The indirect effects of sector-specific emission policy: who wins and who loses?

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Abstract

This paper examines the indirect effects of sector-specific emissions policies in a vertically differentiated duopoly where each firm generates a constant per-unit carbon emission and a significant share of demand originates from environmentally conscious consumers. Firms can undertake a one-time fixed-cost investment that lowers their emissions intensity, and we study their strategic responses under two regulatory mechanisms—carbon taxation (CT) and cap-and-trade (CAT). We characterize equilibrium prices, demands, emissions decisions, and carbon footprints (CFPs). We find that under non-trivial technological costs of emissions reduction, the low-quality firm ultimately serves a smaller market share than the high-quality firm but nonetheless achieves a lower total CFP—even though the high-quality firm reduces its emissions by a larger absolute amount. Per-unit emissions reduction is greater for the low-quality firm whenever the regulator's target emissions lie below a threshold. Under CAT, the low-quality firm ends up below its allocated emissions cap whereas the high-quality firm exceeds its cap and incurs penalties. Although CT and CAT yield identical equilibrium emissions for each firm when designed optimally, firm profits are higher under CAT. By contrast, total surplus is higher under CT when the industry emissions target is sufficiently stringent.

Keywords: emissions, carbon tax, cap and trade.

1 Introduction

Net-zero emissions by 2050 being one of the targets governments considered as a part of the United Nations Climate Change Conference COP30 in Belém, Brazil in November 2025, firms in all sectors of the economy are facing increasing pressure to reduce carbon emissions.[1] Carbon taxes (CT) and cap-and-trade (CAT) systems are the two primary policy instruments to incentivize firms to reduce carbon emissions to meet the goverment's emission targets. The European Union Emissions Trading System (EU ETS), the world's largest carbon trading market covers more than 10,000 installations across energy and industrial sectors (European Commission, 2023). Carbon taxation has also gaining popularity as more than 30 countries, including Canada, Sweden, and Japan, have enacted explicit carbon taxes, and the number is expected grow in the next decade.[2] While these schemes have lead to a net decrease in carbon emissions, it is not clear how heterogeneous firms with an industry sector are affected and respond to these schemes.

This paper investigates the indirect effects of emissions reduction strategies in a vertically differentiated duopoly, where each firm produces output associated with a constant per-unit carbon emission rate and a significant fraction of demand comes from environmentally conscious consumers. Firms undertake a one-time fixed-cost investment to reduce emissions, and their strategic responses are analyzed under two regulatory policies: carbon taxation (CT) and cap-and-trade (CAT). In this context, we consider three important research questions:

1. Given that a low quality firm competes with a high quality firm, how are firm profits affected by the implementation of a sector-specific cap in terms of emisssions? Does the answer to this question depend on whether the policy is a carbon tax or cap and trade?

2. While total emissions depends on both the investments made by firms to reduce the carbon footprint of each unit produced and the volume sold, which firm (the low quality firm or the high quality firm) offers a product to the market with the lowest carbon footprint per unit? Does the answer to this question depend on whether the policy is a carbon tax or cap and trade?

3. How are the answers to questions 1 and 2 affected if targets are set on a per unit basis versus on a total sector ceiling for emissions?

We characterize the equilibrium demand allocation, emissions outcomes, and firm incentives

[1] Source: https://unfccc.int/cop30/about-cop30 (accessed: November 26, 2025)

[2] World Bank (2022). State and Trends of Carbon Pricing 2022.(https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099045006072224607 accessed November 28, 2025)

under varying degrees of product differentiation. We find that under non-trivial technological costs of emissions reduction, and binding regulatory targets on total sectoral emissions, both firms reduce their CFPs relative to pre-intervention levels. However, the low-quality firm achieves a lower post-regulation carbon emissions despite a smaller absolute emissions reduction. This is driven by the disproportionate burden imposed by emissions penalties on firms with lower profit margins. The low-quality firm, more sensitive to marginal cost increases from emissions pricing, reduces both output and emissions more aggressively than the high-quality firm.

Our analysis demonstrates that these outcomes hold under both CT and CAT mechanisms. Although CT imposes a per-unit emissions tax, and CAT assigns emissions caps proportionate to historical output with penalties for overages, both schemes yield equivalent emissions reductions and welfare outcomes under optimal design. Nevertheless, profit distributions differ: CAT is more favorable to industry profits due to reduced fiscal transfers, with only the high-quality firm incurring cap overages.

