Voluntary Corporate Emission Targets in a Patchwork Policy Landscape

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Abstract

Many large, publicly-traded companies adopt voluntary greenhouse gas emission reduction commitments in the presence of a fragmented public policy landscape. To explore the potential emission implications of such commitments, we develop a framework for understanding how firms' voluntary emission targets interact with carbon pricing, regulatory mandates, subsidies, and heterogeneous policies across political jurisdictions. This analysis highlights the difficulty of distinguishing incremental voluntary emission abatement from policy-induced emission reductions. We introduce the Harvard Salata Corporate Emission Targets Database, which we produced from public domain reports published by Russell 3000 firms over 2000-2024. The database documents the growth, form, scope, and sectoral distribution of voluntary greenhouse gas emission targets, including net-zero, carbon-neutral, carbon-reduction, energy-related, and qualitative commitments. Comparing this database with CDP, a non-profit organization formerly known as the Carbon Disclosure Project and the most common source of corporate emission targets used in the research literature, reveals substantial omissions in their survey-based data, especially in recent years. We show that voluntary corporate targets often mirror government-established goals and public policies, and some firms benchmark their internal carbon prices to existing carbon taxes and emission trading systems. The paper concludes by outlining empirical challenges and future research needs for evaluating the emission impacts of voluntary commitments.

Keywords: Carbon Targets; Net Zero; Carbon Neutrality; Internal Carbon Prices; Voluntary Regulation; Carbon Pricing

JEL Codes: Q54, Q58, M48

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Voluntary Corporate Emission Commitments in a Patchwork Policy Landscape

1. Introduction

In recent years, an increasing number of corporations have voluntarily adopted greenhouse gas emission commitments. This reflects an evolution in firms' strategies, as they move from energy efficiency and renewable power goals to setting emission intensity goals, absolute emission reduction goals, and science-based targets and net-zero emission goals. The voluntary adoption of such goals occurs against a policy patchwork, with corporations operating in an array of jurisdictions implementing carbon pricing, regulatory mandates, and clean energy subsidies, as well as others without any meaningful climate change policy. As nations, states and provinces, and cities adopt net-zero goals, what are the implications of voluntary corporate emission commitments?

Evaluating the impact of voluntary emission goals must confront several key questions. Does a corporate goal require substantive changes to a firm's investment, management, and strategy, or does it reflect what it would have done anyway? A firm's emissions may fall as a result of mergers and acquisitions shifting the corporate footprint or improvements in the carbon intensity of the local electricity grid that powers its facilities. A voluntary goal may simply reflect greenwashing by a firm's communications department (Montgomery et al. 2024). With the vast array of subsidies, regulations, and carbon pricing policies, what are the incremental impacts of a voluntary emission target? Does voluntary adoption and announcement of an emissions goal serve as a sufficient commitment device for the firm to take actions to deliver on the goal? The mixed record of progress to date by firms with voluntary goals suggests this may not be the case (Aldy et al. 2023; Jiang et al. 2025).

To address these questions, however, requires information about firms' voluntary targets. How firms disclose information about their emission targets may undermine efforts by researchers and analysts to evaluate their impact. In the context of voluntary action on climate change, firms can disclose information about their goals through their own publications (e.g., sustainability reports), regular financial communications (e.g., earnings calls), independent reporting platforms (e.g, CDP[1]), and commitment validation bodies (e.g., Science-based Targets Initiative, SBTi[2]) (Aldy et al. 2025). Consider the multiple levels of selection that characterize a firm adopting a commitment and disclosing it through CDP, the most common source of commitment data used in this research literature. The firm decides whether to adopt a target, as well as whether to conform to the conditions of a commitment validation body, such as SBTi. CDP decides whether to survey a firm, and for a firm selected by CDP, it may decide whether to complete the CDP questionnaire (once or annually) and, if so, whether it consents to publication of its information.

To address the potential incomplete nature of survey-based data, we have constructed a database of voluntary corporate emission commitments for companies listed in the Russell 3000 index by sourcing all information from corporations' public reports. Our database compiles information on

[1] CDP, formerly known as the Carbon Disclosure Project, makes available data and reports at: https://www.cdp.net/en.

[2] The Science Based Targets Initiative makes available information about corporate targets and their standards for approving corporate targets at: https://sciencebasedtargets.org/.

greenhouse gas emission commitments, climate-related energy targets, and qualitative goals for 2,986 U.S. publicly-traded companies over the 2000-2024 period. We find that more than 1,000 of the largest publicly-traded firms in the United States have voluntarily adopted emission reduction targets by 2024, with more than 500 adopting net-zero emission commitments.

To inform our understanding of whether voluntary corporate emission reduction targets simply reflect the incentives and requirements under public policy or, instead, incremental emissions abatement, we develop a framework for characterizing how firms could set their emission reduction targets and their incentives for emission abatement. We then evaluate the implications of implementing such voluntary targets in the presence of carbon pricing, regulatory mandates, and subsidies for low-emissions technologies. We also explore how the patchwork of policies across multiple jurisdictions influences the mix of emissions reduction for a firm operating multiple facilities across these jurisdictions.

Firms' voluntary emission reduction targets clearly reflect both the aspirational goals agreed to through international negotiations and the specific details of public policy implementation that governs the jurisdictions in which these firms operate. For example, some firms have adopted so-called "Paris-aligned" targets indicating that these are consistent with the long-term goals to limit global warming well below 2°C relative to pre-industrial levels as agreed to in the 2015 Paris Agreement. Some firms have gone a step further and formally secured review and approval of their voluntary emission target through the Science-based Targets Initiative (SBTi), which has developed sector-specific emission commitment pathways consistent with the Paris Agreement temperature goals. Firms with more ambitious emission reduction targets and higher internal carbon prices are more likely to operate in countries with more ambitious carbon pricing and other emission abatement policies (Bento and Gianfrate 2020; Bento et al. 2021). Some firms have established emission reduction targets that are explicitly conditioned on the appropriate policy environment. For example, Constellation Energy commits its electricity generation to be 100 percent carbon-free by 2040 "subject to policy support and technology advancements" (Constellation 2024, p. 35).

The next section of the paper illustrates how voluntary corporate emission targets may interact with carbon pricing, regulatory mandates, and clean energy subsidies. Section three describes the new, comprehensive database of Russell 3000 firms' voluntary emission reduction targets. We describe in detail the various types of emission reduction targets, and how they vary across industry and over time, and we compare these to the CDP database used in this literature. Section four places firms' voluntary emission targets and, for some, their announced internal carbon prices in the context of the public policy landscape in which their facilities operate. The fifth section presents some descriptive statistical analyses of firms' outcomes under voluntary emission reduction targets and patchwork public policies. We conclude the paper with a discussion of the research agenda on evaluating the emission impacts of voluntary corporate emission targets.

2. Graphical Analyses of Voluntary Corporate Emission Targets and Public Policies

The management of a firm may have an array of motivations for reducing their greenhouse gas emissions consistent with conventional notions of their fiduciary duty to the owners of the firm (Welch et al. 2000; Lyon and Maxwell 2003, 2019; Hoffman 2007; Delmas and Montes-Sancho 2010; Henderson and Steen 2015; Aldy et al. 2023, 2025).

The firm may be developing a substitute for the polluting activity that will become favored if other firms follow its voluntary action, or if the regulatory agency adopts standards compelling the use of the lower-emitting substitute. Conversely, the firm (or a group of similar firms) may use the existence of their voluntary efforts to address emissions as sufficient, thereby preempting the need for government regulation. For example, the Edison Electric Institute explicitly made this case in the context of investor-owned utilities adopting emission goals under the mid-to-late 1990s Climate Challenge Program.

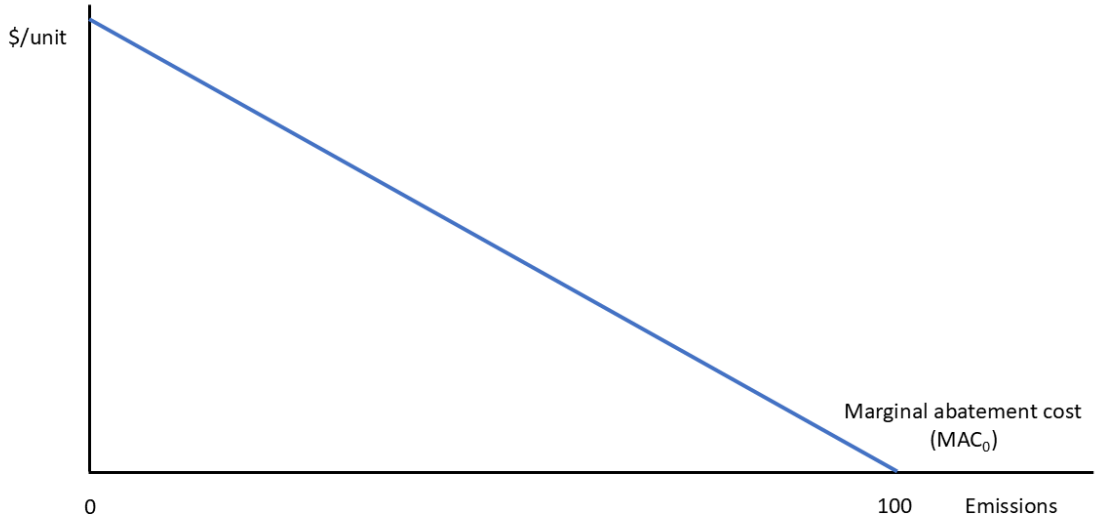
The firm may produce goods for the final retail market in which some segment of consumers is willing to pay a premium for "green" versions of these goods. Managers may find that they can recruit higher-quality labor if workers believe they will contribute to social improvement. Managers may respond to investors who have green preferences. Finally, managers implement strategies and undertake investment that reduces emissions in response to public policies, such as carbon pricing programs, clean energy subsidies, regulatory mandates and more.

Moving beyond conventional notions of fiduciary duty, managers may have their own green preferences that they attempt to satisfy through their management of the firm. Some scholars and advocates have also made the case that managers of large corporations may have a responsibility to address climate change (Henderson 2021, 2023).

While there are myriad explanations for why a firm may undertake emissions abatement, for the purposes of this analysis, we will consider the corporate benefit as a general concept without further elaboration of the underlying mechanism or rationales. Let us suppose that a representative firm opts to select an emission target that reflects an explicit weighing of the benefits and costs to the firm. In doing so, the firm accounts for its own benefits for reducing emissions, the marginal cost of abating emissions, as well as the policies that influence its incentives for reducing emissions. This graphical analysis illustrates how a firm may react to various public policies, and how the corporate benefit of a voluntary target interacts with these policies. This analysis will also flag some challenges an analyst must confront in estimating the incremental impact of a voluntary target in the presence of various public policies.

Consider a firm with emissions equal to 100 in the absence of emissions abatement effort (Figure 1). It faces increasing marginal abatement costs, represented by MAC_0. An emissions target less than its baseline level of 100 requires the firm to move up the marginal abatement cost function, moving from right to left. This representation focuses on what is observed – emissions – instead of estimated – emissions abatement – and thus presents the supply of emissions abatement in this downward sloping manner from the intercept at the y-axis – corresponding to zero emissions (total emissions abatement) – down to the x-axis intercept – corresponding to full, unabated emissions.

Figure 1. Representative Firm and its Marginal Abatement Cost Function



Suppose that this firm faces a carbon price as represented in Figure 2a. A firm minimizing its compliance costs with the carbon price (and maximizing its profits conditional on policy compliance) reduces its emissions from 100 to Q_0. In the presence of a carbon price, the analyst observes the carbon price and Q_0. The marginal abatement cost function and the unabated emissions quantity of 100 are private information known only by the firm.

