). Traditional green tax systems often apply uniform rates irrespective of firms' financial capacity, potentially leading to inequitable burdens (Jacobs & van der Ploeg, 2019; Oueslati et al., 2017). This imbalance can hinder economic equity and reduce the overall effectiveness of emission reduction efforts.

Many researchers have worked on individual issues related to taxation and environmental policies. The idea of Pigouvian taxes refers to taxes which rectify the negative externalities in society. Many scholars have expanded further on this idea and have examined the optimal tax rates for various pollutants and their economic impacts. On the other hand, the principles of progressive taxation, where tax rates increase with the taxpayer's ability to pay, have been well-documented and widely applied in income and corporate tax policies. These studies, however, typically optimise for either economic efficiency or equity in isolation and seldom combine these principles to address both issues together. Inclusion of these concepts in a single model, as suggested in this paper, is a new concept in establishing a just and effective green tax system.

The following sections of this paper will delve into the conceptual underpinnings of the proposed tax system, detail the formula for income-adjusted emission taxes, and provide hypothetical scenarios to illustrate its application. By examining the potential benefits and challenges of this approach, the paper aims to contribute to the broader discourse on sustainable and equitable economic policies.

II. LITERATURE REVIEW

The relationship between income distribution, taxation, and environmental outcomes has been a concern in public economics since Pigou's foundational work on externalities (Pigou, 1920). His framework established that pollution emerges when private costs diverge from social costs, providing the theoretical basis for corrective environmental taxation. However, the framework carries a fundamental limitation: it assumes perfect information and perfectly competitive markets. It does not adequately account for second-best scenarios in which pre-existing distortions such as monopoly power or existing tax wedges are already present. Its static character limits its capacity to capture the dynamic nature of technological change and evolving emissions patterns. Subsequent contributions by Ramsey and Mirrlees (Ramsey, 1927; Mirrlees, 1971) sought to extend this foundation by examining how income-based taxation could minimise economic distortions while advancing equity. However, Ramsey's approach to goods with inelastic demand most heavily risks placing a disproportionate burden on lower-income groups. Mirrlees's model addressed some of these distributional concerns through optimal income taxation, but does so by assuming a level of informational access that governments rarely possess in practice. Building on these foundations, Piketty and Saez (2007) and Stokey and Rebelo (1995) demonstrated that higher-income entities can absorb greater tax burdens without compromising efficiency, an insight with clear implications for environmental tax design across firms with varying income profiles. However, it bears noting that both contributions were developed outside an environmental context; Piketty and Saez's framework was constructed to address income inequality, while Stokey and Rebelo's growth-theoretic model largely abstracts away from distributional concerns, meaning their application to green taxation represents an extrapolation rather than a direct contribution.

Translating these theoretical principles into policy has proven considerably more complex. Bovenberg and Goulder (1996) formally model how environmental taxes interact with pre-existing distortionary taxes in a general-equilibrium setting, demonstrating that real-world tax design must navigate the dual risks of economic distortion and difficult integration with existing instruments; Dixon and Rimmer (2002) extend this concern into an applied policy setting, examining how such taxes function once embedded within a broader fiscal framework. Both studies rely heavily on computable general equilibrium models, which, while offering comprehensive economy-wide accounting, are highly sensitive to calibration assumptions around elasticities of substitution and factor mobility. Small differences in these choices can produce substantially divergent results, limiting the robustness and generalisability of their findings.

What the existing literature has not systematically produced is a unified operational framework that simultaneously applies progressive, revenue-based differentiation to the *rate* of emission taxation and links that differentiation to firm-level emission intensity relative to a dynamic industry benchmark. Output-based allocation (OBA) mechanisms, as used in the EU Emissions Trading System, adjust permit burdens based on production volumes but do not scale the levy itself to firms' financial capacity (Ellerman et al., 2010). Distributional analyses of carbon taxes, including Metcalf (2009) and Goulder & Parry (2008), address the regressivity of flat carbon pricing but primarily in the context of household-level incidence rather than cross-firm equity within industries. The framework proposed here is distinguished by its attempt to operationalise progressivity at the firm level through a formula that combines revenue normalisation with an emission intensity adjustment factor, targeting the specific gap identified above: that large, high-revenue firms can absorb flat per-unit charges more easily than smaller competitors, diluting the abatement incentive at precisely the scale where it should be strongest. Addressing this within a framework that remains administratively tractable and adaptable to a developing economy context is the central aim of the present study.

III. GREEN TAXES IN COMPARATIVE PERSPECTIVE

Table 1: Green Taxes across Selected Jurisdictions

Country	Year	Type of Tax	Current Scenario
Netherlands	2021	Carbon Tax	Tax: €30 per metric ton of CO2 (rising to €125-150 by 2030) Applicable on: Industrial emissions not covered in EU ETS Impact: Funds green technologies and energy transition projects
United Kingdom	2013	Carbon Price Floor	Tax: £18 per metric ton of CO2 Applicable on: Power sector primarily Impact: Funds renewable energy and environmental initiatives
European Union	2005	Emissions Trading System (ETS)	Tax: Market-based (€25-60 per metric ton of CO2) Applicable on: Power plants, industrial plants, airlines Impact: Funds renewable energy and climate adaptation projects Note: CBAM is the EU's policy to put a fair price on carbon-intensive goods imported into Europe, preventing "carbon leakage" by matching the carbon cost of imports with that of EU-made products under the EU's Emissions Trading System (ETS), coming into full effect from 2026, being phased from 2023-2025.
Germany	2021	Carbon Pricing System	Tax: €25 per metric ton of CO2, rising to €55 by 2025 Applicable on: Transport and heating fuels not under EU ETS Impact: Fund climate action, reduce electricity prices and transit
Canada	2019	Carbon Tax and Output-Based Pricing System	Tax: CAD 20 per metric ton of CO2 (increasing to 170 by 2030) Applicable on: Fossil fuels and industrial facilities Impact: Supporting low-carbon emission initiatives
Japan	Post-2016	Global Warming Countermeasure Tax	Tax: ¥289 per metric ton of CO2 Applicable on: Fossil fuels for heating, electricity generation, etc Impact: Fund energy conservation and renewable projects
India	2010	Clean Energy Cess (Coal Cess)	Tax: ₹400 (approximately $5.50) per ton Applicable on: Coal, lignite, and peat produced or imported Impact: NCEF to support renewable projects and research

The instruments surveyed above represent the dominant approaches to carbon pricing across jurisdictions of varying economic size and institutional capacity, yet a consistent set of design failures recurs across them. The most prevalent is the application of uniform rates across firms of fundamentally different financial capacities. Every instrument in the table imposes an identical per-unit cost on large and small firms emitting at the same intensity. As OECD (2006) documents, this uniformity creates a regressive incidence structure within industries. Smaller firms operating on tighter margins bear a disproportionately heavier relative burden than larger firms that can absorb equivalent per-unit costs through economies of scale and stronger balance sheets, diluting the abatement incentive at the scale where it should be strongest.

