Full Scope Emissions Reporting Mandates and Capital Flows: Prospective Evidence from California's Senate Bill 253

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Abstract

Climate-conscious investors have traditionally relied on direct emissions from operations (Scope 1) and indirect emissions from purchased energy (Scope 2), as disclosures of value-chain emissions (Scope 3) remain sparse and inconsistent, despite often representing a substantial share of firms' total carbon footprints. California's Senate Bill 253 (SB 253) could change this by mandating full-scope emissions disclosure. This paper examines how shifting from partial (Scopes 1–2) to full-scope (Scopes 1–3) emissions-intensity metrics would affect relative carbon-performance evaluations and capital flows. We show that incorporating value-chain emissions fundamentally alters sector-peer rankings, redefining carbon leaders and laggards, and could trigger large, systematic capital reallocations toward firms with stronger value-chain carbon performance. We estimate the magnitude of these reallocations and identify SB 253–eligible firms most likely to experience the largest capital inflows and outflows. Our evidence provides timely insight into how California's SB 253 could reshape sector-peer comparisons and capital allocation.

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Introduction

Amid intensifying climate-related weather events and growing polarization over climate action, California has enacted two first-of-their-kind climate disclosure laws: Senate Bill 253 (SB 253) and Senate Bill 261 (SB 261). SB 253 requires U.S.-incorporated companies that do business in California and have over $1 billion in total worldwide annual revenue to disclose their full carbon footprint, with Scope 1 (direct) and Scope 2 (purchased energy) reporting beginning in 2026 and Scope 3 (value-chain) disclosures following in 2027.[1] SB 261, in parallel, mandates disclosure of climate-related financial risks and mitigation strategies by companies with more than $500 million in annual revenue, also starting in 2026.[2]

Together, these laws establish the most comprehensive climate reporting regime in the U.S. The California Air Resources Board (CARB) is responsible for implementing them by developing regulations, setting reporting standards, and overseeing compliance. Their implementation comes as the Securities and Exchange Commission (SEC) has rolled back federal climate disclosure rules, leaving a regulatory vacuum with respect to mandatory emissions disclosures.[3] As a result, these laws are widely viewed as early test cases for mandatory climate disclosure in the U.S., with several other states—including New York, New Jersey, Illinois, Washington, and Colorado—advancing similar legislation.[4]

At the same time, concerns have been raised about the costs of compliance, estimation uncertainty, and whether the benefits of mandatory full-scope emissions reporting outweigh those costs. These concerns have translated into a series of legal challenges to California's disclosure mandates. Courts have rejected claims under the Supremacy Clause (that only federal securities regulators can set disclosure rules) as well as claims under the dormant Commerce Clause (that California cannot regulate business activity outside its borders). Ongoing litigation centers on a First Amendment challenge: whether the reporting mandates constitute unconstitutional compelled speech or a permissible requirement to disclose information that is relevant to investment decision-making. Notably, in litigation brought by business groups led by the U.S. Chamber of Commerce, the U.S. Court of Appeals for the Ninth Circuit has granted an injunction pending appeal limited to the enforcement of SB 261, temporarily suspending the climate-related financial risk disclosure requirement, while allowing enforcement and implementation of SB 253 to proceed.[5]

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[1] California State Legislature. *Senate Bill 253 (Climate Corporate Data Accountability Act)* (2023). Available online.

[2] California State Legislature. *Senate Bill 261 (Climate-Related Financial Risk Act)* (2023). Available online.

[3] U.S. Securities and Exchange Commission. *SEC votes to end defense of climate disclosure rules*. Press Release 2025-58 (2025). Available online.

[4] Cinamon, A. R. State climate disclosure bills—a growing trend? *Natl. Law Rev.* (10 April 2025).

[5] U.S. Court of Appeals for the Ninth Circuit. Or*der Granting in Part and Denying in Part Motion for Injunction Pending Appeal*, Chamber of Commerce of the United States of America et al. v. Randolph et al., No. 25-5327 (2025). Filed November 18, 2025. Available online.