Figure 2A. Firm Abatement with a Carbon Price

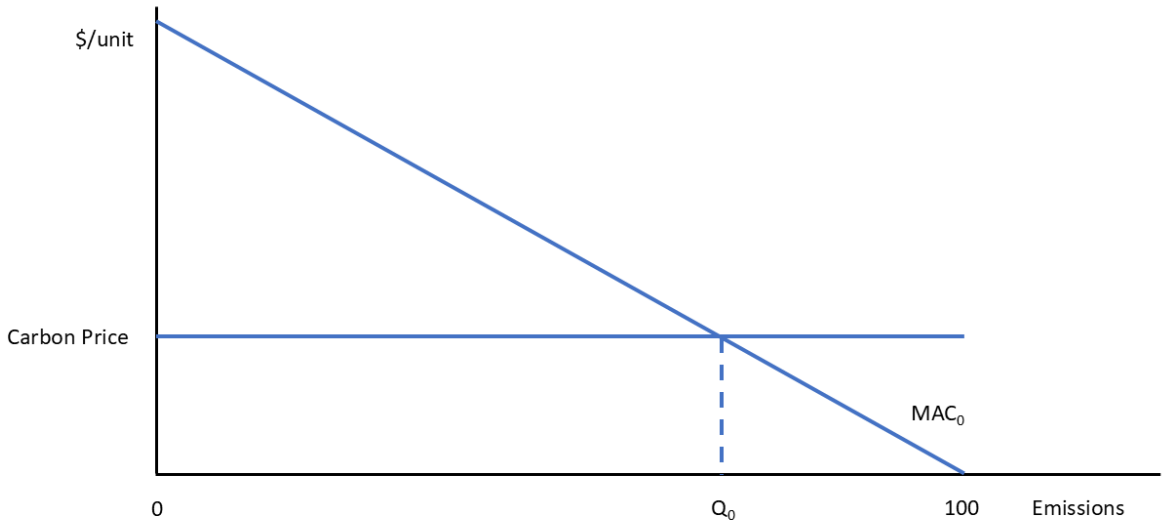
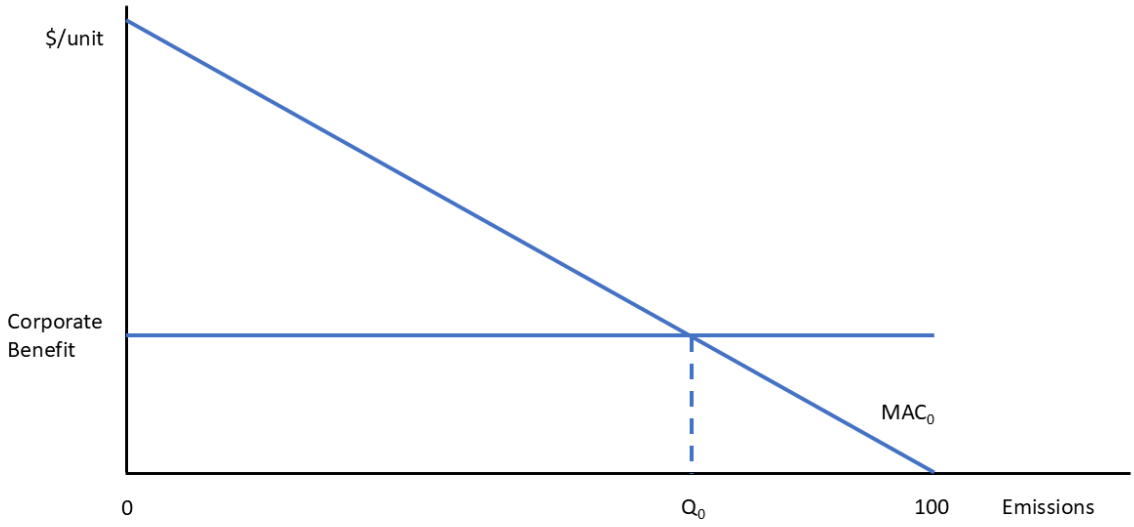


Figure 2b. Firm Abatement with Corporate Benefits



This firm could set an emission reduction target to Q_0, in which case it is expressing an emission goal consistent with what it expects to undertake in order to comply with a carbon price set through public policy.

Suppose that the firm has committed to an emission-reduction target and it derives a corporate benefit based on one or more of the rationales for voluntary corporate emission targets described

above. For simplicity assume that the corporate benefit is a constant marginal benefit per unit of emission abatement as depicted in Figure 2b. This graph intentionally illustrates the corporate benefit as equal to the carbon price in Figure 2a. As described in the next section, some firms with voluntary emission targets have adopted internal carbon prices pinned to the carbon prices they face in (at least some of) the jurisdictions in which they operate. In these cases, firms make investment and strategy decisions with a corporate benefits measure aligned with the carbon price and the analyst cannot distinguish between the carbon price and corporate benefits.

We can also use this comparison between 2b and 2a to present another challenge for the analyst. Suppose there are two firms that appear to be identical, except that one operates in a jurisdiction with a carbon price, and one does not. The latter firm adopts a quantitative target that reflects a corporate benefit that is a constant marginal benefit function equal to the carbon price faced by the former firm. These two firms would each emit Q_0, the former reflecting the incentives associated with a carbon price, and the latter reflecting the firm's own corporate benefits. An analyst identifying these two firms as effectively identical but failing to account for the difference in their carbon pricing exposure, might erroneously conclude that the firm with the voluntary emissions target is not undertaking incremental emissions abatement if it compared its outcome to that of the firm operating under a carbon price.

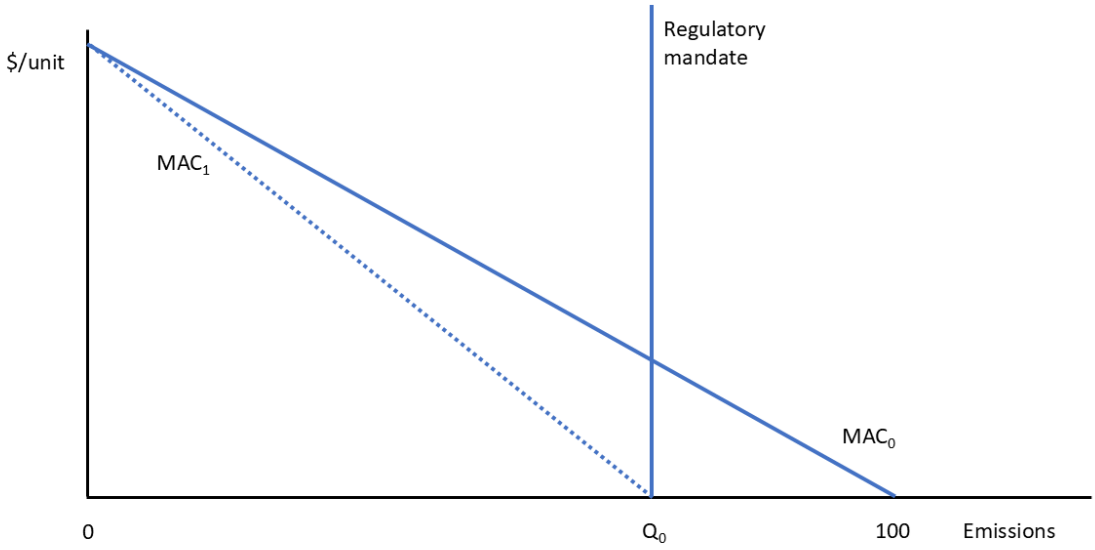
Let us briefly explore the constant marginal benefits function. Suppose that the firm announces a voluntary emission target solely to enhance its public image but does not have an intention to undertake meaningful emissions abatement. In short, the firm is greenwashing. The challenge is that there may be downside costs to being accused of greenwashing. Suppose that greenwashing results in a net cost, thereby eliminating the green image benefits and incurring reputational costs. In this case, suppose that emissions abatement reduces the likelihood of realizing this net cost (e.g., of an external stakeholder successfully accusing the firm of greenwashing). If the probability of realizing this net cost declines linearly in emissions abatement, then the corporate benefit would take a constant marginal benefit representation. In this case, the Y-axis intercept may differ from that in Figures 2a and 2b. One could also imagine that the marginal benefit for avoiding the reputational risk associated with greenwashing to be highest for the first unit of reduction, with a declining marginal benefit as emission reductions increase. This could take the form of a corporate benefits function starting at the origin (i.e., zero marginal benefits for avoiding greenwashing when the firm has realized a zero emissions corporate footprint) and increasing from left to right. See Appendix Figure A1 for an illustration.

Suppose the firm faces a carbon price, sets a voluntary goal, and realizes benefits from avoiding the accusation of greenwashing. There is no incremental incentive to abate emissions if the carbon price exceeds the expected marginal benefit of avoiding greenwashing. If there is a low carbon price, and potentially large net costs of greenwashing, then corporate benefits could exceed the carbon price and thus deliver incremental emissions reductions. Beyond greenwashing concerns, there may be the corporate benefits accounting for investor preferences, worker preferences, and more that could influence the corporate benefits function. For expositional purposes, we will focus on the constant marginal benefits of emissions abatement as reflecting the corporate benefit. In short, this firm could set an emission reduction target to Q_0, in which case it is expressing an emission goal consistent with its own corporate benefit.

Suppose that a firm faces a regulatory mandate that compels a reduction in emissions from 100 to Q_0 (Figure 3a). This is a gross simplification of regulations that typically target specific processes

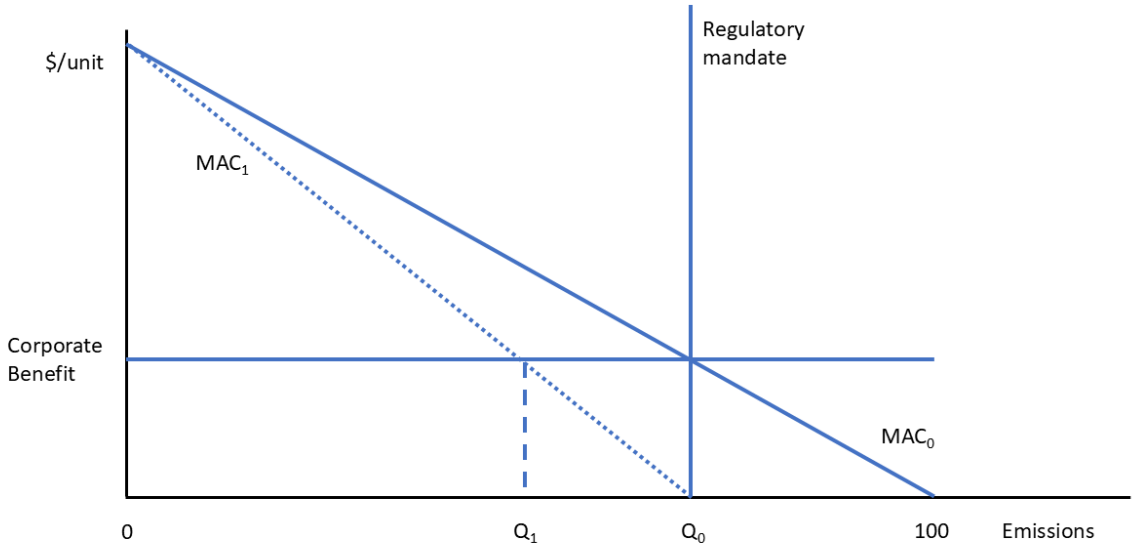
and types of facilities, not the entire emissions footprint of a corporation. (A point we return to later.) In this case, we assume that the regulatory mandate is perfectly random in how it allocates emission reductions across the set of abatement options represented by MAC_0.[3] As a result, the residual MAC_1 function starts at zero at Q_0, and increases to the same value for the last ton of abatement as before the regulation. If there are no carbon pricing policies and the corporate benefit of voluntary emission reductions is zero, then Q_0 is the emissions level as a result of the regulatory mandate.

Figure 3a. Firm Abatement under a Regulatory Mandate



[3] The perfectly random allocation of emission reductions across the firm under regulatory mandates is a strong assumption intended to enable a clear illustration graphically of its implications. With the exception of the special case of a regulatory mandate eliminating all emissions with marginal abatement cost equal to or less than the corporate benefit, the basic insight from the random allocation assumption generalizes to other emission reduction impacts from regulation.