A second recurring failure is the systematic weakening of instruments through exemptions granted to energy-intensive industries. Sweden's carbon tax, Germany's ecological tax reform, and the EU ETS in its early phases each introduced carve-outs that reduced the effective cost faced by the largest industrial emitters, which were precisely those with the greatest capacity to invest in abatement and the greatest obligation to do so. In each case, the exemptions were secured through political pressure from large industrial players, producing a gap between the tax as designed and the tax as enacted that substantially reduced environmental effectiveness. A third failure, documented in the Indian case, is inadequate revenue recycling: the Clean Energy Cess directed revenues toward the National Clean Energy Fund in principle, but weak disbursement mechanisms meant the productive reinvestment that could have generated a double dividend was never realised in practice.

What the comparative landscape does not contain is an instrument that simultaneously addresses all three failures. The absence of such a framework from existing practice is the gap that the following sections address. As India expands its export footprint, the implications of the European Union's Carbon Border Adjustment Mechanism along with other international measures for the design and international positioning of the proposed framework are also examined in Section V.A.

IV. THEORETICAL FRAMEWORK AND MODEL SETUP

A) Progressive Tax Regime

In designing an effective tax policy for large and small producers, it is crucial to ensure that both face comparable disincentives relative to their scale of production, thereby preventing economies of scale from creating an unfair advantage for larger players. A non-discriminatory per-unit tax, where a fixed amount is levied per unit of emission regardless of the size or output of the firm, often fails to address this issue effectively. Larger producers, due to economies of scale, can absorb the impact of such a tax more easily than smaller firms, making the burden disproportionately heavier for SMEs despite similar emission levels. OECD (2006) further finds that uniform charges weigh more heavily on small firms.

A progressive tax regime, where higher revenues face higher effective rates, is widely discussed in public finance for ensuring fairness (Musgrave & Musgrave, 1989). Literature shows that linking fiscal instruments to financial capacity avoids overburdening smaller firms while maintaining efficiency. Bovenberg and Goulder (1996) emphasise that green tax design must balance efficiency with distributional concerns; otherwise, competitiveness in the market would be undermined. Progressive environmental taxes further correct regressivity concerns often associated with flat carbon pricing (Metcalf, 2009).

Studies also find that equity-based design enhances political acceptability; Klenert et al. (2018) argue that fairness in tax distribution is central to the long-term feasibility of green taxation. By taxing corporate revenues in a tiered manner, the proposal integrates the ability-to-pay principle central to optimal tax design (Mirrlees, 1971; Zee, 1995), ensuring larger firms shoulder proportionately greater responsibility while safeguarding smaller firms.

B) Production Bundle creation to get emission-to-income ratio for total tax

To integrate emissions into the framework, this study introduces a *production bundle* approach, benchmarking average sectoral emissions per unit of output. This draws on the "benchmarking" methods used in EU ETS allocation (Ellerman et al., 2010), where output-based measures ensure fairness across industries. This is a proposition to curate production bundles for various sectors and industries, accounting for the variance in company sizes. The average/optimal production bundle provides a metric to calculate the industry average carbon emissions or set an acceptable level that is used in the adjustment factor. By linking bundles to acceptable per-unit emissions, it allows us to create a dynamic adjustment *factor k*. This is proposed to be periodically reviewed and revised under government oversight by analysing key production patterns and keeping in mind the consumption requirements of the economy, so as not to completely stifle production of essential or high-in-demand goods that do not have readily available substitutes.

C) Rationale for a Per-Unit Tax Design

The case for a per-unit emission tax over a lump-sum charge can be understood through the lens of standard producer theory. Consider a firm choosing between two inputs: polluting inputs (X), which generate emissions, and non-polluting inputs (Y). The firm operates under a profit constraint that determines the feasible combinations of these two input categories it can sustain. A lump-sum tax acts as a parallel inward shift of this feasible frontier as it reduces the firm's overall resource envelope uniformly. As illustrated in Figure 1, this places the firm at point A: constrained to a lower level of resources overall, but with the relative cost of polluting versus non-polluting inputs unchanged. The firm has no marginal incentive to substitute away from polluting inputs; it simply produces less across the board.

A per-unit emission tax, by contrast, directly raises the marginal cost of the polluting input X relative to Y. This generates a rotation of the feasible frontier rather than a parallel shift, pivoting inward along the X-axis. The firm is now pushed to point B: not only is its total resource envelope constrained, but the *relative price* of emission-generating inputs has increased, creating a substitution effect that drives it toward cleaner production methods. Point B represents a lower level of polluting inputs than point A. Thus, for a comparable total output reduction, the per-unit tax achieves greater abatement per unit of economic cost imposed on the firm.

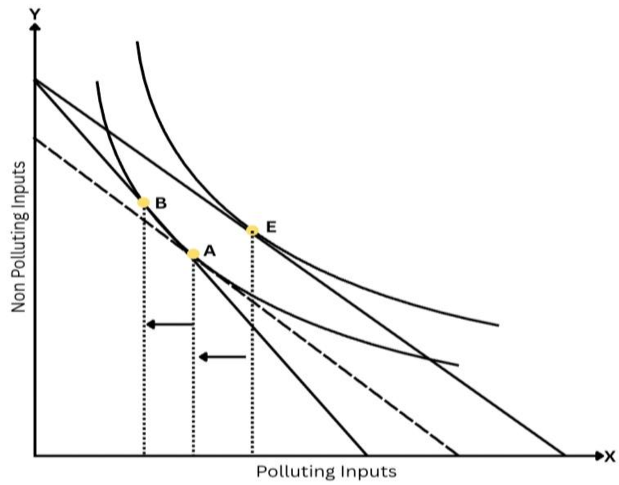

Figure 1. Utility Shifts to Analyse Distortion of Respective Regimes

This distinction has direct implications for the objectives of the proposed tax regime. A lump-sum charge reduces firm size but does not change the internal economics of *how* the firm produces. A per-unit tax changes those internal economics directly, making emission-intensive production relatively more costly at the margin and thereby incentivising substitution toward cleaner inputs. As Bovenberg & Goulder (1996) and Nordhaus (2013) demonstrate formally, it is this marginal cost effect that drives abatement behaviour, not the aggregate tax burden itself.