In dynamic industries with volatile sales volumes, regulatory design shifts toward emissions intensity standards—targeting emissions per unit of output. Firms achieving emissions rates below the target benefit from tradable credits or regulatory incentives. Even in such environments, the high-quality firm maintains a higher CFP, while the low-quality firm constrains both production and emissions to meet compliance. The results highlight a systemic asymmetry: emissions reduction policies, while environmentally effective, impose greater compliance burdens on lower-quality firms that are less financially equipped to absorb carbon costs. Simultaneously, these mechanisms may inadvertently allow higher-margin, high-quality firms to sustain greater environmental impact. Policy design must therefore account for such distributional effects to ensure equitable and efficient decarbonization across vertically differentiated markets.

The increase in total surplus due to incentivization leads to production-demand adjustment as well as reduction of emissions. The low-quality firm bears a heavier burden of reduction of total emissions and necessarily reduces its demand because it has lower profit per unit volume. The high-quality firm reduces emissions but still affords to pay a tax/penalty on account of carbon emissions.

2 Literature Review

A growing body of work studies how consumer environmental preferences shape firms' incentives to invest in cleaner technologies. Aghion et al. (2023) show that exposure to prosocial attitudes fosters clean innovation, and that competitive pressure amplifies this effect. Their insights highlight demand-driven mechanisms for decarbonization but do not address strategic interactions between heterogeneous firms under explicit emissions policies. Our paper builds on this demand-side foundation by incorporating consumer environmental sensitivity directly into the utility function and linking it to equilibrium emissions across differentiated firms.

Firm behavior under carbon regulation has been studied particularly in the field of operations management. In a monopoly, Krass et al. (2013) show how carbon taxes influence technology adoption and production levels, finding that high taxes may discourage cleaner technology investment. However, they assume consumer welfare as independent of emissions, limiting the model's applicability in markets where environmental consciousness shapes purchasing. In Cournot-type competitive markets, Anand and Giraud-Carrier (2020) show that firms strategically balance production and emissions under cap-and-trade. We complement their research by considering a common feature of competitive markets with firms vertically differentiated on product quality and including a decision by firms to make a fixed-cost investment in emissions-reduction technologies. Gao and Souza (2022) model environmentally conscious consumer segments and voluntary carbon offsets provided by NGOs to a monopoly. While they consider two discrete segments of consumers while we model a continuum of consumers offering a stronger generality. Moreover, we consider regulator-determined policies (CT and CAT) rather than NGO offsets, enabling insight into optimal tax and cap levels. Considering fixed-cost technology choices of vertically differentiated firms to abate carbon emissions under CT and CAT schemes, allows us to examine the interaction between product quality, margins, and firm heterogeneity on the reduction of net emissions by competing firms.

General equilibrium models (e.g., Acemoglu et al. 2016; van den Bremer & van der Ploeg 2021) analyze optimal carbon taxation at the national or global level, linking aggregate emissions to uncertain climate damages. While these models provide high-level policy guidance, they offer limited insights into industry-level regulatory design—particularly in markets with differentiated products and heterogeneous firms. They also shed little light on why carbon prices in cap-and-trade markets often remain low, a concern documented in policy reviews (e.g., Marron & Toder 2014). Our contribution differs fundamentally in the fact that ours is a market level analysis of firm-level responses under asymmetric product quality which helps identify conditions when emissions policies impose disproportionate burdens on low-margin firms which are not addressed by the general equilibrium models referred above.

3 Model of a Vertical Differentiated Market with Emission Averse Consumers

Consider a market with two vertically differentiated firms ($i \in \{1,2\}$) where one firm ($i=2$) offers a higher product quality than the other: $v_2 = v + \Delta v$, and $v_1 = v > 0$ with all else being equal. For simplicity we normalize the marginal cost of production $c = 0$. Each unit produced by either firm generates a known fixed rate h of carbon emissions and for simplicity, the number of units sold equals the number of units produced (no inventories) by each firm. Each firm can invest an amount $S(x) = kx^2/2$ toward reducing carbon emissions by an amount x where k captures the technological cost of per unit reduction of emission by the firm (e.g., *The Wall Street Journal* 2021) which is assumed significant reinglfect the practical reality. The resulting or "net emission" or carbon footprint of the firm which spends $S(x)$ on decarbonization is therefore $hD_i - x_i$ where D_i is the demand of the product i.