Figure 3b. Firm Abatement under a Regulatory Mandate and Corporate Benefit

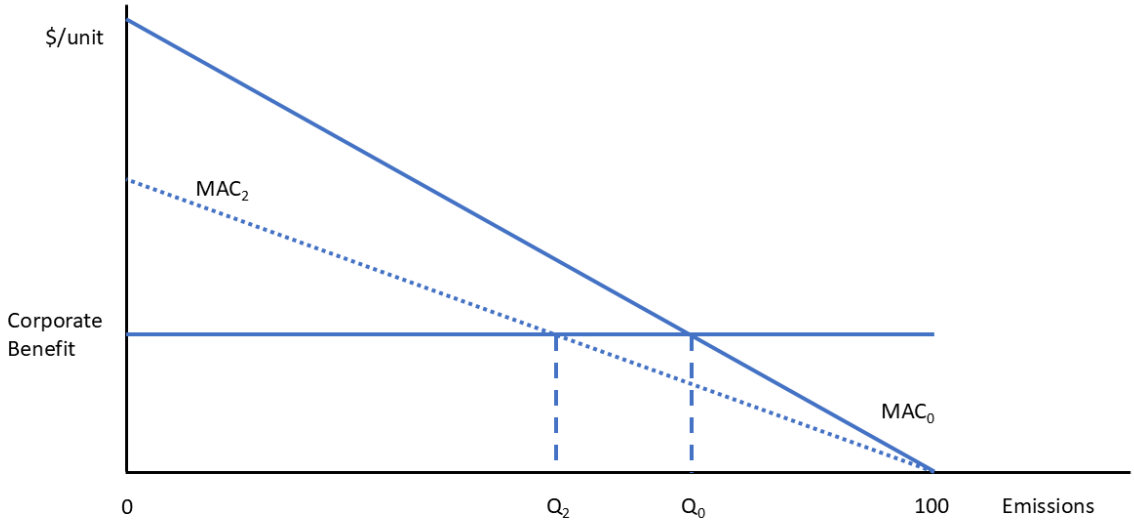


If the firm's corporate benefit is the same as in Figure 2b, then the firm would undertake incremental emissions abatement as represented in Figure 3b. The firm would optimize over its updated, post-regulation emission abatement opportunities reflected under MAC_1, and realize emissions of Q_1. In this case, the firm abates emissions equal to $Q_1 - Q_0$, which is incremental to the regulation. So long as the regulation does not disproportionately cover high marginal abatement cost opportunities in the firm, then the quantity of abatement reflecting the corporate benefit under regulation is less than the abatement resulting from the corporate benefit under the no-regulation counterfactual (Figure 2b): $Q_1 - Q_0 < 100 - Q_0$. (In this stylized set-up, this holds so long as MAC_1 has a steeper slope than MAC_0 as a result of the abatement required to comply with the regulatory mandate.)

In lieu of regulation, suppose that the state offers subsidies for technologies that enable the firm to abate its emissions. While such subsidies can take many forms, we assume that the subsidy reduces, but never eliminates, the marginal cost of abatement technologies. For example, Figure 4 illustrates the downward pivot of the marginal abatement cost function from MAC_0 to MAC_2 as a result of the subsidy regime. Without the corporate benefit (or a carbon pricing policy), the firm would not bear incremental costs (even with a subsidy offsetting some of those costs) to abate emissions and the firm's emissions would be 100. Implementing subsidies in the presence of a corporate benefit, however, can result in greater emissions abatement than under the corporate benefit alone. In Figure 4, the introduction of the subsidy results in a firm realizing emissions of Q2. Depending on the magnitude of the subsidies and the level of the corporate subsidy, the incremental emissions abatement of the interactive effect of the corporate benefit and the subsidy ($Q_0 - Q_2$) could be greater or lesser than the incremental emissions of the corporate benefit alone ($100 - Q_0$).[4]

[4] For our purposes, we have assumed that the corporate benefit function is independent of subsidies, but this may not be the case. The availability of government subsidies could be correlated with the government's

Figure 4. Firm Abatement under Subsidies and Corporate Benefit

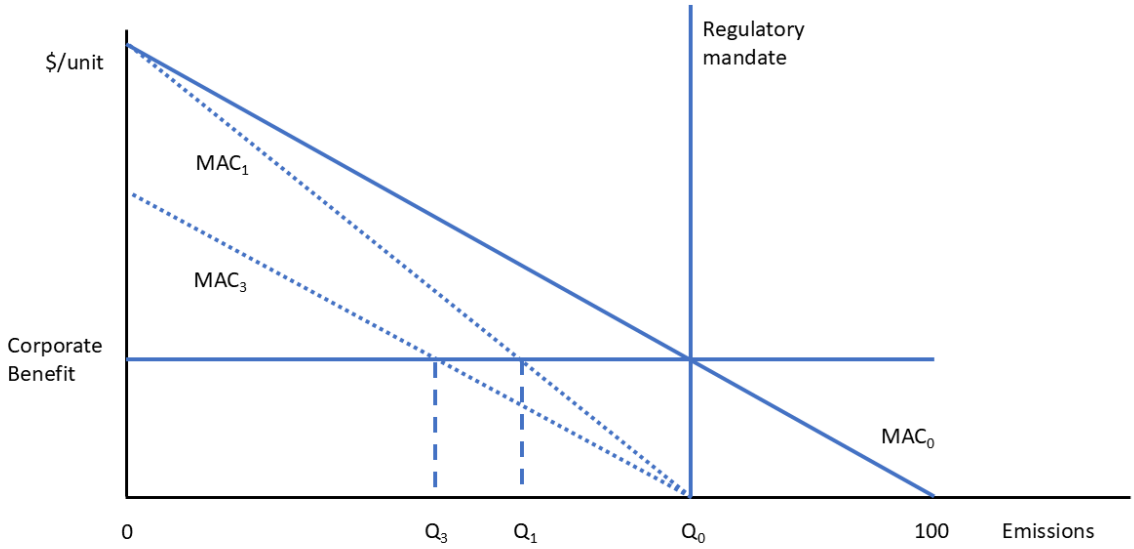


The subsidy depiction in Figure 4 could also be applied to a scenario in which the firm with a voluntary target decides to acquire relatively low-cost emission offset credits as one of their strategies for reducing net emissions. Indeed, many firms have set net emission reduction and net-zero emission targets. Including offsets within the set of opportunities for (net) abatement would effectively pivot the firm's overall marginal abatement cost function like in the subsidy case, with the key condition that the horizontal axis unit of measure becomes net emissions.

Many firms face a suite of contemporaneous policies – regulations and subsidies – that may interact with their corporate benefit in determining their emissions outcomes. Consider Figure 5, which reflects both the regulation from Figure 3b and the subsidies from Figure 4. First, the firm complies with the regulatory mandate, which shifts its marginal abatement cost function to MAC_1. Then, the subsidies adjust the firm's marginal cost of abatement opportunities again, shifting to MAC_3. The result is that the firm realizes emissions of Q_3 as a result of the interactive mix of a regulatory mandate, subsidies, and the corporate benefit.

attitudes toward corporate ESG policy more generally. Thus, generous clean energy subsidies, such as under the Biden Administration-supported Inflation Reduction Act, could be associated with a pro-climate policy government. Demonstrating alignment with such a pro-climate policy government could yield greater corporate benefit in our model. In contrast, a government more hostile to clean energy subsidies and investment, such as the Trump Administration, which supported many reductions and eliminations of clean energy subsidies in the One Big Beautiful Bill Act, may likewise oppose corporate ESG initiatives. In this case, demonstrating alignment with such an anti-climate policy government could yield lower corporate benefit in our framework.

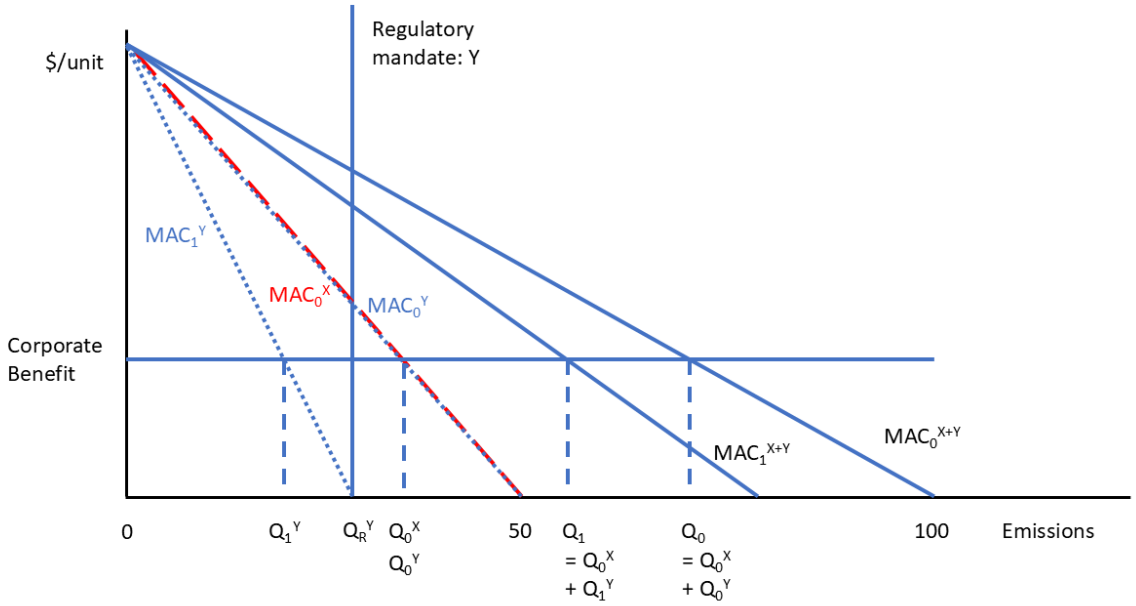
Figure 5. Firm Abatement under Regulatory Mandate, Subsidies, and Corporate Benefit



Firms may operate facilities that emit greenhouse gases across multiple political jurisdictions (states, countries). The regulatory and subsidy regimes may differ across these jurisdictions. Suppose that our firm operates two facilities, one in state X without emission regulations and one in state Y with ambitious regulations (Figure 6). Suppose that the two facilities, which we will denote X and Y based on their state of location, are equal-sized emission sources of 50 units, summing to the firm aggregate of 100 absent abatement. These facilities have identical marginal abatement cost functions, represented by the red dashed line (X) and blue dashed line (Y). The facility-specific marginal abatement cost functions sum to the original MAC_0 line, represented by MAC_0^{X+Y} in this figure.

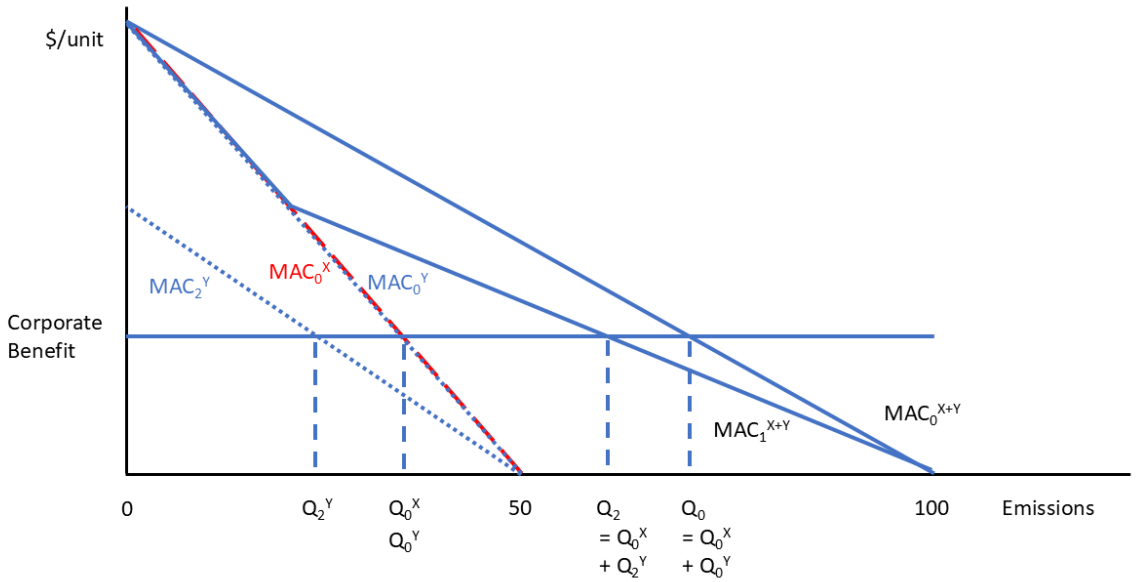
Q_0^X and Q_0^Y represent the emission reductions at each facility given the corporate benefit. Facility Y is subject to a regulatory mandate, but facility X is not. Just as before, we assume that the mandate randomly allocates abatement among the abatement options at facility Y as represented by its marginal abatement cost functions. This results in a shift from MAC_0^Y to MAC_1^Y. The emissions level at facility Y, with the impact of the regulatory mandate and the corporate benefit, is now represented by Q_1^Y and firm-wide emissions are now represented by Q_1, which is Q_0^X (unchanged from before since it does not face a regulatory mandate) plus Q_1^Y.