Against this backdrop, California's SB 253—the Climate Corporate Data Accountability Act—stands out as a landmark in mandatory emissions reporting with broad reach. Because California law establishes a business nexus at relatively low thresholds, virtually all U.S.-incorporated firms with more than $1 billion in annual revenue qualify as reporting entities. As we document below, these firms collectively account for a disproportionate share of corporate greenhouse gas (GHG) emissions.

California's SB 253 parallels the E.U.'s Corporate Sustainability Reporting Directive (CSRD), which mandates sustainability reporting—including full-scope emissions disclosures—for E.U. and non-E.U. firms with significant activity in the E.U.[6] Following an Omnibus simplification approved in December 2025, the CSRD was substantially narrowed to focus on large firms, bringing its scope more closely in line with California's SB 253.[7] Beyond the E.U., other major jurisdictions—including Australia, Brazil, China, Singapore, and the United Kingdom—are also moving toward mandatory climate reporting.[8] Yet despite this growing regulatory momentum, investors' carbon performance assessments continue to rely primarily on partial emissions data produced under voluntary reporting regimes, such as those developed by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB), now under the auspices of the International Sustainability Standards Board (ISSB).

Regulatory fragmentation and largely voluntary reporting regimes limit investors' ability to evaluate corporate carbon performance across sector peers and over time. Climate-conscious investors demand climate data that are consistent, comparable, and reliable. While the widespread adoption of voluntary standards has led most SB 253–eligible firms to disclose Scopes 1 and 2 emissions, value-chain (Scope 3) emissions remain sparse and inconsistent, despite often representing a substantial share of firms' total carbon footprints. Scope 3 reporting is a complex undertaking, requiring extensive estimation of emissions sources that lie largely outside firms' direct operational control. Because Scope 3 data are limited, inconsistently disclosed, and largely vendor-estimated rather than company-reported, investors tend to focus on Scopes 1 and 2 and place little weight on value-chain emissions in sector-peer analysis and corporate valuation.[9]

California's SB 253 could change this landscape by mandating full-scope emissions disclosure. By requiring companies to report Scope 3 emissions, the law would make value-chain emissions data available to investors who wish to look beyond Scopes 1 and 2 and assess emissions embedded upstream and downstream. As Scope 3 reporting becomes more standardized and shifts from vendor-estimated proxies to company-reported disclosures, value-chain emissions data are likely to become an increasingly important input for investors' sector-peer benchmarking and capital allocation decisions.

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[6] European Union. *Corporate Sustainability Reporting Directive (CSRD)*, Directive (EU) 2022/2464. *Off. J. Eur. Union* (2022). Available online.

[7] PwC. *EU reaches compromise on 'Omnibus' proposals*. PwC Global Assurance (16 December 2025). Available online.

[8] PwC. *Sustainability Reporting Adoption Tracker*. PwC Global Assurance (17 October 2024). Available online.

[9] Perdichizzi, S., Buchetti, B., Cicchiello, A. F. & Dal Maso, L. Carbon emissions and firm value: evidence from Europe. *Energy Econ.* 131, 107324 (2024).

This paper examines how a shift from partial (Scopes 1–2) to full-scope (Scopes 1–3) emissions-intensity metrics under California's SB 253 disclosure mandate would affect relative carbon performance evaluations among sector peers and capital flows within sectors. We show that incorporating value-chain emissions into relative carbon performance evaluation would fundamentally alter sector-peer rankings, redefining carbon leaders and laggards, and could trigger large, systematic reallocations of capital. Our estimates indicate that the prevailing focus on partial emissions-intensity metrics is prone to diverting capital toward firms with weaker overall carbon performance, but a larger share of emissions embedded in their value chains. Our prospective analysis provides timely insight into how California's SB 253 could influence climate-conscious investors' capital allocation decisions by enabling a shift from partial to full-scope emissions metrics for sector-peer comparisons.

Identifying SB 253-Eligible Firms

Our primary data come from S&P Global Sustainable1 (formerly Trucost), which provides broad coverage of corporate greenhouse gas (GHG) emissions, using company disclosures where available and model-based estimates otherwise. Each observation is flagged as either company-disclosed or vendor-estimated.[10] The Sustainable1 emissions data follow the reporting-boundary definitions of the GHG Protocol. We verify key inferences using emissions data from alternative providers, including MSCI and Refinitiv/LSEG. We obtain financial accounting data from Compustat (S&P Global) and stock market data from the Center for Research in Security Prices (CRSP).