The market consists of a unit mass of individuals who are heterogeneous in taste for product quality θ which is continuously distributed, for simplicity, according to a uniform distribution $\theta \sim U[0,1]$ in the population. Among them, there are further there are two types, a fraction $\alpha \in [0,1]$ of "green-conscious" or emission-averse consumers and $1-\alpha$ of others who are not. Accordingly, a green consumer derives a utility $u_{gb,i} = \theta v_i - p_i - \eta_b(hD_i - x_i)$ from buying the firm i's product and a social utility $u_{gs,i} = -\eta_s(hD_i - x_i)$ from not buying. Hence, a green consumer considers buying the product sold by a firm i only if $\Delta u_{g,i} = u_{gb,i} - u_{gs,i} \geq 0$ (individual rationality condition) which simplifies to $\theta v_i - p_i - (\eta_b - \eta_s)(hD_i - x_i)$. Define $\beta := \eta_b - \eta_s$ as the incremental disutility of buying a product from a firm (i) leaving a carbon footprint $hD_i - x_i$. In addition, a green consumers also have an additional social (dis)utility $u_{gs,-i} = -\eta_s(hD_{-i} - x_{-i})$ due to the carbon footprint of the firm she does not buy from. Green consumers who do not buy at all, have a social utility of $u_{gs,n} = -\eta_s(hD_1 - x_1 + hD_2 - x_2)$. Consumers constituting the remainder (fraction $1-\alpha$) of the market who do not perceive any disutility from the climate change impact derive the standard utility $u_{nb,i} = \theta v_i - p_i$ from buying the firm's product and $u_{ns,i} = 0$ otherwise.

The game proceeds as follows: 1) The regulator decides a carbon tax rate ρ to achieve a target net emission T for the industry. 2) The firm i decides to spend an amount $S(x_i)$ to reduce emissions by an amount x_i and decides price p_i for its product and declares its net carbon emission. 3) The consumers decide to buy or not. 4) The net carbon emission of each firm is certified by an external auditor. 5) A transfer of carbon emissions tax or penalty if the emissions exceed the cap is made to the regulator or the provider of carbon credits from the carbon credit market, or the firm receives a transfer from the sale of its carbon credit in the carbon credits market. 6) The profits are realized.

A green consumer θ buys the product sold by the high-quality firm if $\Delta u_{gb2} \geq \Delta u_{gb1}$ (incentive compatibility condition) which solves as $\theta \geq \hat{\theta}_{g2}$ where $\hat{\theta}_{g2} = \frac{(p_2-p_1)+\beta(h(D_2-D_1)-(x_2-x_1))}{\Delta v}$. She buys the product sold by the low-quality firm if $\theta < \hat{\theta}_{g2}$ and $\Delta u_{gb1} \geq 0$, i.e., $\theta \geq \hat{\theta}_{g1}$ where $\hat{\theta}_{g1} = \frac{p_1+\beta(hD_1-x_1)}{v}$. Similarly, a "non-green" consumer buys the product sold by the high-quality firm if $\Delta u_{b2} \geq \Delta u_{b1}$, i.e., $\theta\Delta v - (p_2 - p_1) \geq 0$ (incentive compatibility condition) which solves as $\theta \geq \hat{\theta}_2$ where $\hat{\theta}_2 = \frac{p_2-p_1}{\Delta v}$. She buys the product sold by the low-quality firm if $\theta < \hat{\theta}_2$ and $\Delta u_{b1} \geq 0$, i.e., $\theta \geq \hat{\theta}_1$ where $\hat{\theta}_1 = \frac{p_1}{v}$. As a result, the demands for the products of the two firms are given by

$$\begin{aligned} D_2 &= \alpha\left(1-\hat{\theta}_{2g}\right) + (1-\alpha)\left(1-\hat{\theta}_{2n}\right) \\ &= 1 - \frac{p_2-p_1}{\Delta v} - \frac{\alpha\beta\left(h\left(D_2-D_1\right)-\left(x_2-x_1\right)\right)}{\Delta v}, \end{aligned} \tag{1}$$

$$\begin{aligned} D_1 &= \alpha\left(\hat{\theta}_{2g}-\hat{\theta}_{1g}\right) + (1-\alpha)\left(\hat{\theta}_{2n}-\hat{\theta}_{1n}\right) \\ &= \frac{p_2-p_1}{\Delta v} - \frac{p_1}{v} + \alpha\beta\left(\frac{h\left(D_2-D_1\right)-\left(x_2-x_1\right)}{\Delta v} - \frac{hD_1-x_1}{v}\right). \end{aligned} \tag{2}$$