Figure 6. Two-Facility Firm Abatement under Heterogeneous Regulatory Mandates and Corporate Benefit



Consider an analogous scenario in which the firm faces heterogeneity in subsidies across political jurisdictions, as opposed to heterogeneity in regulatory mandates. The firm operates two, equal-sized emission sources, X and Y (Figure 7). As before, these sources have identical marginal abatement cost functions, represented by the red dashed line (X) and blue dashed line (Y). These functions sum to the original MAC_0 line, represented by MAC_0^{X+Y} in this figure. Thus, each of X and Y's marginal abatement cost functions have a horizontal intercept of 50 (one-half of the firm's emissions of 100). Q_0^X and Q_0^Y represent the emission reductions at each facility given the corporate benefit level. Suppose that facility Y is subject to a subsidy in state Y, but facility X is not. Just as before in Figure 4, we assume that the subsidy reduces the slope of the marginal abatement cost function, shifting down to MAC_2^Y. The emissions level at facility Y, with the impact of the subsidy and the corporate benefit, is now represented by Q_2^Y and firm-wide emissions are now represented by Q_2, which is Q_0^X (unchanged from before since it does not face a subsidy) plus Q_2^Y. Note that the firm-wide marginal abatement cost function, MAC_1^{X+Y}, follows MAC_0^X for high-cost abatement that lies above that of facility Y's MAC at zero emissions with the subsidy, and then represents the summation of the marginal abatement cost functions for lower-cost abatement.

Figure 7. Two-Facility Firm Abatement under Heterogeneous Subsidies and Corporate Benefit



Let us synthesize a few key takeaways from this set of stylized, graphical analyses.

- If firms realize some private, corporate benefit to reducing emissions, then their emission levels may reflect a mix of policy-induced as well as voluntary emission abatement effort.

- Under regulatory mandates, a firm realizing corporate benefit is likely to abate below what is required of the mandate.

- Under subsidies, the subsidy may amplify the emission abatement a firm undertakes given its corporate benefit.

- A patchwork of subsidies and regulations could induce some policy-driven abatement and some voluntary abatement, and the relative contributions will depend on the extent of the corporate benefit and the generosity of the subsidies.

- In a patchwork of policies across jurisdictions, firms may reduce emissions more in their facilities subject to regulation or eligible for subsidies than in their facilities in the no-policy jurisdictions.

- In all of these cases, the corporate benefit is represented as a constant marginal benefit to the firm. If the firm operates in a jurisdiction with a carbon price that is at least equal to the corporate benefit, then there may be no incremental emissions abatement resulting from corporate voluntary action.

- This stylized analysis takes as a starting point that emissions absent any policy or voluntary corporate benefits are known. In practice, empirical analysis to distinguish the impacts of policies from voluntary efforts will require the estimation of an appropriate counterfactual.

Given the nature of selection that is the defining characteristic of a corporate voluntary emission target, this represents a significant evaluation challenge.

Let us close with a caveat and speculation about a dynamic extension. The insights generated by these graphical analyses may be specific to the assumptions made in illustrating these effects. Most notably, the specification of the corporate benefit as a constant marginal benefit enables a clear exposition of how firms respond to various policies given their corporate benefit. This function could take quite different forms in practice and could vary across firms.

Second, the firm may consider its corporate benefit as an input in setting its emission reduction goal – i.e., using the constant marginal benefits and marginal abatement cost to identify Q_0 as represented in Figure 2. Having done so, the management of the firm may simply aim for attaining the target, and it may interpret the marginal benefits of reducing emissions beyond the quantity necessary to meet its target as negligible. In this context, the firm may find value in lobbying for subsidies in order to reduce its marginal and total costs of attaining a target but would not reduce emissions below its established target level.

To put these takeaways in context, we turn now to the development of a new, comprehensive database on voluntary corporate emission targets.

3. Database of Voluntary Corporate Emission Targets

We have produced the Harvard Salata Corporate Emission Targets Database drawn exclusively from primary sources published by the largest publicly-traded firms listed on U.S. stock exchanges: annual reports, SEC 10-K filings, and sustainability and related reports. Specifically, the database covers the 2,986 U.S. firms listed on the Russell 3000 Index as of June 2023. We have compiled these firms' voluntary emission targets that they announced over the 2000-2024 period, with target years spanning 2001-2050. In covering the Russell 3000, our database covers emission targets associated with approximately 98 percent of the U.S. equity market.

This database addresses a current gap that has important implications for the evaluation of voluntary corporate emission reduction targets. In 2024, the Securities and Exchange Commission (SEC) both promulgated its climate-related disclosure rule and immediately stayed its implementation in response to legal challenges (SEC 2024; Dewey 2026). In May 2026, the SEC signaled its intent to rescind the regulation through a new rule-making process (Gillison 2026). As a result, there is no standardized disclosure requirements for U.S.-listed public equities or other firms with respect to their voluntary emission reduction targets or emissions.

Researchers, stakeholders, and the media have long relied on CDP as a source of information of voluntary emission reduction targets. CDP, formally known as the Carbon Disclosure Project, is a non-profit organization that has operated an independent greenhouse gas emissions disclosure system for companies for more than two decades. CDP was originally organized by climate-aligned investors focused on surveying identified companies about their greenhouse gas emissions and associated goals and strategies, but has expanded to additional environmental impacts and reporting entities. CDP-collected and publicized data have been quite effective as a way for investors to engage companies, but as we note below, incomplete response rates, among other factors, undermine the comprehensiveness of CDP data and the suitability of CDP data for

empirical evaluation.

Going to the firm's own publications can ensure that every firm that publicly announces an emission reduction target is represented in the database. The lack of standardization, however, creates a number of database construction challenges. Firm targets vary considerably in scale, time horizon, and scope. For example, some firms set annual incremental targets, while others commit to a single, longer-term target. Firms may have more than one target in a single year. Some firms have a long-term target complemented by short- and medium-term targets. Targets may be defined in absolute terms, such as a specific percentage or quantity of emission reduction, or in intensity terms, where the reductions are expressed per unit of output. The scope of these targets can include any combination of Scope 1, 2, and/or 3. Some targets apply to the entire firm, while others are limited to specific subsidiaries, business units, or geographic areas.

Variation in target form is complicated by both the lack of standardized language surrounding firms' voluntary carbon targets and ambiguity in firm statements. For this reason, we establish clear criteria for what constitutes a target. A statement in a public domain document must meet the following conditions to be considered a measurable emissions target in our database: (1) it must be forward looking; (2) it must explicitly identify the type of target; (3) it must specify a target amount (in terms of either absolute greenhouse gas or carbon dioxide emissions or emission intensity); and, (4) it must include a target year. In addition, we collect information on the base year, base year quantity, the year firms made public the commitment, and target coverage, when available. We also track, and code separately, qualitative statements about intent to adopt quantitative targets in the future.

If a firm has multiple targets in a given year, each one is recorded. We classify emission targets into five types:

1. Net-zero – commitments to achieve net-zero emissions.
2. Carbon neutrality[5] – commitments to become carbon neutral.
3. Carbon reduction – commitments to reduce emissions that do not explicitly refer to net zero or carbon neutrality.
4. Others – any other commitments that contribute to emission reductions, such as energy efficiency, renewable energy, or methane emissions goals.
5. Qualitative – non-quantitative statements that explicitly express the firm's intention to set emission-related targets in the future.

To produce the database, we trained several waves of research assistants to review public domain documents issued by firms that may include information about corporate emission reduction targets. In the first wave, each firm in the Russell 3000 was assigned blindly and randomly to two RAs. Each RA reviewed the firm's documents and submitted entries for the targets database. After completing this assignment, RAs were notified of each pairing and they were tasked with reviewing and reconciling discrepancies in their work to produce a single set of entries for each firm. Each

[5] We follow the experience in practice by distinguishing carbon neutrality targets from net-zero targets because carbon neutrality relies on carbon offsets, while net zero targets emphasize reducing corporate footprint greenhouse gas emissions as much as possible before going to the carbon offsets market. This distinction may matter more for communication and image-building purposes than for abatement strategy and implementation.

submitted set of entries was reviewed by a designed quality controller for accuracy and adherence to data coding guidelines. Every entry in the database was checked by at least one quality controller to verify that the targets in coded data matched the details of commitments in the firm's published reports. In addition to cataloguing the defining characteristics of each emission target, the research assistant team collected URLs and PDFs for the public domain documents sourced for data on emission reduction targets.

As checks on errors of omission, we have also used an array of secondary sources to identify firms who have announced emission reduction targets. We reviewed CDP, SBTi, the Transition Pathway Initiative, Climate Action 100+, and other online compilations of voluntary emission reduction targets and compared these lists of firms with our compilation. In response to discrepancies, we tasked research assistants to undertake another review of the public domain documents.

We drew from the insights of Bauer et al. (2024), who developed large language models to evaluate business news media and related press releases through several large databases to identify emission targets. We employed the prompts designed in Bauer in gpt-4o to review reports in the Wall Street Journal, New York Times, and Barrons over 2005-2023 to identify corporate emission reduction targets. The large language model identified media articles on 374 firms in our Russell 3000 sample – these articles include an array of environmental and climate topics related to these firms. The LLM 27 of these 374 with emission reduction targets, all of which we had identified and documented in our database. In addition, our process drawing from primary sources identified another 301 firms out of these 374 with at least one emission reduction target.

We compiled a corpus of annual reports, 10-K filings, and sustainability reports for all Russell 3000 firms in our database, including those firms for which we have not identified any voluntary emission reduction targets. We have trained a large language model in GPT-4o to review all of these reports to produce a duplicate database (work in progress). Our research team will compare the two databases and resolve discrepancies. Finally, we are emailing a representative at each of the nearly 3,000 firms in our sample with the information in our database pertaining to their firm for their review and corrections, if necessary (as of May 15, this is ongoing).

The vast majority of scholarship on voluntary emission targets have relied on CDP. The challenge is that CDP disclosure of voluntary emission targets was not designed for research and evaluation purposes. CDP began to survey firms about their emissions and voluntary goals based on firm-targeted requests by major investors. Some firms adopt emission targets but are not surveyed by CDP. Some firms receive a survey from CDP, but do not reply. Some firms reply to CDP, but request that some or all of their responses are not made publicly available. CDP has been quite effective at drawing attention to voluntary targets and emission disclosures and facilitating the sharing of information and lessons among firms. The various levels of selection, however, risks producing a sample of firms' voluntary emission targets subject to bias from the standpoint of statistical analysis.

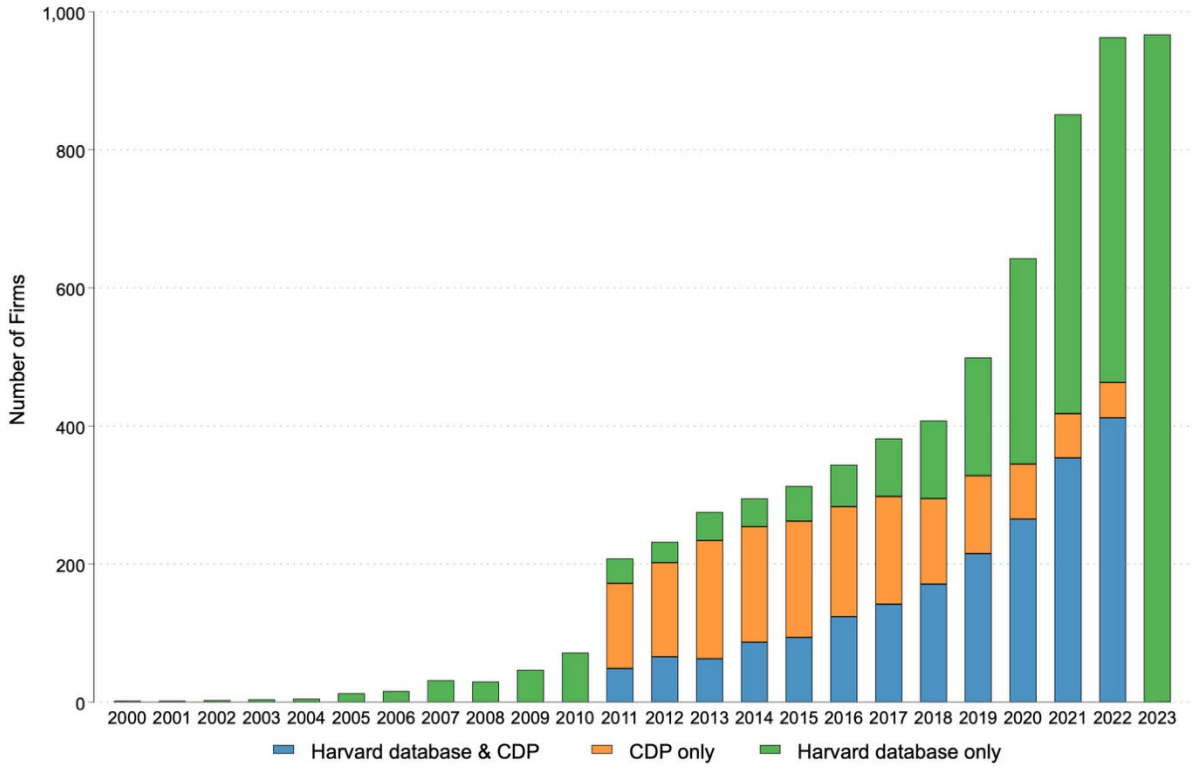
To illustrate the potential scale of omissions, we compared our database to the CDP database that a researcher can subscribe to (Figure 8). CDP discloses voluntary emission targets starting in 2010. Our database illustrates a modest number of Russell 3000 firms with voluntary emission reduction targets before 2010. In every year that CDP discloses corporate emission targets, we have identified Russell 3000 firms that disclosed through their own communication channels (e.g., sustainability reports) in lieu of CDP. In the early 2010s, CDP covered a large fraction of all Russell 3000 emission

reduction targets, and it identifies more firms with voluntary targets than those that we identify through the review of their public reports. During this time period, some firms appear to have relied on CDP as its medium for communicating its voluntary emission reduction target.