Beyond the immediate substitution effect, the per-unit structure accelerates investment in emissions-reducing technologies. When the cost of each unit of carbon is priced, firms face a continuous incentive to reduce per-unit emission intensity through process innovation, fuel switching, and capital upgrading. Aghion et al. (2016) and Yang et al. (2024) provide evidence that carbon pricing mechanisms of this kind stimulate directed technical change toward low-carbon alternatives. A lump-sum tax, which imposes a fixed cost independent of emission intensity, provides no such ongoing incentive: a firm that halves its emission intensity gains no tax relief. Over time, this difference in dynamic incentives compounds, producing faster industry-wide transitions under per-unit regimes than under lump-sum charges.

While some theorists might argue that a "predatory" tax structure such as the one proposed through the study would be detrimental to the overall health of the economy and the manufacturing sector, this is where the argument necessitating a per unit tax for the desired outcome and results of shifting production practices comes into picture, wherein the purpose of the tax is to bring about a shift in the way the sector functions rather than ceasing existence altogether. A taxation regime that particularly penalises inefficient production practices and incentivises active shifts will bring about the desired change without severely hampering macro structures and causing gradual improvement.

Table 2: Lump-Sum Tax versus Per-Unit Green Tax

Feature	Lump Sum Tax	Per-Unit Green Tax
Marginal Cost Impact	No Change	Increases marginal cost, changing behaviour
Incentive to reduce emissions	Weak (fixed cost)	Strong (cost scales with pollution level)
Encouragement of Green Innovation	Limited	High (reducing emissions reduces tax)
Long-Run Industry Shift	Slow	Faster transition to sustainability
Revenue for Green Investments	Fixed Amount	Scales with pollution, funding further change

V. POLITICAL ECONOMY CONSIDERATIONS AND POLICY PARAMETERS

The income-augmented structure of the proposed tax creates a distinct political economy relative to flat carbon pricing, and understanding this distinction is essential to anticipating implementation challenges and designing appropriate compensatory mechanisms.

The proposed regime, by design, concentrates a disproportionate share of the burden on the largest, highest-revenue firms within each sector. This concentration has two countervailing political consequences. On one hand, it reduces the opposition surface among smaller firms and SMEs, which under flat regimes are often among the most vocal opponents of carbon pricing due to their tighter margins and lesser capacity to absorb compliance costs (Carattini et al., 2017). On the other hand, it intensifies opposition from the largest industry players, specifically those with the greatest lobbying capacity and political influence. As Carattini et al. (2017) document, well-organised industries can slow, dilute, or derail ambitious reforms, and the proposed regime's explicit targeting of large firms may sharpen this dynamic compared to a uniform levy.

Three design features can help manage this political economy tension.

1. Klenert et al. (2018) find that public acceptability of carbon pricing increases substantially when revenues are visibly directed toward sector-specific transition support rather than consolidated into general fiscal revenues. The grant mechanism proposed in Section VII.B is directly compatible with this requirement, as it creates a traceable link between tax payments and reinvestment.
2. The progressive structure itself can be framed as a competitiveness protection measure for smaller firms, which may attract political support from SME associations and downstream industries whose input costs are affected by large emitters' pricing power.
3. Phased implementation with predetermined rate escalation schedules, as used in British Columbia's carbon tax and Germany's ecological tax reform, reduces adjustment costs and allows firms to incorporate future tax liabilities into capital planning, weakening the argument that the tax creates unmanageable shocks.

A) International Competitiveness and Alignment with CBAM

In the backdrop of India's trade deal with the European Union, the European Union's Carbon Border Adjustment Mechanism substantially changes this calculus in ways that are directly relevant to the proposed framework's political economy.

CBAM places a carbon price on certain goods imported into the EU marketspace based on the amount of carbon emissions generated during their production (European Commission, 2023). Critically, this cost applies regardless of the exporting country's domestic carbon policy, with one exception: where the exporting country operates a credible domestic carbon pricing mechanism, the CBAM charge is reduced by the amount already paid domestically to avoid double taxation. The mechanism is explicitly designed to prevent carbon leakage while eliminating the competitive disadvantage that EU producers face relative to competitors in less-regulated jurisdictions.

For India's industrial exporters, this creates a structural shift in competitiveness. The question is no longer whether Indian industry should bear a carbon cost, as it will bear one regardless, under CBAM at the EU border if not domestically. Framed this way, the competitiveness objection to domestic carbon pricing is not merely weakened, it is inverted. The absence of a credible domestic carbon pricing mechanism becomes the competitive disadvantage, since it forfeits the CBAM credit that a qualifying domestic mechanism would provide.

This provides significant political support to the proposed framework because it aligns the interests of India's largest export-oriented industrial firms with the interest in establishing a credible domestic mechanism. A firm paying T_i under the proposed framework, and able to document that payment to EU customs authorities, faces a lower net cost than a firm paying nothing domestically and then absorbing the full CBAM charge at the EU border.

Beyond the firm-level dynamics, CBAM alignment serves a national fiscal interest that strengthens the political case for early adoption. Where Indian exporters pay no equivalent domestic carbon cost, CBAM revenues flow to the EU budget. The World Bank (2023) estimates that India's exposure to CBAM across sectors runs to several billion dollars annually as the mechanism phases to full implementation. Establishing a qualifying domestic carbon pricing mechanism redirects this fiscal resource from the EU budget to the Indian exchequer.

On a global stage, India's Nationally Determined Contribution under the Paris Agreement commits to reducing the emissions intensity of GDP by 45 per cent by 2030 relative to 2005 levels and achieving approximately 50 per cent of cumulative electric power installed capacity from non-fossil fuel sources by 2030 (Government of India, 2022). The proposed framework advances both commitments through complementary mechanisms. The tax component creates incentives for emission intensity reduction at the firm level, while the grant component funds structural investment in renewable energy and clean production technology.

VI. MODEL DESIGN AND FORMULA

A) Desiderata for Tax Design

- Property 1: Universal Baseline Contribution: Every firm, regardless of revenue or emission intensity, must contribute at least a minimum tax. This reflects the principle of shared environmental responsibility.

- Property 2: Progressive Revenue Scaling: The effective tax rate must be non-decreasing in firm revenue, ensuring that financial capacity is reflected in tax obligation.
- Property 3: Emission Sensitivity: The effective tax rate must be non-decreasing in a firm's emission intensity relative to the industry benchmark. Firms emitting above the acceptable level face a higher rate; firms emitting below face a lower rate.
- Property 4: Industry-Relative Assessment: Tax differentiation across firms must be based on their *relative* revenue position within the industry rather than absolute revenue levels, ensuring the framework is portable across industries of different scales.
- Property 5: Incentive Compatibility at the Margin: For large, high-emission firms, the marginal cost of increasing output (through higher emissions) must exceed the marginal cost of abatement. This ensures the tax creates a genuine nudge toward abatement rather than simply raising costs.