SB 253 applies to U.S.-incorporated entities with annual revenue exceeding $1 billion that do business in California. Importantly, the revenue threshold is based on total worldwide annual revenue, rather than revenue generated in California. SB 253 does not itself define "doing business in California," but CARB's draft regulations propose a definition derived from California's tax code.[11] Under this definition, an entity is considered to be doing business in California if it is engaged in any transaction for financial or pecuniary gain and meets at least one of the following conditions during a reporting year: (a) it is organized or commercially domiciled in California, or (b) its California sales exceed an inflation-adjusted threshold ($757,070 for 2025) or 25% of total sales.

To identify SB 253–eligible firms, we therefore restrict the Sustainable1 universe to U.S.-incorporated companies with worldwide annual revenue exceeding $1 billion. This cutoff serves as a practical proxy for SB 253 eligibility because U.S.-incorporated firms of this size almost certainly meet California's nexus thresholds for doing business in the state. Because these thresholds are relatively low, virtually all U.S.-incorporated firms with more than $1 billion in annual revenue fall within the law's scope, regardless of headquarters location.

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[10] S&P Global Sustainable1. *Trucost Environmental Data: Methodology* (November 2025). Available online.

[11] California Air Resources Board (CARB). *Corporate Greenhouse Gas Reporting and Climate-Related Financial Risk Disclosure Programs: Frequently Asked Questions About Regulatory Development and Initial Reports* (posted 9 July 2025; updated 17 November 2025). Available online.

Using revenue data from the most recent fiscal year, we identify 2,427 SB 253–eligible firms, tracking the California Air Resources Board's (CARB) preliminary list of covered entities.[12] Although SB 253 is a California law, our data underscore that its reach extends nationwide. Panel A of Figure 1 maps eligible firms by headquarters location, showing that California (15%), Texas (10%), and New York (8%) together account for roughly one-third of covered firms. For our main analysis, we use Sustainable1 full-scope emissions data from 2017–2023 and restrict the sample to publicly traded U.S. companies, yielding 8,158 firm-year observations across 1,553 unique firms. Panel B of Figure 1 shows that this sample of SB 253–eligible firms represents roughly half of the Sustainable1 universe but accounts for 95% of aggregate market capitalization, 97% of sales, and 96% of total emissions. These patterns indicate that the $1 billion revenue threshold captures nearly all corporate emissions while deferring compliance costs for smaller firms until they grow beyond the disclosure cutoff.

Emissions Profile of SB 253-Eligible Firms

Figure 2 presents the emissions profile of SB 253–eligible firms. Panel A shows the distribution by year, and Panel B by Global Industry Classification Standard (GICS) sector. Between 2017 and 2023, Scopes 1 and 2 account for 14% of total emissions, while Scope 3 accounts for the remaining 86%, split between 13% upstream and 73% downstream, underscoring the dominance of value-chain emissions. Sectoral differences are pronounced. Utilities report approximately 60% of emissions in Scopes 1 and 2 and 40% in Scope 3, whereas firms in Energy, Technology, Industrials, Consumer Discretionary, and Finance each exhibit more than 90% of emissions in Scope 3, with substantial variation in the upstream–downstream composition.