As more and more firms have adopted voluntary targets in the past decade, however, the omissions from the CDP database have become more pronounced. By 2023, the last year for comparison between CDP and our database, more than 800 Russell 3000 firms disclosed through either CDP or in corporate public documents reflected in our database. Of these firms, 41 percent are captured by both databases, 7 percent are captured by CDP alone, and 52 percent are captured by only the Harvard database. Thus, empirical analyses of large companies listed in the Russell 3000 using CDP data would miss more than half with emission reduction targets in recent years.

The disclosure environment – both mandatory under existing regulations and voluntary by firms – has evolved over time. Some U.S.-listed firms are also listed on European exchanges, where they face mandatory disclosure (e.g., bp). Some U.S.-listed firms operate large emission sources that, at the facility level, are subject to mandatory disclosure under the Environmental Protection Agency Greenhouse Gas Reporting Program or Title IV of the Clean Air Act Amendments of 1990 reporting requirements. Some firms have disclosed through CDP but then shifted to disclosure either through (a) CDP and firm-specific publications, or (b) only firm-specific publications. The costs and benefits of producing and communicating information through these various regulatory and voluntary disclosure channels merits further examination.

Figure 8. Comparison of Russell 3000 Firms with Active Targets, Disclosed through CDP and Identified through the Harvard Salata Database

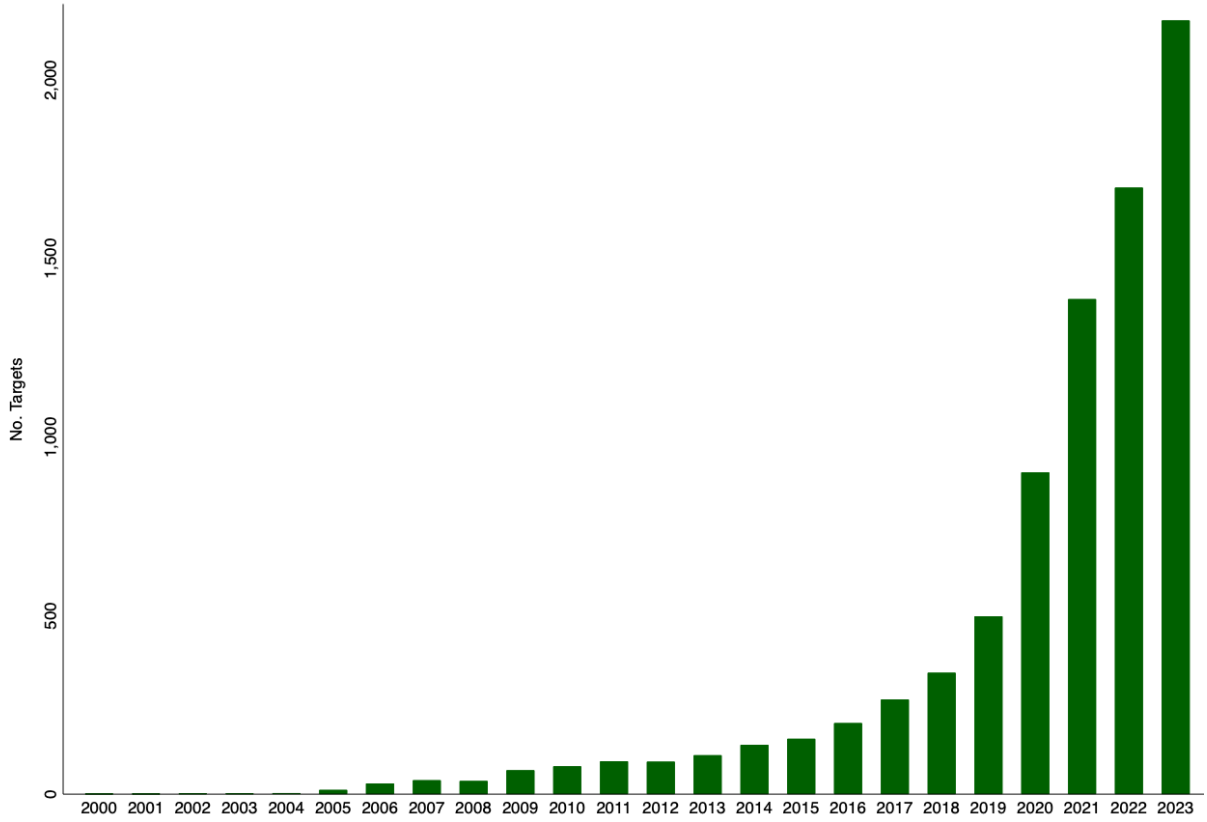


Sources: Harvard Salata Corporate Emission Targets Database, 2025, and CDP 2025. Note that we have not updated the database comparison for the 2023 CDP database update.

Conditional on adopting a voluntary corporate emission reduction target, firms typically announce a number of targets over time (Figure 9). In the early years of voluntary corporate targets, emission intensity targets were more likely, but mass-based quantitative emission reduction targets have become more common in recent years. In 2010, intensity targets represented nearly 60 percent of all targets, but, by 2023, mass-based reduction targets amounted to nearly 75 percent of all targets.[6] Of the firms that have announced intensity targets, 26 percent have subsequently announced a mass-based reduction target. Energy efficiency and renewable power targets serve as both entry points for some firms and are coupled with explicit emission reduction targets by others. In 2010, energy-focused targets represented about 40 percent of all targets. While still significant, the energy-focused share of all targets fell to about one-quarter in 2023. About 80 percent of the firms that have established longer-term net-zero targets (e.g., with 2040 or 2050 as target years) have adopted near-term interim emission reduction targets.

[6] We have excluded net-zero and net-zero adjacent targets for these calculations, since an intensity target and a mass-based target is equivalent for the net-zero class of targets.

Figure 9. Total Number of Active Emission Reduction Targets by Year, Russell 3000



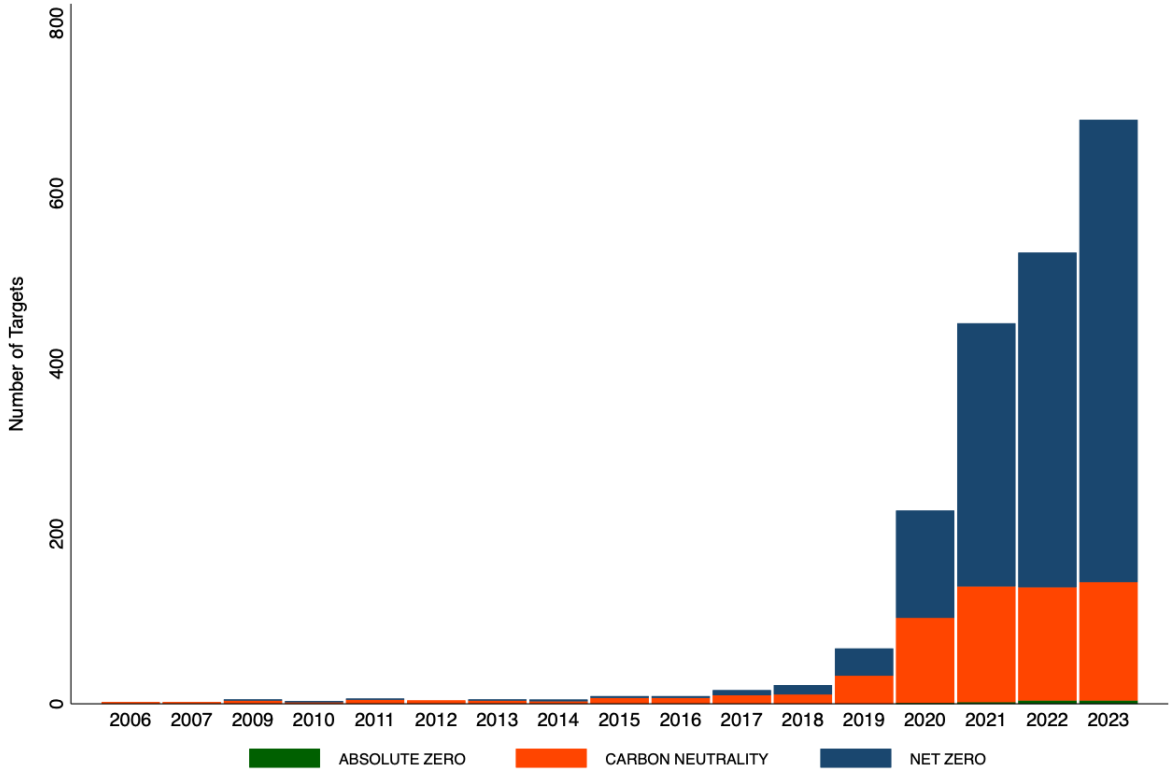
Source: Harvard Salata Corporate Emission Targets Database, 2025.
Note: The total number of active emission reduction targets can exceed the total number of firms having active emission targets, since a firm can operate with multiple active targets at any point in time.

The significant growth in the total number of targets over the past decade coincides with the growing interest in adopting ambitious long-term targets. Before the UN climate conference in Paris in 2015, very few firms had adopted net-zero or related emission targets (Figure 10). Since 2015, the adoption of such ambitious targets has accelerated dramatically. Firms have adopted absolute zero, carbon neutral, and net-zero targets. Subtle differences distinguish net-zero from carbon neutral targets. Under net-zero targets, the expectation is that the firm would reduce emissions as much as possible within its corporate footprint and then offset the balance of its emissions through greenhouse gas emission removal (such as through forest projects that sequester carbon dioxide in biomass, or industrial direct air capture with durable storage). Under climate neutral targets, firms undertake a mix of emission abatement and acquisition of emission offset credits, which could come from an array of project types, such as renewable energy projects and emission reduction activities in addition to removals, such as under net-zero targets. In practice, a firm with a net-zero target may pursue a strategy quite similar to that of a firm with a climate neutral target.

Approximately 500 firms in the Russell 3000 have announced their intent to reduce their net emissions to zero by a specified target year. The dramatic increase in the adoption of net-zero targets by major firms occurred soon after the Biden Administration announced its goal for the United States to achieve net-zero emissions by 2050. With the Trump Administration striking this

net-zero goal and the U.S. goal to cut emissions by 50 to 52 percent by 2030 under the Paris Agreement, an open question is whether many of these firms will walk away or delay their net-zero target goals. For example, TotalEnergies indicated that it would not move forward with a net-zero transition plan because the current slate of public policies is inadequate to deliver on the decarbonization necessary to meet the Paris Agreement goals (TotalEnergies 2026; Crellin and Nasralla 2026). In 2025, PepsiCo (2025) announced that it would push back its net-zero goal from 2040 to 2050. In its 2025 ESG report, Walmart announced that it would likely miss its 2025 emissions target and noted the importance of performance by other key players in society, including governments in making progress on achieving net-zero emissions. We plan to continue to update our database over time to enable more extensive analysis of firms' goals, goal revisions, and progress in achieving their goals.