As we show subsequently, the parameters α and β appear together in the solution of the model and hence defined as $A := \alpha\beta$ interpretable as a "demand pull" exerted by a combination of the fraction α of the green consumers present in the market and their sensitivity β to net emissions of the firm. Further, we assume that the relative weight on the utility of the carbon emissions β does not exceed the maximum weight of the utility $\theta = 1$ of the product quality. Since $\alpha \in [0, 1]$, we have $A \in [0, 1]$. We further assume that the technological cost of unit reduction of emission k is significant such that $k \geq Ah$. Simultaneous solution of equations 1 and 2 leads to the demand functions

$$\hat{D}_2 = \frac{v\left(\Delta v - p_2 + p_1\right) + A\left(h\left(v+\Delta v - p_2\right) + v\left(x_2 - x_1\right) + Ahx_2\right)}{v\Delta v + A\left(h\left(2v+\Delta v\right) + Ah^2\right)}, \tag{3}$$

$$\hat{D}_1 = \frac{p_2 v - p_1\left(v+\Delta v\right) + A\left(h\left(v-p_1\right) - vx_2 + \left(v+\Delta v\right)x_1 + Ahx_1\right)}{v\Delta v + A\left(h\left(2v+\Delta v\right) + Ah^2\right)}. \tag{4}$$

Without loss of generality, we normalize $v = 1$, $c = 0$, and hereafter refer to the CFPs as $r_i = hD_i - x_i$. The above leads to the following result.

Lemma 1 *In the absence of regulation ($\rho = 0$), the demands and the carbon footprints for high-quality product are higher than the low-quality product and positive ($\hat{D}_2\left(p_1^*, x_1^*, p_2^*, x_2^*\right) \geq \hat{D}_1\left(p_1^*, x_1^*, p_2^*, x_2^*\right) \geq 0$, and $r_2(\cdot) \geq r_1(\cdot) \geq 0$ where $r_2(\cdot) = h\hat{D}_2(\cdot) - x_2^*$, and $r_1(\cdot) = h\hat{D}_1(\cdot) - x_1^*$) given the sufficient condition $k \geq A/h$. Nonetheless, the high-quality firm invests more in the reduction of carbon emissions and achieves a greater extent of reduction in carbon emissions than the low-quality firm ($x_2^* \geq x_1^*$).*

With higher quality, hence higher prices, the high-quality firm affords a higher investment in reduction of carbon emissions and therefore achieves a greater extent of reduction in carbon emissions. Nevertheless, since its demand and hence production volume is greater, the net carbon footprint of the high-quality firm is higher than that of the low-quality firm which earns a lower margin and therefore can afford a lower investment in reducing emissions for a given level of A. It optimal decision is to serve a lower demand hence, has a lower production volume which leads to a lower carbon footprint besides investing in decarbonization (reduction of carbon emissions) the cost of which is high because $k \geq A/h$.

4 Cap-and-Trade or Carbon Tax

As a part of a cap-and-trade (CAT) scheme, the regulator allocates a "cap" t_i to firm i based on the total sales before the scheme is implemented based on the total industry target T such that $t_i = TD_i/\sum_{i=1}^{2} D_i$ and then sets the penalty for exceeding the cap ρ such that $h\hat{D}_2 - x_2 - t_2 + h\hat{D}_1 - x_1 - t_1 = T$ leading to $t_1 = T - t_2$ where

$$t_2 = \frac{T\,(Ah+1)\begin{pmatrix} 2A^2(\Delta v+1)h^2k - A^3h(\Delta v+1) \\ +Ahk(2\Delta v(\Delta v+3)+3) - (\Delta v+1)\left(A^2(\Delta v+1) - 2k\Delta v\right) \end{pmatrix}}{k\begin{pmatrix} 3\Delta v(\Delta v+1) + 2A^3h^3(\Delta v+2) \\ +A^2(\Delta v(2\Delta v+11)+10)h^2 + A(\Delta v+2)(5\Delta v+3)h \\ -A^2(\Delta v+2)(Ah+1)(\Delta v+Ah+1) \end{pmatrix}}.$$

In the case of a carbon tax (CT) scheme, the regulator simply imposes a carbon tax ρ on any amount of emissions by the firms, i.e., $t_2 = 0 = t_1$. Solving simultaneously the firm decision problems under either scheme, we get the following result.