By definition, full carbon intensity (S123/Sales) equals partial carbon intensity (S12/Sales) multiplied by the inverse of the share of Scope 1 and 2 emissions in total emissions: $\frac{\text{S123}}{\text{Sales}} = \frac{\text{S12}}{\text{Sales}} \times \left(\frac{\text{S12}}{\text{S123}}\right)^{-1}$. This identity clarifies that heterogeneity in emissions composition, captured by S12/S123, is the key driver of reshuffling when moving from partial to full carbon-intensity metrics. In the absence of within–sector–year heterogeneity in S12/S123, partial and full emissions-intensity metrics would yield identical rankings. However, when firms within the same sector and year differ in the share of Scope 3 emissions in total emissions, transitioning from partial to full metrics would systematically alter relative sector-peer rankings. Panel C of Figure 2 quantifies the degree of heterogeneity in emissions composition by examining variation in S12/S123. We regress S12/S123 on sector and year fixed effects and use the resulting R^2 to decompose its variation. Sector–year effects explain 16% of the variation in S12/S123, while the remaining 84% reflects within–sector–year heterogeneity. This residual within–sector–year heterogeneity in S12/S123 is critical for understanding why shifting from partial to full emissions-intensity metrics fundamentally alters relative carbon performance evaluations.

[12] California Air Resources Board (CARB). *California Corporate Greenhouse Gas (GHG) Reporting and Climate-Related Financial Risk Disclosure Programs: Preliminary List of Reporting/Covered Entities* (24 September 2025). Available online.

We note that the degree of within–sector–year heterogeneity in S12/S123 documented using vendor-estimated data is likely to underestimate the corresponding heterogeneity in firm-reported data. Vendor estimation models necessarily rely more heavily on industry-level averages and standardized assumptions, which may attenuate firm-specific differences in emissions profiles. Once firms disclose their full scope of emissions under mandatory reporting regimes such as California's SB 253, reported Scope 3 data are likely to capture greater idiosyncratic variation across firms arising from differences in supply chains, production technologies, and downstream use. As a result, the true extent of heterogeneity—and the corresponding potential for reshuffling sector-peer rankings—is likely to be larger than what we observe in vendor-estimated data. Until such disclosures occur, our analysis necessarily provides prospective evidence.

SB 253 Compliance Costs

Figure 3 examines disclosure coverage to infer where the incremental compliance costs of SB 253 are likely to arise. Panel A shows that in 2017 about 52% of SB 253–eligible firms issued an annual sustainability report, a share that rose steadily to 97% by 2023. Over the same period, the share obtaining sustainability assurance increased from 15% to 40%. Unlike financial audits, sustainability assurance rarely reaches the "reasonable assurance" standard used in financial reporting; it is typically less comprehensive, provides only moderate confidence, and generally covers only Scopes 1 and 2.[13] Under SB 253, however, assurance requirements will ratchet up: limited assurance for Scopes 1 and 2 by 2026, reasonable assurance by 2030, and limited assurance for Scope 3 by 2030. By 2023, nearly three-quarters of SB 253–eligible firms disclosed Scopes 1 and 2, and about half disclosed at least one of the fifteen Scope 3 Categories under the GHG Protocol.[14]

Panel B breaks down Scope 1 and 2 emissions into company-disclosed versus vendor-estimated values. Firms disclosing Scopes 1 and 2 account for roughly three-quarters of SB 253–eligible firms but represent about 96% of aggregate emissions, indicating that disclosure is concentrated among the largest emitters. Vendor estimates therefore cover only a small residual share of Scope 1 and 2 emissions, underscoring substantial progress in operational emissions reporting. A comparable breakdown for Scope 3 emissions is not feasible in our setting because the Sustainable1 disclosure indicator captures only whether a firm discloses at least one Scope 3 category, rather than emissions by individual category. As a result, we do not separately quantify the share of total Scope 3 emissions that is company-disclosed versus vendor-estimated. However, our review of firms' sustainability reports suggests that disclosures most frequently cover upstream Category 1 (Purchased Goods and Services) and downstream Category 11 (Use of Sold Products), with additional sector-specific patterns, such as Category 3 (Fuel- and Energy-Related Activities) for Utilities, Category 13 (Downstream Leased Assets) for Real Estate, and Category 15 (Investments) for Financials.

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[13] Gipper, B., Ross, S. & Shi, S. X. ESG assurance in the United States. *Rev. Account. Stud.* 30, 1753–1803 (2025).

[14] GHG Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2011). World Resources Institute and World Business Council for Sustainable Development. Available online.