Figure 10. Total Number of Net-Zero and Net-Zero Adjacent Emission Targets by Year, Russell 3000

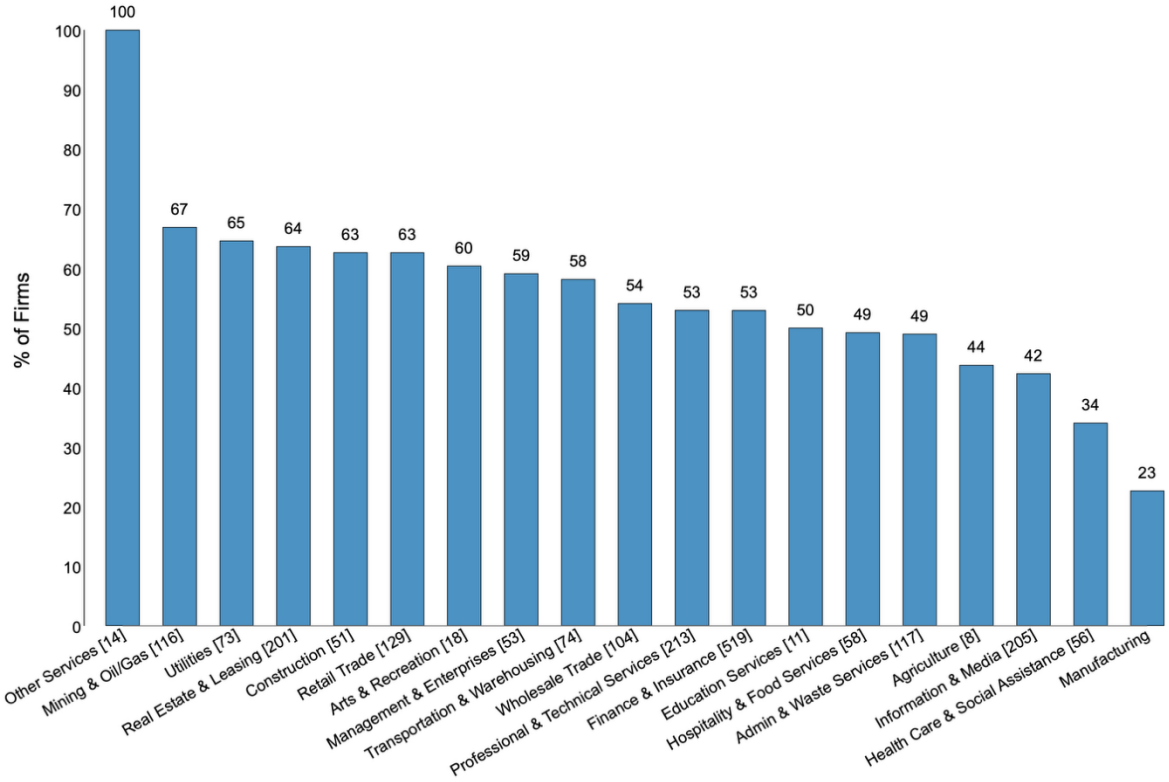


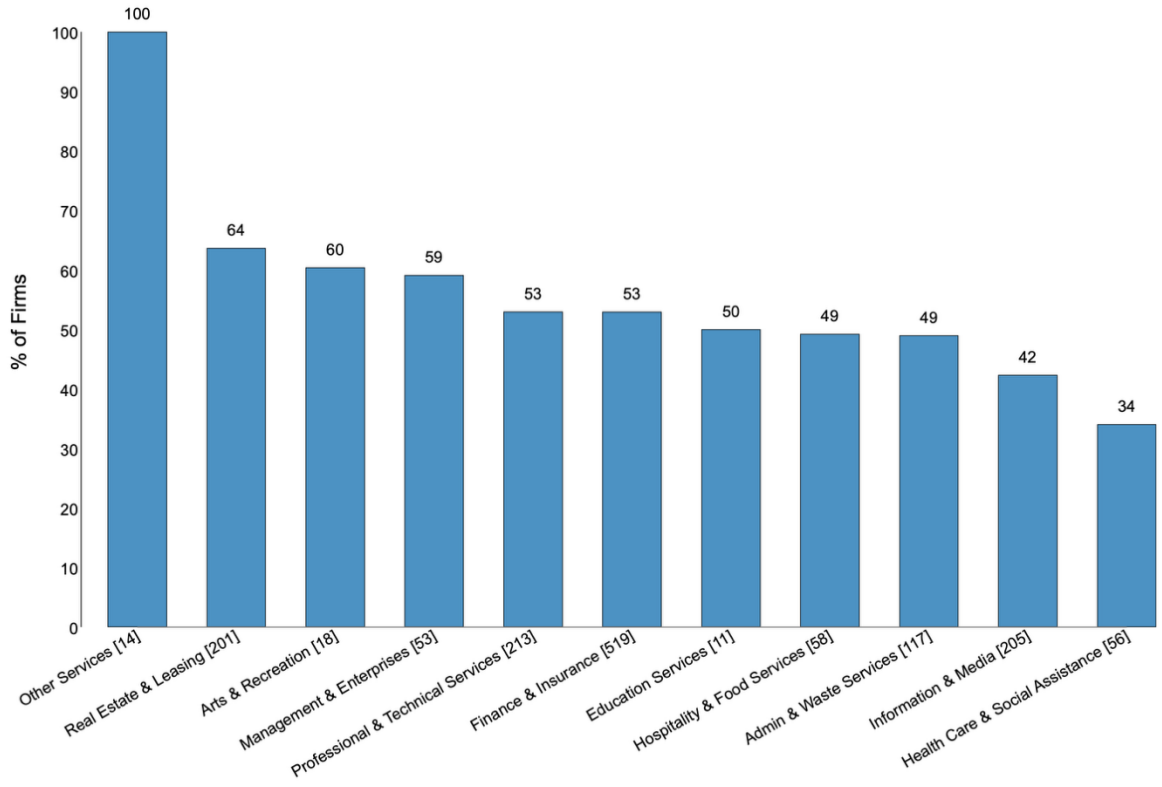
Source: Harvard Salata Corporate Emission Targets Database, 2025.

Across nearly every major industry, firms have adopted emission reduction targets (Figure 11). Slightly more than half of all electric utilities in the Russell 3000 have set such targets, and nearly 40 percent of transportation and oil and gas companies in the Russell 3000 have adopted emission reduction targets. About one-quarter of retail-facing firms, in the retail trade and food and accommodations industries, have adopted emission reduction targets. While manufacturing firms comprise nearly one-third of the Russell 3000, only about one in ten of these firms has established an emission reduction target. Likewise, financial firms make up about one in six firms in the Russell 3000, but only ten percent of these firms have adopted such targets. The next section explores the relationship among these voluntary corporate emission reduction targets and current public

policies. Further analysis of trends and determinants of voluntary emission targets, disclosure behavior, and decarbonization progress is left for future work.

Figure 11. Russell 3000 Firm Targets by Major Industry, Organized by Goods (Top) and Services (Bottom) Industries





Source: Harvard Salata Corporate Emission Targets Database, 2025.
Note: This represents the industry counts for firms with at least one emission reduction target announced over 2000-2024 in our database.

4. Voluntary Emission Targets and Public Policies

Corporate voluntary targets reflect the design of public policy goals and emission reduction policies along a number of dimensions. The form of emission reduction targets adopted voluntarily by firms follows the form of national emission quantitative goals and targets. For example, near-term national goals, referred to as Nationally Determined Contributions under the 2015 Paris Agreement, typically take one of three forms: a percentage reduction relative to a historic base year by some future date (e.g., 2030), a percentage reduction relative to a projected baseline or business-as-usual emission level in 2030, or a percentage reduction in emissions intensity (ratio of emissions to gross domestic product) relative to a historic base year by some future date. In the multilateral climate context, the developed countries with greater experience and resources have taken on the first type of goal, and developing and emerging economies, with less experience and to a varying degree fewer resources, have taken on the later two types of goals. There is an expectation in this context that countries will evolve away from intensity and percentage reduction versus projected baseline targets and towards mass-based emission reduction targets.

In the U.S. context, national goals have varied in their form and ambition. During the Clinton Administration, the U.S. Government agreed to a 7 percent reduction relative to 1990 levels by 2010 at the 1997 Kyoto Conference. The Bush Administration replaced this with an emission intensity goal. The Obama Administration supported both a near-term emission reduction target (17 percent

below 2005 by 2020) and a mid-century goal (80% reduction by 2050). After the Trump Administration withdrew from the Paris Agreement, the Biden Administration established more ambitious near-term targets (50-52 percent below 2005 by 2030), and a mid-century net-zero target. Many other countries have, over the past half dozen years, adopted net-zero targets around 2050 or soon thereafter.

In a similar fashion, firms' voluntary targets have employed each of these three forms and these have evolved over time. In the 2000s, the initial, small set of firm targets focused on emission intensity goals and modest mass-based emission reduction goals. Firms that gained early, initial experience established more ambitious goals over time. For example, the electric utility AEP pledged to cut emissions by about 4 percent over 2003 to 2006, then 10 percent over 2011 to 2020. By 2018, AEP pledged to cut emissions 80 percent by 2050, which has subsequently adjusted to 80 percent reduction by 2030 and net-zero by 2050 (AEP 2023).

Firms have quite frequently undertaken "midstream" revisions of their targets: updating them before the target year for their active targets. In our database, 83 percent of firms that have announced at least one emission reduction target has made a midstream revision. About 15 percent of revisions increased ambition in terms of the level of the target (e.g., a target with a lower emissions level or emissions intensity), while about 42 percent set less ambitious targets and 44 percent maintained the ambition of their target. It was much more common for firms to move up the target year of their goal, especially in the case of those that maintained the quantitative level of their target from the previous announcement.

Some firms, like some countries, that failed to meet initial goals nonetheless set subsequent, ambitious targets. In some cases, a firm would revamp a goal – with a deeper emissions reduction but over a longer timeline than a previously established goal. For example, the electric utility Xcel Energy pledged to cut its emissions intensity 7 percent relative to its 2003 level over 2004-2012 but failed to meet this target. In 2015, it pledged to cut its mass-based emissions 23 percent relative to its 2005 level by 2017 but again failed to meet this target.[7] In 2018, it pledged to cut its emissions 80 percent by 2030 (Xcel Energy 2018). This is analogous to the Biden Administration selecting a goal to halve U.S. emissions by 2030 but opting not to re-adopt the Obama Administration Nationally Determined Contribution to reduce emissions 26 to 28 percent below 2005 levels by 2025.

In recent years, many firms that have adopted mid-century net-zero goals – like many of the countries in which they operate – have also set interim (e.g., 2030) emission reduction targets. For example, ConocoPhillips (2022) announced in its 2021 sustainability report the goals to cut emissions 40 to 50 percent by 2030 and to net-zero by 2050.

In both the context of voluntary country goals under the Paris Agreement's Nationally Determined Contributions and voluntary corporate emission reduction targets, the agent deciding on behalf of the country or the firm has discretion in the form and ambition of the target. Such discretion may facilitate broader participation – by countries under the Paris Agreement and by firms through voluntary goal adoption. Such discretion may also make it easier for some agents to structure a voluntary commitment that could give the appearance of reducing emissions without requiring emission abatement effort in practice (e.g., greenwashing). Such experiences create opportunities

[7] These assessments of Xcel Energy's performance with its emission goals reflects analyses we have made using unit-level carbon dioxide emissions in Xcel Energy's corporate footprint.

to learn not just why a nation or firm adopts an emissions goal, but how they structure the form of the goal that they adopt. Indeed, given the multiple rationales for corporate benefits of a voluntary emission target described in section 2, there may be multiple audiences and multiple messages a firm attempts to deliver through the formulation and communication of its emission target. One approach under a dual-stakeholder communication strategy would be to set an emissions target with a large percentage reduction in emissions relative to a high baseline. One audience interested in environmental benefits may find attractive the large percentage reduction, and another audience concerned about costs associated with activities beyond the conventional scope of the firm's business may find attractive the high baseline. In the context of national goals – whether it's economies in transition under the Kyoto Protocol holding the option of reducing emissions relative to a base year that pre-dated the fall of the Berlin Wall, or the United States selecting 2005 as a base year in the lead up to the 2009 Copenhagen talks, or many developing countries under the Paris Agreement setting percentage emission reduction targets against forecast emission levels for 2030 – it has been quite common for quantitative emission targets to be set relative to high baseline emission levels. Further investigation of this phenomenon in the context of firm-determined voluntary emission targets could be illuminating.

Some firms that have adopted quantitative emission reduction targets also employ an internal carbon price, which they have disclosed, to inform their implementation.[8] In some cases, an internal carbon price is effectively an internal carbon tax. For example, Microsoft began implementing a $10/tCO2e tax inside the company, which it has increased over time (Aldy and Gianfrate 2019). In other cases, an internal carbon price serves as a means for policy-testing the robustness of investment decisions. For example, ExxonMobil employs an internal carbon price informed by its assessment of current and projected emission trading system allowance prices and carbon taxes to evaluate major investment decisions. The disclosure under litigation brought by New York State against ExxonMobil revealed a fairly systematic assessment of various political jurisdictions carbon prices that could influence the value and returns to the firm's investments (New York County Clerk 2017).

More generally, other major companies have adopted an internal carbon price informed by the public policy carbon price that they face (Table 1). Indeed, firms have employed internal carbon prices benchmarked to allowance prices in the EU, United Kingdom, California, and Regional Greenhouse Gas Initiative (Tennant, Constellation Energy, Dow), as well as carbon taxes in Germany, Chile, and Singapore (Adtran Holdings, AES Corporation, Global Foundries), and the CORSIA offset credit market for commercial aviation (American Airlines). Many others have set internal carbon prices based on scenario analysis of potential carbon prices their assets and facilities may face under future public policies.