B) Constructing the Tax Formula

Step 1 - Revenue Normalisation

A revenue normalisation term $\alpha_i = \frac{Ri-Rmin}{Rmax-Rmin}$ anchors the model to industry-specific conditions. This avoids crude absolute thresholds and ensures that firms are assessed relative to their peers. It equals 0 for the lowest-revenue firm and 1 for the highest-revenue firm. Crucially, it is dimensionless and industry-specific, satisfying Property 4.

Step 2 - Emission Adjustment Factor

To satisfy Property 3, emission intensity is incorporated through a factor k that compares a firm's per-unit emissions to an industry-level acceptable benchmark defined through the production bundle methodology described in Section IV.B.

$$k = \frac{Firm's\ Per\ Unit\ Emission}{Industry\ Acceptable\ Per\ Unit\ Emission} = \frac{e_i}{\underline{e}}$$

This ensures that firms emitting above acceptable benchmarks face proportionately higher tax rates. Linking this factor to the efficient production bundle discussed above makes the adjustment robust, since it accounts for per-unit efficiency rather than absolute emissions, avoiding penalties for scale while still incentivising abatement.

- k>1: Firm emits above the benchmark — penalised
- k=1: Firm emits at the benchmark — neutral
- k<1: Firm emits below the benchmark — rewarded

Step 3 - Combining into an Interaction Term

Properties 2 and 3 could in principle be satisfied additively, i.e. by adding separate revenue and emission adjustments to the base rate. However, an additive structure would treat financial capacity and emission intensity as independent contributors to tax burden, missing a crucial regulatory insight: the obligation to reduce emissions should be strongest precisely where financial capacity to do so is greatest. A firm with both high revenue and high emissions represents the clearest case for aggressive abatement incentivisation.

This calls for a multiplicative interaction between $\boldsymbol{\alpha_i}$ Moreover, k, producing a compounding effect: high revenue amplifies the emission penalty, and high emissions amplify the revenue-based adjustment. Formally, define the adjustment term as:

$$\delta = \alpha_i * k = \frac{Ri - Rmin}{Rmax - Rmin} * \frac{e_i}{\underline{e}}$$

This term is supermodular in (Ri,k), and the cross-partial being greater than 0 confirms that revenue and emission intensity are complementary in their effect on tax burden rather than substitutable.

Step 4 - Final Tax Rate Formula

Incorporating the baseline contribution (Property 1) and the interaction term yields the complete effective tax rate:

$$Ti \quad = Tb \times \quad [1 + (\frac{Ri-Rmin}{Rmax-Rmin} \times \ (k)]$$

The term in brackets is always at least 1 (since $\boldsymbol{\alpha_i} \geq 0$ and $k \geq 0$), guaranteeing Property 1. The structure ensures Properties 2 and 3 simultaneously, and the multiplicative form ensures the interaction effect described above in step 3.

a. Revenue as the Ability-to-Pay Proxy

The use of firm revenue *Ri* rather than profit or net income as the measure of financial capacity warrants explicit justification, since ability-to-pay in classical tax theory is typically grounded in net income rather than gross revenue.

Three considerations motivate this choice in the present context. First, revenue is substantially more resistant to strategic manipulation than profit. Net profit is subject to accounting treatments like depreciation schedules, amortisation of intangible assets and intercompany transfer pricing that can be adjusted within legal bounds to reduce reported earnings. In India's corporate landscape, where thin-capitalisation strategies and related-party transactions are permitted under Indian law and have drawn regulatory scrutiny, profit-based measures would create significant avoidance opportunities. Revenue, by contrast, is directly observable from sales records, GST filings, and mandatory disclosure requirements under SEBI's listing obligations, making it considerably harder to reduce on paper while maintaining real productive activity.

Second, revenue more accurately reflects a firm's *scale of environmental impact* than profit does. A firm generating ₹75,000 Cr in revenue from cement production imposes environmental costs commensurate with that production volume regardless of what its net margin happens to be in any given fiscal year. The external costs of emissions are a function of output scale, not accounting profit, making revenue the more natural denominator for a tax designed to align private costs with social costs.

For the present framework, revenue is retained on grounds of administrative tractability and manipulation-resistance, consistent with the approach adopted in output-based allocation systems in the EU ETS (Ellerman et al., 2010).

b. Boundary Conditions and Transitional Provisions

The normalisation term α_i requires explicit handling of four boundary cases that arise from the structure of the min-max transformation.

Case 1: Assessment Period Stability: To prevent retroactive rate changes within a period, boundary values are fixed using prior-period data:

$$\alpha_{i,t} = \frac{Ri, t - Rmin, t - 1}{(Rmax, t - 1) - (Rmin, t - 1)}$$

Boundaries update annually at the start of each assessment period using audited accounts from the preceding fiscal year filed with the Ministry of Corporate Affairs.

Case 2: New Entrants: Firms in their first full assessment period are assigned. $\alpha_i = 0$, paying only the base rate *Tb* scaled by their emission factor k, with the effective rate being Ti=Tb·k. From the second period onward, their prior-year revenue enters normalisation. This prevents penalising new facilities before their revenue profile is established while preserving the emission intensity incentive from the first period of operation.

Case 3: Revenue Concentration and Outliers: In industries where revenue is highly concentrated, which can be defined as a Gini coefficient of the industry revenue distribution exceeding a predetermined metric, the regulatory authority should apply a logarithmic normalisation in place of the linear form on an industry-to-industry basis:

$$\alpha_i = \frac{ln(Ri) - ln(Rmin)}{ln(Rmax) - ln(Rmin)}$$

This prevents the progressive component from operating only at distribution extremes and ensures meaningful differentiation across the bulk of the industry's firm population.

Case 4: Monopoly and Near-Monopoly Markets Where an industry contains fewer than three active firms in an assessment period, the revenue normalisation term is suspended and the effective rate defaults to Ti=Tb·k, preserving the emission intensity incentive while avoiding a degenerate application of the progressive component. The three-firm threshold should be revisited as industry structure evolves.

C) Tax Incidence and Incentive Effects

Here, the base tax rate (Tb) provides a baseline contribution for all firms regardless of their specific circumstances. This ensures that all entities pay at least a minimum tax, reflecting the principle of shared responsibility for environmental sustainability.