Taken together, these patterns imply that incremental compliance costs under SB 253 are likely to be relatively low for Scopes 1 and 2 among SB 253–eligible firms, where disclosure is already widespread. By contrast, compliance costs are likely to be substantially higher for Scope 3 emissions, where voluntary reporting remains incomplete, category-specific, and uneven across firms and sectors. Achieving compliance with SB 253's Scope 3 requirements will require investments in new data collection processes, expanded engagement with suppliers and customers, and the development of estimation methodologies that propagate up and down the value chain. Additional costs will arise from building the internal controls, documentation, and governance structures necessary to support third-party assurance of value-chain emissions. These structures will be critical to ensuring that Scope 3 emissions reporting is reliable rather than mere guesswork.

From Partial to Full Scope Carbon Metrics

Investors increasingly seek to incorporate carbon data into portfolio construction, typically comparing sector peers using emissions per dollar of revenue as the primary measure of carbon intensity.[15] To date, the focus has been on Scopes 1 and 2, which are more widely disclosed and relatively standardized, while Scope 3 data remain sparse and inconsistent. SB 253 will mandate disclosure of full-scope emissions, enabling investors to incorporate value-chain emissions into relative carbon performance evaluation. This raises the central question: how would shifting from partial (Scopes 1–2) to full-scope (Scopes 1–3) emissions-intensity metrics affect sector-peer evaluations and capital allocation?

Figure 4 quantifies the impact of shifting investor focus from partial carbon intensity, defined as Scope 1+2 emissions per dollar of revenue (S12/Sales), to full carbon intensity, defined as Scope 1+2+3 emissions per dollar of revenue (S123/Sales), for sector-peer comparisons. We rank firms within each sector-year on both metrics and assign percentile ranks normalized between zero (least carbon-intensive) and one (most carbon-intensive). We compute percentile ranks separately for partial intensity, denoted R(S12/Sales), and full intensity, denoted R(S123/Sales).

Panel A plots firms' average full-intensity ranks against their average partial-intensity ranks, with firm-level ranks averaged across all years in which each firm appears in the sample. If the two metrics were perfectly aligned, observations would fall on the 45-degree line. Instead, we observe substantial dispersion, indicating significant reshuffling of sector-peer rankings. The correlation between partial and full intensity ranks is 42%, and the average absolute difference in ranks is 23 percentile points. The reshuffling is closely related to firms' emissions composition. Firms with a higher share of Scope 1+2 emissions relative to total emissions tend to rank worse under partial intensity and better under full intensity. Panel B confirms this relationship, showing a correlation of –90% between the difference in full versus partial intensity ranks and S12/S123. Within-sector heterogeneity in emissions composition is therefore the primary driver of the reshuffling.

[15] Aswani, J., Raghunandan, A. & Rajgopal, S. Are carbon emissions associated with stock returns? *Rev. Finance* 28, 75–106 (2024).

Panel C reports the average absolute rank spread by sector. The degree of reshuffling varies substantially across sectors, ranging from approximately 15 percentile points for Utilities, where Scope 3 accounts for about 40% of aggregate full-scope emissions, to roughly 30 percentile points for Consumer Discretionary and Finance, where Scope 3 accounts for 95% and 98% of emissions, respectively.

Panel D reports regressions of the rank spread between full and partial intensity on S12/S123, controlling for sector and year fixed effects and for firm fundamentals, including percentile ranks of sales, profit margins, asset turnover, leverage, and valuation multiples. S12/S123 alone explains 77.5% of the variation in rank spreads, while the incremental explanatory power of the other firm characteristics is only 0.1%. Taken together, these results identify within-sector heterogeneity in emissions composition as the dominant characteristic driving sector-peer reshuffling when moving from partial to full intensity rankings. In the absence of within-sector heterogeneity in S12/S123, shifting from partial to full carbon-intensity metrics would leave relative sector-peer rankings unchanged.

Firm-level examples help illustrate these patterns. Vistra Corp., a major U.S. utilities firm with Scope 3 emissions representing only about 5% of its total carbon footprint, ranks in the 97th percentile under partial intensity and shifts to the 100th percentile under full intensity, reflecting minimal change. Apple, with 88% of emissions in Scope 3, moves from the 8th percentile under partial intensity to the 43rd percentile under full intensity. Tesla, with 96% of total carbon emissions in Scope 3, shifts from the 14th to the 64th percentile, reflecting large upstream and downstream emissions associated with battery production and vehicle use.