[8] We have undertaken an initial exploration of some Russell 3000 firms' documents to identify their disclosure, use case, and rationale for their internal carbon prices. We have planned a LLM exercise, akin to the production of the duplicate LLM-based emission reduction targets database described in section 3, to produce a dataset of internal carbon prices.

Table 1. Sample of Russell 3000 Firms with Internal Carbon Prices

Firm Name	Type of ICP	ICP Value	Rationale and Uses
Adtran Holdings Inc	Shadow Price	€49/tCO2e	Price based on compliance for German-based facilities under the German carbon tax
AES	Shadow Price	$5/tCO2e	Price based on compliance for Chile-based facilities under the Chilean carbon tax
Alphabet	Implicit Price	$50–$160/tCO2e	Cites $50–$160/tCO2 by 2030 as amounts needed for Paris-aligned goals.
American Airlines Group	Shadow Price	$4–$25/tCO2e	Aligned with estimated CORSIA offset prices and used to assess regulatory obligations for international aviation emissions.
Capital One	Internal Fee	$15/tCO2e	Establishes dedicated revenue stream for carbon reduction and sustainability initiatives.
ConocoPhillips	Shadow Price	$60/tCO2e	Company states it uses carbon price assumptions to navigate GHG regulations.
Constellation Energy	Shadow Price	market-specific	Function of the ETS price in the market is relevant to a specific facility.
Dow	Shadow Price	$50-$102/tCO2e	Aligned with EU and CA ETS allowance prices.
Duke Energy	Shadow Price	$16.53/tCO2e	Designed to account for potential future CO2 regulation in non-North Carolina jurisdictions.
Global Foundries	Shadow Price	$48.4/tCO2e	Price based on compliance for Singapore-based facilities under the Singapore carbon tax
Host Hotels & Resorts	Shadow Price	$100–$268/tCO2e	$100/tCO2e benchmark is from the 2017 World Bank/IMF recommendation, and upper end of range reflects NYC Building Performance Standards.
Microsoft	Internal Fee	$15/tCO2e, $100/tCO2e for air travel	Finances investment in climate-related innovation, including purchases of renewable electricity and carbon removal.
Pfizer	Shadow Price	$200/tCO2e	Aligned with current and projected schemes applicable to operating locations including facilities facing EU ETS and carbon taxes.
Pinnacle West Capital Co	Internal Fee	$25/tCO2e	Based on California cap-and-trade 2020 CO2 cost and escalated at 2.5% beginning in 2028; used in integrated resource planning
PPL Corporation	Implicit Price	$15–$25/tCO2e	Implied cost of potential future CO2 regulations in resource planning; used in capital expenditure, risk management, and integrated resource planning.
Procter and Gamble	Shadow Price	$8–$200/tCO2e	References alignment with carbon tax price carbon allowance price under an Emissions Trading Scheme.
Southern Co	Shadow Price	$0–$50/tCO2e	Scenario analysis represents a range of potential policies affecting carbon-emitting resources.
Tennant Co.	Shadow Price	varies with UK ETS price	Aligned with UK ETS allowance prices.

Source: Compiled by authors from sustainability reports and publicly disclosed responses to CDP questionnaires for select Russell 3000 firms in the Harvard Salata Corporate Emission Targets Database, 2025.

An internal carbon price for a firm could be interpreted as the price per ton of carbon that equates the marginal benefit and the marginal abatement cost for the firm. In effect, this would be consistent with how we represent corporate benefit in the graphical analyses in section 2. The extent to which the internal carbon price is a function of the allowance price or carbon tax that the firm faces, however, suggests that the corporate benefit may have limited, if any, contribution to incremental emission reduction effort. Instead, it may simply represent what the firm faces, or expects to face, under public policy. Moreover, it is important to emphasize that the application of ICPs – and the extent to which they are binding on firm investment and operational decisions – varies significantly across firms and, in many cases, falls well short of what would be expected under an allowance price or carbon tax.

The patchwork nature of public policy also suggests that some firms adopt voluntary emission reduction targets in jurisdictions without carbon pricing or regulatory mandates. As noted above, about half of the investor-owned utilities in the Russell 3000 have adopted emission reduction targets. The power sector in the United States is subject to a rich mix of public policies: carbon pricing in California (and with recent expansions along the West Coast) and Regional Greenhouse Gas Initiatives in the Mid-Atlantic and New England states, renewable portfolio standards requiring a specified fraction of power must be generated from renewable sources in about thirty states, and subsidies for renewable power available across the entire country. These Russell 3000 firms comprise about half of all U.S. power generation, and those within the Russell 3000 that have adopted targets tend to generate more power than Russell 3000 utilities without voluntary targets.

In practice, Russell 3000 utility firms with voluntary targets represent a larger fraction of U.S. power generation (Figure 12a) and power sector emissions (Figure 12b) than firms covered by emission trading systems on the East and West Coasts. More of the U.S. power sector is covered by renewable portfolio standards (and, by definition, the production tax credit and investment tax credit for renewable power under the U.S. internal revenue code over our 2000-2024 period) than voluntary firm targets, but the ambition, as reflected in the quantitative amount of emissions permitted by their targets, and the explicit focus on carbon emissions of the voluntary targets suggest that they may also exceed the incentives of the regulatory mandates, at least in some jurisdictions. About half of the Russell 3000 utilities that have adopted voluntary targets operate in multiple states, and these firms face a mix of policies and regulations across their corporate footprint.

Both figures illustrate how an increasing share of generation (figure 12a) and an increasing share of emissions (figure 12b) are covered by firms adopting voluntary emission reduction targets over the past decade. Over 2015-2022, the share of generation covered effectively doubled, while the share of emissions covered increased by about 50 percent. This also illustrates how utility firms with less emission-intensive generation portfolios are more likely to adopt emission reduction targets in recent years.

Figure 12a. U.S. Power Generation by Russell 3000 Utilities

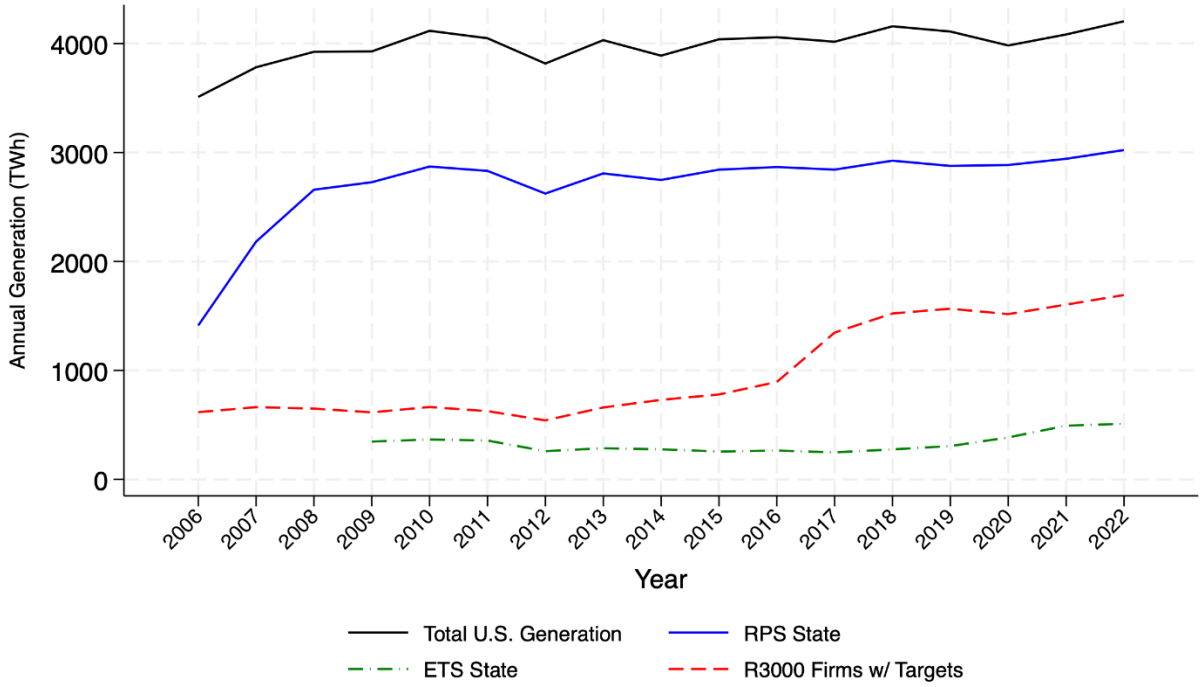
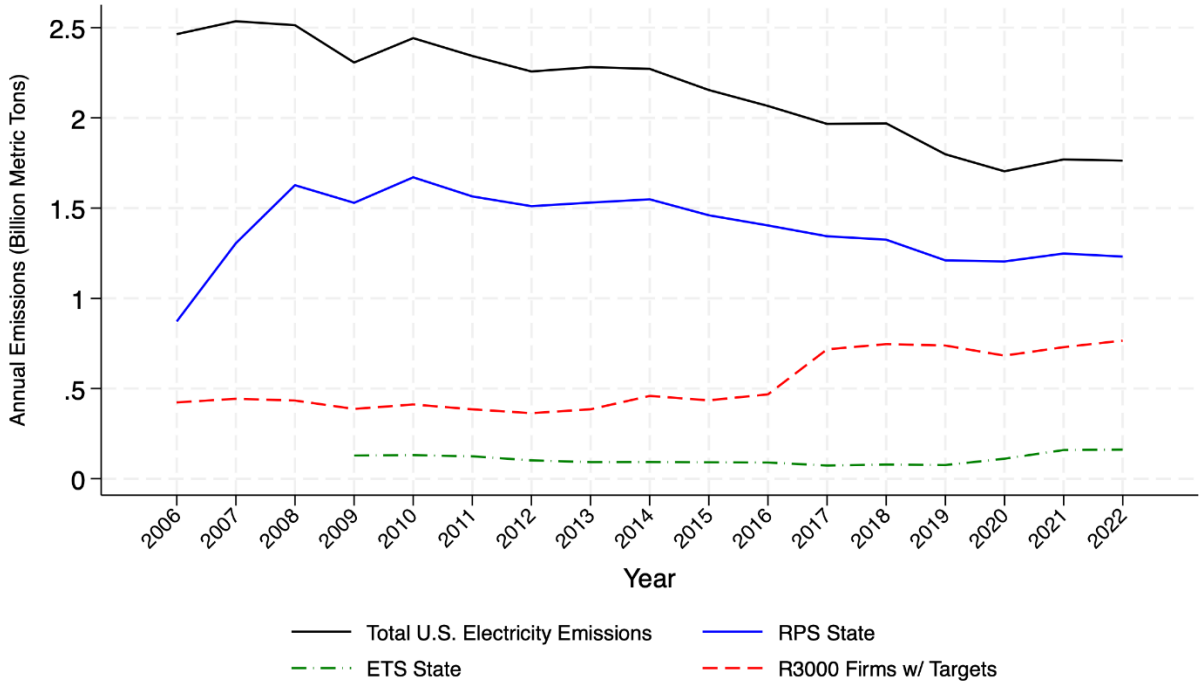


Figure 12b. U.S. Electric Sector Carbon Dioxide Emissions by Russell 3000 Utilities



Sources: Compiled by authors using the Harvard Salata Corporate Emission Targets Database, 2025; U.S. EPA CEMS data; and policy information produced in DSIRE and LBNL databases.

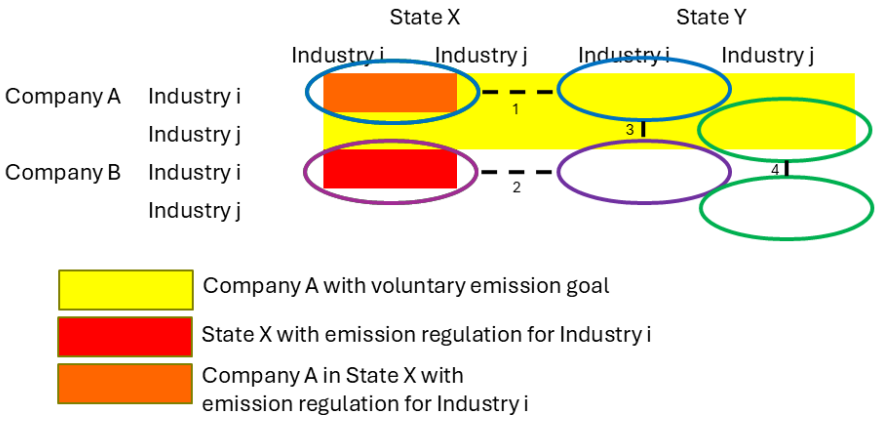
5. Empirical Illustration of Voluntary Corporate Emission Reduction Targets and Patchwork Public Policies

As noted above, empirical evaluation of voluntary corporate emission reduction targets faces significant challenges. By design, firms select into voluntary targets and the act of choosing to adopt a form of self-regulation may reflect an array of confounding factors that could bias estimation of the impact of target adoption. These could reflect overlapping subsidy, regulation, and carbon pricing policies, as well as evolving corporate strategy and investment decisions that may affect a firm's future emissions trajectory and hence its incentive to adopt (or not) a voluntary emission target.