The term, α_i normalises a firm's revenue R_i within the range of revenues in the industry [R_{min}, R_{max}]. Thus, firms with higher revenues will have larger normalised values. This means that higher-revenue firms face a proportionally larger adjustment to their tax rate, ensuring that entities with greater financial capacity (higher revenues) contribute more.

The emission adjustment factor, k, scales the tax based on a firm's emissions relative to an acceptable benchmark. The tax's effects are enhanced or dampened relative to the firm's k value to ensure that no unnecessary tax is levied on a non-polluting firm purely due to its size. This acts as a safeguard for firms that adhere to environmental norms and make an effort to reduce their emissions continually. It follows the polluter pays principle, where entities with a greater environmental impact should bear higher costs.

a. Analysing Impact on Large Firms

In the following section, we will show the effectiveness of the tax regime in nudging large firms to reduce their emissions. We take the firm's profit maximisation problem at hand and base our analysis on it. We take into account the abatement costs associated with reducing carbon-intensive emissions or switching to carbon-friendly production practices. After this, the firm's problem looks as follows:

$$\text{Max. } \pi = R(q) - C(q) - A(a) - Ti(\theta(q) - a)\,;[a < \theta(q)]$$

Where:

- π - Profit
- **R(q)** - Revenue as a function of production with R'(q) > 0 and R''(q) < 0
- **C(q)** - Cost as a function of production with C'(q) > 0 and C''(q) > 0
- **A(a)** - Abatement cost as a convex function, ie A'(a) > 0 and A''(a) > 0 which represents increasing marginal costs of abatement
- **Ti** - Tax Rate calculated as

$$Ti = Tb \times [1 + (\frac{Ri - Rmin}{Rmax - Rmin} \times (k)] \qquad \textbf{(1)}$$

- $\theta(\boldsymbol{q})$ - Baseline emissions (in tonnes of CO2 produced)
- a - Abatement/Reduction in emissions (in tonnes of CO2 reduced)

We analyse the marginal impacts of both abatement and output. The regime is successful in achieving a reduction in emissions if it meets the condition of having $\Delta Ti > \Delta A$, ie an increase in tax paid for the increase in one unit of production is greater than the cost incurred to reduce one unit of carbon-intensive production. To visualise this, we take the following first-order conditions:

With respect to abatement (a) -

$$\frac{\partial \pi i}{\partial a} = -A'(a) + Ti = 0$$

$$\Rightarrow A'(a*) = Ti \qquad \textbf{(2)}$$

With respect to output (q) -

$$\frac{\partial \pi i}{\partial q} = R'(q) - C'(q) - Ti\theta = 0$$

$$\Rightarrow R'(q*) = C'(q*) + \theta Ti \qquad \textbf{(3)}$$

Thus, an increase in output raises the tax incidence by θTi, which, upon comparison with the increase in abatement, costs Ti from equation (2). Considering a large firm that implies carbon-intensive practices and has a baseline emission$\theta(q) > 1$, we prove our initial condition required for the nudge to large firms, ie $\Delta A < \Delta T$.

From equation (2),

$$A'(a*) = Ti$$

Moreover, since $A''(a) > 0$, there exists an inverse function, implying.

$$a* = (A')^{-1}(Ti)$$

Now, differentiating with respect to Ti, we get $\Rightarrow \frac{\partial a}{\partial Ti} = \frac{1}{A''(a*)} > 0$

Thus, the optimal abatement is strictly increasing in the emission tax rate. Moreover, drawing from our previous analysis of the Tax Rate calculation Ti, we know that Ti increases with both Ri and k.

VII. FISCAL ARCHITECTURE

A) *Transition Mechanisms and Fiscal Support*

To complement the tax regime and encourage firms to adopt environmentally sustainable practices, a grant mechanism is proposed. An effective incentive mechanism paired with fair taxation would allow this policy change to leverage the "double dividend" theory developed by Bovenberg & Goulder (1996) and elaborated by Goulder & Parry (2008), who show that environmental tax revenues, when recycled productively, can simultaneously improve environmental outcomes and reduce the efficiency costs of the broader tax system.

It is worth noting that the original double dividend formulation refers specifically to revenue recycling through reductions in pre-existing distortionary taxes. The present paper adapts this logic to a developing economy context, where the more pressing recycling mechanism is direct reinvestment in industrial transformation and green infrastructure rather than reductions in labour or capital taxes, which is consistent with the arguments of Stern (2006) and the empirical observations of Arimura et al. (2024).

Within this adapted framework, the tax component achieves the environmental objective by altering marginal incentives for emission-intensive production. In contrast, the grant component serves a distributional and dynamic function of channelling revenues toward firms and sectors undertaking the transition to cleaner production, thereby reducing the capital cost barriers that would otherwise slow adoption.

Strategic allocation of green investment revenues toward emerging and underfunded sectors has been shown to enhance long-term productivity growth (Stern, 2006), and direct grant mechanisms have demonstrated advantages over tax credit instruments in sectors with significant financing constraints. Johnston (2019) finds that nonrefundable tax credits in the U.S. wind energy sector were valued at a discount relative to equivalent grant amounts, and Zhou et al. (2024) document that grants generate higher innovation outputs than tax credits among Chinese high-tech SMEs, findings that the IMF (2020) corroborates in the broader context of sectors facing elevated financing constraints. Unlike tax relief, which benefits only firms with taxable profits, grants are accessible to smaller or early-stage firms operating on thinner margins, making them a more effective redistributive instrument in heterogeneous industries.

B) Design of the Grant Allocation Mechanism

The grant formula is derived to satisfy symmetric conditions to the tax; just as the tax increases progressively with k above the benchmark, the grant should increase progressively ask falls below it.

Define an eligibility cap k_g slightly above 1, such that grants are available to firms with k∈[0, k_g]. The grant G_i for an eligible firm should satisfy:

- $G_i = G_b$ when k=1 (benchmark firm receives the base grant)
- $G_i \to G_b[1 + \frac{1}{k_g - 1}]$ as k→0 (maximally clean firm receives the largest grant)
- $G_i = 0$ when k = k_g (at the eligibility boundary, grant falls to zero)

A formula satisfying these conditions is:

$$G_i = G_b[1 + \frac{1-k}{k_g - 1}] \text{ for } k < k_g$$

Where:

- G_b**:** Base Grant—a fixed baseline amount available to all eligible firms.
- k: Firm's Relative Emission Factor.

This ensures:

1. Firms achieving k < 1 receive larger grants, incentivising further emissions reduction.
2. Firms with k = 1 receive the base grant G_b).
3. Firms with k > k_g receive no grant.