Lemma 2 *There exists an industry emissions target $T = \overline{T}$ such that the regulator sets a positive penalty for exceeding the cap on emissions same as a carbon tax on emissions ($\rho^{CAT} > 0$ and $\rho^{CT} > 0$) only if $T \leq \overline{T}$ where*

$$\overline{T} = \frac{(hk-A)\begin{pmatrix} 2A^3h^3k(\Delta v+2) + A^2h^2\left(k(\Delta v(2\Delta v+11)+10) - A^2(\Delta v+2)\right) \\ +Ah(\Delta v+2)\left(k(5\Delta v+3) - A^2(\Delta v+2)\right) \\ -(\Delta v+1)\left(A^2(\Delta v+2) - 3k\Delta v\right) \end{pmatrix}}{\begin{matrix} \Delta v\left(A^4(Ah+1) + k^2(Ah+1)(8Ah(Ah+2)+3) - A^2k(6Ah(Ah+2)+5)\right) \\ +2\Delta v^2k(Ah+1)\left(2k(Ah+1) - A^2\right) \\ +A\left(A^2(Ah+1) - k(Ah+2)(2Ah+1)\right)\left(A + h\left(A^2 - k(2Ah+3)\right)\right) \end{matrix}}.$$

Intuitively, if the target is sufficiently high such that is achieved without any regulation but only due to the presence of emission-averse consumers in the market ($T > \overline{T}$), regulation is not needed ($\rho^C = 0$). Only when $T \leq \overline{T}$, $\rho^C > 0$. Considering $T \leq \overline{T}$, we get the following result.

Proposition 1 *The penalty of the exceeding the cap under CAT that achieves the total industry emission $T \leq \overline{T}$ is the same as the carbon tax CT ($\rho^{CAT} = \rho^{CT} := \rho^{C}$); and the price, demand, reduction in carbon emissions, and the net carbon footprints (CFP) of each firm are the same under CAT and CT: $p_i^{CAT} = p_i^{CT} := p_i^C$, $D_i^{CAT} = D_i^{CT} := D_i^C$, $x_i^{CAT} = x_i^{CT} := x_i^C$, and $r_i^{CAT} = r_i^{CT} := r_i^C$.*

Although there is some debate about the benefits or efficacy in reduction of emissions between the schemes CAT and CT (cite), we find that an opitmal choice of the penalty of exceeding the cap in a CAT scheme is the same as an optimal choice of a CT to achieve a total industry target emissions T. Furthermore, the firm decisions, pricing and the reduction of carbon emissions are also the same for the two schemes.

Corollary 1 *The total surplus in the economy arising out of the consumer and producer surplus, and the taxes also are the same under the two schemes CAT and CT, but the firm profits are lower under CT than under CAT.*

Intuitively, there is a higher payout of taxes under CT because any positive emission by either firm is taxed than under CAT where a penalty is applied to only the amount of emissions exceeding the cap.

Proposition 2 *The implementation of carbon regulation (CAT or CT) leads to a lower net emission or carbon footprint (CFP) of the low-quality firm than the high-quality firm ($r_1^C(\cdot) \leq r_2^C(\cdot)$) although the actual reduction of emission is higher for the high quality firm ($x_1^C \leq x_2^C$).*

As without regulation, the low-quality has lower margins hence can afford a lower investment in the reduction of carbon emissions than the high-quality firm. With the possibility of an additional payout due to a tax or penalty due to regulation forces the low quality firm to both reduce demand and emissions to reduce such a payout. The investment in reduction of the emissions still, predictably, is lower than the high-quality firm but an additional reduction of demand leads to a lower net emissions or CFP and hence the payout in terms of carbon taxes or penalties.