As a preliminary way to explore the emissions of facilities operating under a patchwork of public policies and voluntary emission reduction targets, we present some descriptive statistics on facility-level emissions. These are not intended to reflect the causal effect of either voluntary targets or public policies but are simply illustrations of facility-level outcomes associated with coverage by either voluntary targets, carbon pricing, or both.

Figure 13 provides a graphical illustration of a framework for interpreting how outcomes may vary for facilities under heterogeneous policies and voluntary targets – in short, a set of pairwise comparisons motivated by the end of section 2. Suppose that a firm, Company A, has adopted a voluntary emission target that covers its facilities in State X and State Y. Company B is a similar firm that also operates in States X and Y, but has not adopted a voluntary emission target. State X has implemented an emission regulation for industry i that Company A and B operate in. (This figure also depicts a second industry in which A and B operate, but we can ignore this complexity here.)

Figure 13: Illustration of Empirical Framework for Evaluating Emission Outcomes under Voluntary Corporate Targets and Public Policies



The first comparison, represented by the dashed line numbered 1, could serve to show how a firm with a voluntary target allocates reduction effort between facilities in states under regulation (represented in orange) and facilities in states without regulation (yellow). The second comparison, for the firm without a voluntary target, could serve to show how emissions differ for this firm in the state under regulation (red) and in the state without regulation (yellow). The third comparison could explore how emissions may differ across these two firms in the state without regulation.

For this illustration, we focus on the patchwork of policies and voluntary corporate emission reduction targets that cover energy-intensive manufacturing facilities in California and other states. These firms' facilities operating in California face a carbon price under the state's emission trading system (ETS), but their non-California U.S. facilities do not. Some, but not all firms in petroleum refining, steel or aluminum metal production, Portland cement manufacturing, chemicals, and pulp and paper facilities operating in California have adopted a voluntary emission reduction target. We have drawn from U.S. EPA Greenhouse Gas Reporting program facility-level emissions data and CARB-identified facilities covered by the California ETS to produce a sample of facilities' emissions since 2011. California is State X in our framework. We have mapped these facilities to their parent companies and identified the parent companies' facilities in these industries in non-California states (all of which are State Y in our framework). To be included in our non-California sample, the facility must be owned by a firm that operates a facility in California and is covered by its ETS. We have produced the mean emissions for 2011-2012 – the last two years before the start of the California ETS – and 2022 and 2023 (the last two years of available data) and can compare these long differences over time under the patchwork of carbon pricing and voluntary emission reduction targets (Table 2).

Table 2. Facility-Average Emissions by Regulation (CA ETS) and Voluntary Corporate Targets

California / Vol. Target, 2011-2012	California / Vol. Target, 2022-2023	Percentage Change	Non-CA / Vol. Target, 2011-2012	Non-CA / Vol. Target, 2022-2023	Percentage Change
1.160 (0.24) n = 38	1.242 (0.27) n = 38	+7%	0.635 (0.092) n = 74	0.616 (0.091) n = 74	-3%
California / No Target, 2011-2012	California / No Target, 2022-2023	Percentage Change	Non-CA / No Target, 2011-2012	Non-CA / No Target, 2022-2023	Percentage Change
0.527 (0.10) n = 70	0.450 (0.071) n = 70	-15%	0.420 (0.064) n = 90	0.408 (0.064) n = 90	-3%
Non-CA / Vol. Target, 2011-2012	Non-CA / Vol. Target, 2022-2023	Percentage Change	Non-CA / No Target, 2011-2012	Non-CA / No Target, 2022-2023	Percentage Change
0.635 (0.092) n = 74	0.616 (0.091) n = 74	-3%	0.420 (0.064) n = 90	0.408 (0.064) n = 90	-3%

Notes: Emissions expressed in million metric tons of carbon dioxide equivalent, drawn from EPA Greenhouse Gas Reporting Program. Standard errors are presented in parentheses. Targets are based on the Harvard Salata Corporate Emission Targets Database, 2025, and reflect firms with voluntary targets by 2022. The sample sizes are 38 for California ETS-covered facilities of firms with voluntary targets, 70 for California ETS-covered facilities of firms without voluntary targets, 74 for non-California facilities of firms with voluntary targets and facilities operating under the California ETS, and 90 for non-California facilities of firms without targets and facilities operating under the California ETS.

The table presents three sets of estimates, corresponding to the three numbered comparisons in Figure 13. The first row represents facility-level emissions for a common set of firms. These firms have facilities covered by the California ETS and all of these firms have adopted a voluntary emissions target. The left three columns of this row present the emissions for these firms' California ETS covered facilities in 2011-2012, 2022-2023, and the long difference between these time periods. The second three columns present the emissions for these firm's non-California facilities in these two time periods, and the long difference again. These firms' facilities covered by the ETS experienced a 7 percent increase, while their facilities outside of California experienced a 3 percent decline. Note as well that for firms with voluntary emission reduction targets in these energy-intensive industries, their facilities are larger (in terms of emissions) in California than outside of California.

The second comparison explores a second set of firms that (a) operate facilities in both California (covered by the ETS) and in non-California states (b) have not adopted a voluntary emissions target. These firms have smaller facilities, in terms of emissions, than firms with voluntary emission reduction targets. Their facilities in California had emissions 15 percent lower in 2022-2023 than in

2011-2012. Outside of California, their emissions were 3 percent lower in the latter time period compared to the earlier time period. While this is the same percentage change in emissions as for non-California facilities for firms with voluntary targets, given that these are smaller facilities than those operated by firms with voluntary emission reduction targets, the change in emissions is only about two-thirds the magnitude of the facilities operating under voluntary targets.

The third comparison of facilities operating outside of California by firms that also have facilities operating in California, shows small, similar percentage reductions in emissions over 2011-2012 to 2022-2023. Again, given the larger size of the facilities operated by firms with voluntary emission targets, the magnitude of the emission reductions over time are larger for those facilities operated by firms with voluntary targets.

This initial illustration of trends in emissions at the facility-level will motivate future empirical analysis to explore firms' emissions across facilities under a patchwork of regulation and voluntary emission targets. The association of increasing emissions for facilities owned by firms with voluntary emission targets and operating under a cap-and-trade program relative to those firms' facilities operating in unregulated environments does not necessarily square with the view that more emission reductions would occur in more regulated environments. More rigorous statistical analysis and examination of potential mechanisms can better illuminate firms' behavior under their voluntarily adopted emission targets in the presence of incomplete regulation.

6. Conclusions

The significant increase in the adoption of voluntary emission reduction targets, including ambitious net-zero emission targets, by major U.S. firms over the past decade prompts the question: are such voluntary targets leading or lagging indicators of emission mitigation effort? While the era of voluntary corporate goals in the late 1990s and early 2000s represented a period in which voluntary action served as an alternative to regulation, the current era of voluntary targets occurs against an evolving patchwork landscape of carbon pricing, emissions regulations, and clean energy subsidies. Do voluntary targets simply orient a firm around the public policy goals and instruments that will cover the facilities, processes, and actions of the firm? Or do they reflect incremental emission mitigation abatement?

As an initial step in examining this question, we have produced a framework for assessing the potential interactions among public policies and voluntary emission reduction targets. This simple graphical analysis can frame empirical analyses moving forward. Given the extent of policy evaluation research that ignores voluntary corporate emission reduction targets and the applied finance literature that ignores public policy incentives, this integrating framework may enable more explicit consideration of the multiple incentives firms face operating under their voluntary targets and public policy constraints.

To facilitate broader research on voluntary emission reduction targets, we have produced a new, comprehensive database of voluntary emission reduction targets for the 3000 largest, publicly-traded firms in the United States. Pending final quality control of the database, we will make it freely available to interested researchers and practitioners. By sourcing information directly from firms' public-domain communications, we can provide a more comprehensive characterization of the

scope and nature of voluntary corporate emission reduction targets than what has typically been employed in the literature.

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Appendix: Supplementary Figures

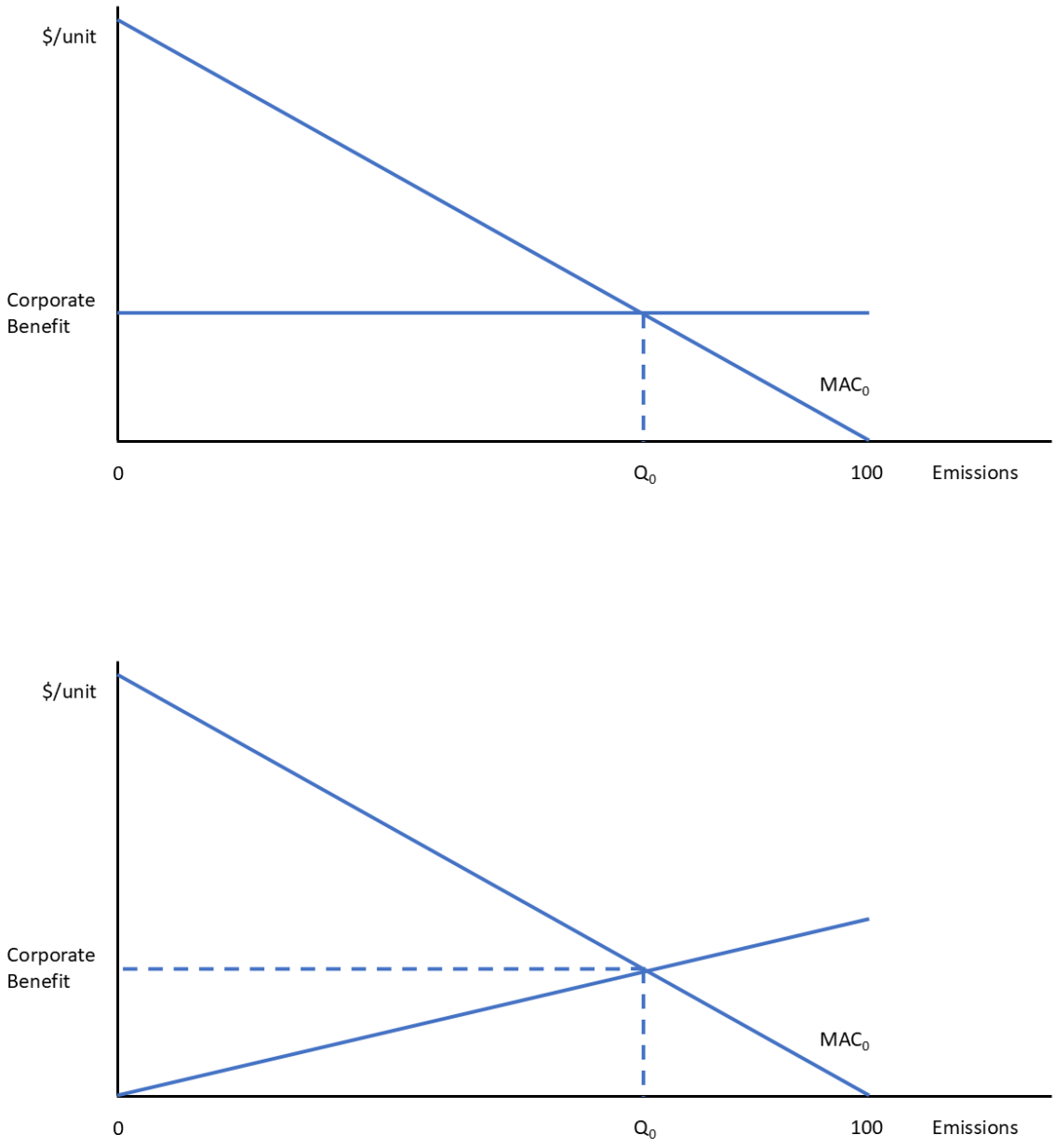


Figure A1. Firm Abatement under Corporate Benefits Expressed as a Constant Marginal Benefit (Figure 2b replicated, top) and Increasing Marginal Benefit (bottom)