This formula ensures that grant allocation is progressive, with greater rewards for firms further from k = 1 in the less-than-1 direction.

The grant mechanism redistributes funds collected from taxes (primarily from high-revenue, high-emission firms) to reward environmentally responsible firms. The grant embodies vertical equity where entities that contribute disproportionately to environmental harm subsidise those adopting responsible practices.

VIII. COMPLIANCE ARCHITECTURE

A) Monitoring, Reporting, and Verification (MRV) Framework

A tax regime's effectiveness depends not only on its incentive structure but on the credibility of its enforcement. This section models the firm's evasion decision under the proposed framework and derives implications for the design of the Monitoring, Reporting, and Verification (MRV) system. The creation of a new tax regime not only presents academic challenges but also challenges in its implementation. This places importance on the role of regulatory monitoring, taking the focus beyond purely academic value.

Furthermore, to create a robust system of checks and balances, it is important first to understand the decision to evade at its core. It provides for regular evaluation of the functionality and effectiveness of the system created, ensuring continued progress and amendments to keep pace with changing paradigms. The paper delves into how it can be mitigated to varying extents by formalising and modelling the decision to evade as a mathematical concept, primarily relying on the assumption of maximising utility as the driving force for all decisions taken.

Breaking down this model, we first understand the variables in it.

- X: Emission declared
- T: Tax rate
- Z: Actual emission
- F: Fine
- Yz: Revenue associated with actual emission
- Yx: Underreported revenue
- A: Benchmark

Thus, there are 2 factors here that impact the final calculation of the tax liability to be imposed upon a given entity, namely through the factor k' or through the revenue variable 'Ri'

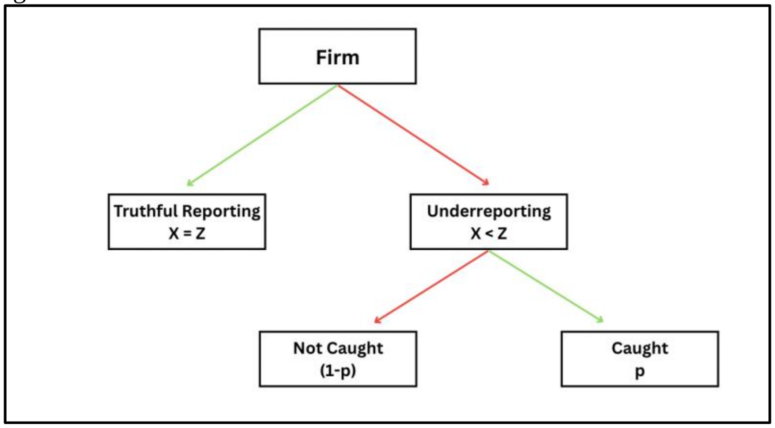

Figure 2. Decision Tree with the Option of Evasion

Considering the case where the person is underreporting but not caught:

$$NC = Yz - Ti\,(Yx)$$

Then, $\boldsymbol{U(NC) = Yz - Ti(Rx, kx) \cdot Yx}$

If caught, then the case would be:

$$\boldsymbol{U(CA) = [1 - Ti(Rz, kz)] \cdot Yz - F \cdot Ti(Rz, kz) \cdot (Yz - Yx)}$$

If caught, not only will the actual tax rate go up, but they will also have to pay a fine as a penalty, thereby increasing the risk of having to pay more through 2 mechanisms as described above. Additionally, a rating system can be developed that punishes and penalises repeat offenders over multiple time periods to increase tax incidence, or another way to impose a more compliant transition.

An effective part of compliance is also working with the expected utilities and understanding the factors that affect the decision we are trying to control and impact, namely, the payoff when a person is caught or when a person is not caught.

4 major factors can be identified as having an impact on the decision and the outcome, namely:

1. Probability of Detection, P
2. Fine Rate, F
3. Tax Rate (only from Tb)
4. Income level, Y

Analysing the payoffs, U(NC) and U(CA), the maximisation incentive for the entity can be broken down as follows:

$$\boldsymbol{Max.E[U(Yx, kx)] = (1 - p) \cdot U(NC) + p \cdot U(CA)}$$

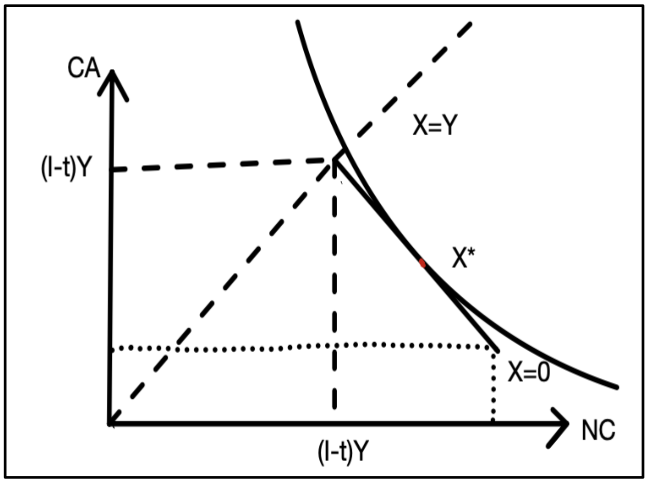

Figure 3. Disclosure Choice that Exists With a Firm

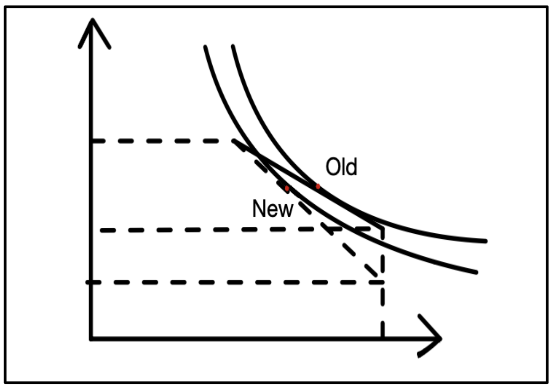

Figure 4. Case for Rise in Probability of Detection

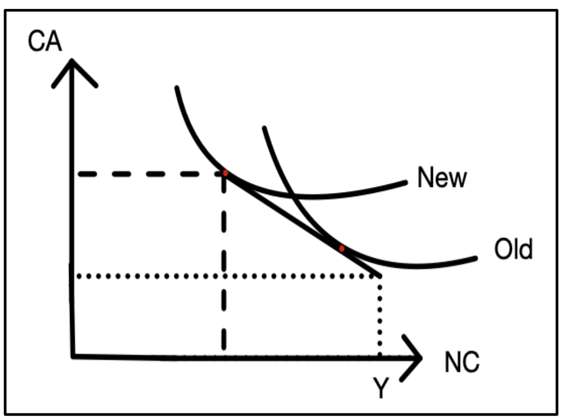

Figure 5. Case for Increase in Fine Rate

These results point to three concrete MRV design principles:

1. Detection probability p should be targeted strategically. Because the deterrence value of detection is amplified for high Ti firms (large, high-emission), audit resources should be disproportionately concentrated on the upper revenue and emission intensity segments of each industry. This is consistent with risk-based audit strategies used in advanced tax administration systems and is operationally feasible given that large firms are also more likely to have auditable paper trails and mandatory disclosure requirements.
2. Fine rates F should be set above a minimum threshold to ensure the expected cost of evasion exceeds the expected tax saving. A sufficient condition for this is$F > \frac{1-p}{p}$, which ensures that the penalty-weighted probability of detection

outweighs the probability of avoiding detection. This threshold should be incorporated into the legislative design of the regime.