Proposition 3 *The implementation of an optimal cap-and-trade scheme (CAT) or a carbon tax (CT) reduces the net carbon footprints of both firms to levels below that under no regulation: $r_2^C(\cdot) \leq r_2(\cdot)$, and $r_1^C(\cdot) \leq r_1(\cdot)$. Both firms also reduce their demands under CAT to levels below that without regulation $D_2^C(\cdot) \leq D_2(\cdot)$, and $D_1^C(\cdot) \leq D_1(\cdot)$ but the low-quality firm reduces demand more than the high-quality firm due to the regulatory CAT or CT scheme ($D_1(\cdot) - D_1^C(\cdot) \geq D_2(\cdot) - D_2^C(\cdot)$).*

The firms have two means to reduce their emissions: a) reduce the production volume which leads to a lower demand, and b) implement technological solution at a cost $k \geq A/h$ to reduce emissions from their production process. The result suggests that both firms utilize a combination of the two as a response to the regulation. Hence the introduction of a CAT or CT scheme amplifies the difference in sales volume between the high- and low-quality firms.

Proposition 4 *The per-unit reduction in emissions is higher for the low-quality firm than the high-quality firm ($x_1^C/D_1^C(\cdot) \geq x_2^C/D_2(\cdot)$) if and only if the technological cost of reduction of emissions exceeds a threshold ($k \geq \hat{k}$) and the target emissions are below a threshold ($T \leq \hat{T}$), where*

$$\hat{k} = \frac{\begin{array}{c}(Ah+1)^2 \Delta v + Ah(2Ah+3) \\ +\sqrt{A^2h^2(2Ah+3)^2 + (2Ah+1)(Ah+1)^2 \Delta v^2 + 2Ah(Ah+3)(Ah+1)^2 \Delta v}\end{array}}{(Ah+1)h^2 \Delta v}$$

$$\hat{T} = \frac{2A(A(Ah+1) - kh(2Ah+3)) + (Ah+1)\left(A^2 - 2Ahk - 2k + h^2k^2\right)\Delta v}{(hk-A)\left(k(Ah(2Ah+3) + 2(Ah+1)\Delta v) - A^2(Ah+1)\right)}$$

Thus, while either scheme delivers the targeted emissions reduction, the policies lead to a situation when $k \geq \hat{k}$ and $T \leq \hat{T}$, in which products with a higher per unit carbon footprint (the high quality product) increase market share. Oddly, the firm making a greater investment per unit basis loses traction in the market.

5 Conclusion

While prior research has analyzed carbon taxation, cap-and-trade, and technology adoption in monopoly or symmetric competitive settings, little is known about how heterogeneous firms, differing in product quality, margins, and emissions technology, respond to regulatory interventions. Our work bridges this gap by analyzing a fixed-cost emission abatement investment by vertical differentiated firms facing consumers with environmental preferences. We show that under uniform policies at the sector level, firms selling products of lower quality achieves a lower total carbon footprint than firms selling higher quality products under both carbon taxation and cap-and-trade. Since low-quality firms have thinner margins when competing with high-quality firms, they face higher effective carbon costs and hence respond by reducing both emissions and output more aggressively than high-quality competitors. Managers in such firms should anticipate downward pressure on volume and proactively invest in emissions-efficient technologies. Conversely, because they can absorb emissions penalties more easily, high-quality firms sustain higher production levels and contribute more to total sector emissions. Managers in high-margin firms tradeoff environmental regulatory compliance with alone ensures environmental leadership; operational adjustments may be required to meet stakeholder expectationsprofits. Even in dynamic industries where regulatory emissions standards are defined per unit of output, low-quality firms still reduce output more aggressively, while high-quality firms maintain a higher total carbon footprint. Hence using emissions intensity standards does not eliminate distributional imbalances inherent in differentiated markets. We thus identify an unintended consequence of sector-level regulation: seemingly neutral emissions policies place a disproportionate compliance burden on low-margin firms, while high-quality firms retain a greater share of industry emissions. This insight is critical for regulators designing equitable decarbonization pathways and for managers navigating carbon costs under demand-driven environmental preferences.

For regulators and industry planners, the choice between CT and CAT does not materially affect emissions outcomes. However, CAT generally yields higher firm profits because fewer payments are transferred to regulators, suggesting an incentive-aligned design for industry adoption. However, when emissions ceilings are tight, CT delivers larger consumer and social benefits because it avoids distortions associated with fixed allocations of emissions permits. Regulators in tightening regulatory environments should consider CT for maximizing societal value. Taken together, these contributions advance our understanding of how emissions policy interacts with product differentiation and firm heterogeneity—providing new guidance for the design and implementation of sector-specific decarbonization strategies.

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