3. Since the proposed regime creates cross-exposure between emission reporting and income tax reporting, regulatory coordination between environmental and tax authorities is both necessary and efficiency-enhancing. Joint audit frameworks reduce duplication of enforcement costs while increasing effective detection probability without additional resource expenditure.

Understanding the mechanics of the evasion decision provides a direct foundation for designing effective Monitoring, Reporting, and Verification (MRV) systems. Implementing the proposed tax regime requires several institutional pillars that may evolve into greater responsibilities and broader jurisdictions.

- Firstly, it necessitates standardised and industry-specific emission measurement protocols to ensure consistency and comparability across firms.
- Secondly, it requires a central authority or technical body responsible for defining, updating, and enforcing industry-level benchmarks for acceptable emissions, including calibrating emission intensity factors.
- Finally, it demands a dedicated regulatory agency tasked with overseeing emission reporting, conducting audits, enforcing penalties, and ensuring alignment with both national policy objectives and evolving international standards.

Together, these institutions form a system of checks and balances that minimises leakage, reduces strategic misreporting, and ensures that the tax regime delivers its intended environmental outcomes.

IX. ILLUSTRATIVE APPLICATION: CEMENT INDUSTRY

To provide empirical support to the proposed tax framework, this section presents an illustrative calibration using firm-level data from the Indian cement industry. The purpose of this exercise is not to estimate behavioural responses, but to demonstrate how the proposed tax design operates in practice and how it alters tax incidence and incentives relative to existing uniform emission-based levies.

The dataset constructed for this exercise includes firm-level information on annual revenues, output volumes, and emissions intensity. Total emissions for each firm are computed using reported output and per-unit emissions data. These inputs are drawn from publicly available disclosures and industry reports, ensuring that the calibration relies on information that can reasonably be accessed and verified by regulatory authorities.

A key feature of the proposed framework is the incorporation of firms' relative financial capacity, which is captured in the 'Ability to Pay' calculation. To operationalise this, firm revenues are normalised within the industry, allowing each firm's revenue position to be assessed relative to its peers rather than against absolute thresholds.

The table can be seen below with a dynamic representative categorisation tag added to the firms based on their ability to pay. This helps identify how the tax regime impacts various categories within an industry.

Table 3: (The Full Set of Assumptions Taken and the Calculations are Available Here)

Company Name	Revenue (in Rs Cr)	Emission Intensity (kg CO2/tonne)	Output (MTPA)	Total Emission	Ability to Pay	k Adjustment	Representative Categorisation
UltraTech Cement	75,955	557	135	75,195,000,000.00	1.000	1.260	High
Ambuja Cements	38,900	515	34.3	17,664,500,000.00	0.472	1.165	Medium
Shree Cement	21,000	525	39	20,475,000,000.00	0.217	1.188	Medium
ACC Limited	24,000	530	42.2	22,366,000,000.00	0.259	1.199	Medium
Dalmia Bharat	13,980	460	31	14,260,000,000.00	0.116	1.041	Low
JSW Cement	5,813	244	12.3	3,001,200,000.00	0.000	0.552	Low
Nuvoco Vistas	10,357	457	19.4	8,865,800,000.00	0.065	1.034	Low
JK Cement	11,500	563	17.5	9,852,500,000.00	0.081	1.274	Low
Birla Corporation	9,478	595	18.1	10,769,500,000.00	0.052	1.346	Low
The Ramco Cements	9,200	575	16	9,200,000,000.00	0.048	1.301	Low

Environmental performance is incorporated through a comparison of firm-level emissions intensity with an industry benchmark representing an efficient production process. Firms emitting above this benchmark are treated as relatively inefficient, while firms at or below the benchmark are considered more efficient.

The benchmark emission intensity used here is derived by applying the production bundle methodology of Section IV.B to the cement manufacturing process. Table 4 presents the bundle construction for the cement sector, disaggregating the production process into its four principal emission-generating stages and then assigning a per-unit emission intensity to each based on best-practice technology currently achievable in the Indian context.

The calculation for the industry benchmark emission is done on an input required per unit basis. The calculations for the same are attached below. Using these two dimensions, the spreadsheet computes an effective tax rate for each firm under the proposed regime. This rate is then applied to the firm's total emissions to obtain its overall tax liability. For comparison, tax liabilities are also calculated under a baseline regime in which a uniform rate is applied to emissions, mimicking existing flat or quasi-flat carbon levies.

Table 4: Benchmark CO_2 Emissions from Cement Production by Process Type (kg CO_2 per Tonne of Cement)

Process Type	Input	Quantity Used	Emission per unit	Remarks
Process Emissions (Calcination)	Limestone	~1.0 tonne	330	Chemically unavoidable. CO_2 released during $CaCO_3 \rightarrow CaO$ conversion; independent of fuel choice
Thermal Energy	Coal / Alt. Fuels	~3,000 MJ	100	Technology & fuel dependent. Assumes modern dry kiln with ~20% biomass/RDF substitution
Electrical Energy	Grid / Renewable	~90 kWh	10	Grid-mix dependent. Lower bound assumes ≥80% renewable electricity.
Additives	Gypsum	~0.05 tonne	2	Minor process. Limited impact on total emissions
Total Benchmark Emissions		1.0 tonne cement	442 kg/tonne	

The calibration results reveal clear differences in tax incidence across the two regimes. Under the proposed framework, higher revenue firms bear a larger share of the tax burden relative to their size. In comparison, smaller firms face a lower relative burden compared to a uniform tax. At the same time, firms with emissions intensities exceeding the industry benchmark experience higher effective tax rates, strengthening incentives to improve production efficiency and reduce emissions per unit of output.

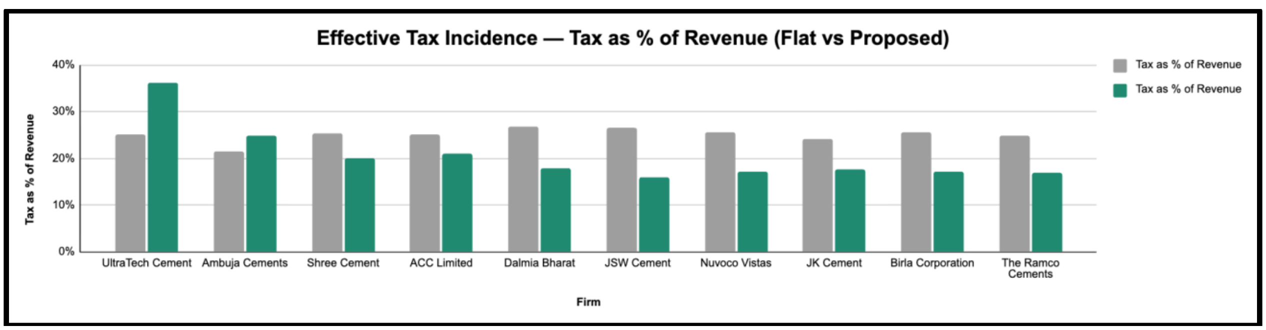

Figure 6. Comparison of Tax Incidence under the Proposed Regime versus a Uniform Levy

While the calibration does not model firm-specific abatement choices explicitly, it demonstrates that the proposed tax design generates a more progressive incidence structure and more effective marginal incentives for emissions reduction than existing approaches. The spreadsheet framework further allows for straightforward scenario analysis, including changes in benchmark stringency, base tax rates, or industry composition. The calibration serves to illustrate how the proposed tax regime can be operationalised using readily available data and align with administrative feasibility while delivering both equity and efficiency gains.

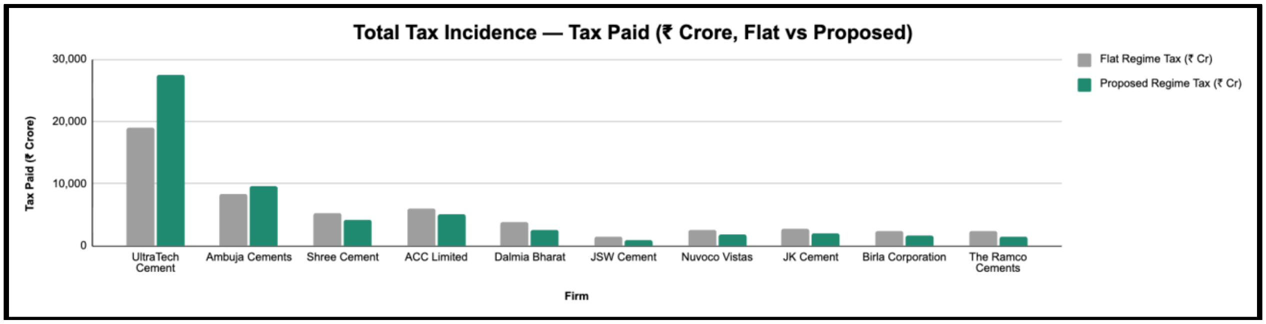

Figure 7. Effective Tax Rate across Firms under the Proposed Regime

X. LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

The study is subject to several conceptual, empirical, and institutional limitations that also define important avenues for future research. At the modelling level, the framework operates within a partial equilibrium setting, holding input prices, wages, and downstream market conditions fixed. Consequently, the incidence and efficiency effects derived should be interpreted as partial equilibrium approximations rather than economy-wide outcomes. Empirically, using revenue as a proxy for firms' ability to pay, though relatively resistant to manipulation and broadly correlated with environmental impact, may disadvantage high-revenue, low-margin firms despite the inclusion of safeguard mechanisms. Similarly, the production bundle benchmarks and normalisation mechanisms rely on engineering estimates and PAT scheme data that require broader empirical validation across sectors with differing industrial structures.

The framework also faces significant implementation constraints. It’s monitoring, reporting, and verification architecture presumes a level of institutional and regulatory capacity that extends beyond India's current administrative infrastructure and would require substantial inter-agency coordination and legislative reform. Another unresolved issue concerns the long-run fiscal relationship between the proposed tax and grant mechanisms, particularly as successful decarbonisation simultaneously reduces the taxable emissions base while expanding grant eligibility.

Future research should therefore focus on sector-specific calibrations, alternative scaling variables such as EBITDA, and the incorporation of dynamic fiscal sustainability constraints. Extending the framework to a computable general equilibrium setting, modelling stochastic fiscal dynamics, would provide stronger evidence regarding the framework's practical viability and long-term effectiveness.

XI. CONCLUSION

The progressive green tax model developed in this study addresses a structural gap in existing environmental taxation frameworks: the failure to account for the differential financial capacity of firms when designing per-unit emission levies. By integrating revenue-based progressivity with an emission intensity adjustment factor, the proposed formula ensures that the marginal cost of emission-intensive production is highest for precisely those firms best equipped to bear it and most capable of financing the transition to cleaner alternatives. This is not merely an equity consideration; it is an efficiency argument. Flat carbon taxes dilute their own abatement incentives by imposing identical marginal costs on firms with vastly different capacities to respond. The proposed framework corrects this by making the effective tax rate a function of both environmental performance and financial scale.

The paper makes several connected contributions. Theoretically, it derives the tax formula from explicit axiomatic desiderata, demonstrating that the multiplicative interaction between revenue normalisation and the emission adjustment factor is not an arbitrary design choice but a necessary consequence.

The bid to align with international standards and its structural compatibility identifies a further advantage of the proposed framework that is specific to India's trade context. Because the formula generates a verifiable, firm-specific per-tonne carbon cost derived from auditable inputs, it produces the documentation required for credit against border charges, which is a capability that India's tax regime does not provide. This positions the proposed framework not only as a domestic environmental instrument but as a foundation for India's integration into the emerging global carbon economy.

The ultimate test of any tax design is whether it can be implemented, enforced, and sustained politically over the time horizon required to drive genuine industrial transformation. By building on mechanisms that already function and including credible bridges to the current paradigm, the framework seeks to close the gap between theoretical environmental tax design and the political and administrative realities of a large, heterogeneous developing economy. Whether it succeeds in doing so is ultimately an empirical question. One that pilot implementation in a single sector, with careful monitoring and iterative calibration, is best positioned to answer.

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