Robustness to Reporting Quality and Alternative Data Providers

To assess whether the reshuffling of sector-peer rankings when moving from partial to full emissions-intensity metrics reflects measurement error in Scope 3 emissions rather than underlying differences in emissions composition, we examine how the extent of reshuffling varies with the quality of firms' sustainability reporting. We partition the sample using indicators of reporting quality that are likely to affect the reliability of Scope 3 emissions estimates. If reshuffling were primarily an artifact of noisy vendor estimates, it should be more pronounced among firms with lower-quality reporting and attenuated among firms with more developed disclosure practices.

We use four indicators of sustainability reporting quality. First, an indicator for fully modeled Scope 3 emissions identifies firms for which all Scope 3 categories are vendor-estimated rather than at least partially disclosed under the GHG Protocol. Second, an indicator for adoption of Sustainability Accounting Standards Board (SASB) standards, based on data from the IFRS Sustainability Alliance, captures alignment with investor-oriented sustainability standards emphasizing consistency, comparability, and decision-useful metrics. Third, an indicator for reporting under the Global Reporting Initiative (GRI) framework reflects broader sustainability disclosure practices. Fourth, an indicator for firms responding to the Carbon Disclosure Project (CDP) survey captures voluntary participation in detailed climate disclosure regimes.

Panel A of Figure 5 reports the annual frequencies of these indicators. Between 2017 and 2023, the share of SB 253–eligible firms with fully modeled Scope 3 emissions declined from nearly 80% to about 50%. Over the same period, SASB adoption increased from 7% in 2018 to nearly 80% by 2022, GRI adoption roughly doubled, and CDP participation rose from 29% to 44%. Together, these trends indicate substantial changes in sustainability reporting quality over the sample period.

Panel B of Figure 5 reports the degree of reshuffling from partial to full carbon-intensity metrics across reporting-quality partitions, measured by the correlation between partial and full intensity sector-peer ranks using Sustainable1 data. Across all partitions, the estimated correlation remains close to the full-sample value of 42%. There is no evidence that the extent of reshuffling varies systematically with reporting quality, alleviating concerns that the low overlap between partial and full rankings is driven by noise in vendor-estimated Scope 3 emissions.

We next assess robustness to alternative emissions data providers. Using emissions data from MSCI and Refinitiv/LSEG, we estimate the degree of reshuffling both unconditionally and within reporting-quality partitions. MSCI covers approximately 85% of SB 253-eligible firms, while Refinitiv/LSEG covers about 52% for Scope 1 and Scope 2 emissions, with more limited Scope 3 coverage for both providers. Although these datasets offer less comprehensive coverage of full-scope emissions than S&P Global Sustainable1, they provide a useful robustness check.

Despite differences in coverage, Panels C and D of Figure 5 show that the correlation between partial- and full-intensity sector-peer ranks is highly consistent across data sources: 42% for Sustainable1, 45% for MSCI, and 52% for Refinitiv/LSEG. Across data providers and subsamples, the overlap between partial and full carbon-intensity rankings remains tightly centered around a 45% correlation, well below the 100% benchmark corresponding to perfect overlap. This consistency indicates that the observed reshuffling is not driven by idiosyncrasies of any single data source or by differences in reporting quality.

SB 253 and Investment Portfolios

The analysis above shows that incorporating value-chain emissions into carbon-intensity metrics substantially reshapes relative carbon performance rankings among sector peers. This reshuffling is systematic and is largely attributed to within-sector heterogeneity in emissions composition: firms with a larger share of Scopes 1 and 2 emissions in total emissions tend to rank worse under partial intensity but better under full intensity, relative to their sector peers.

If investors allocate capital within sectors based on relative carbon performance—as is common in carbon-tilting strategies—then a shift from partial (Scopes 1–2) to full-scope (Scopes 1–3) emissions-intensity metrics would translate into capital reallocation among sector peers. In what follows, our portfolio analysis quantifies the capital-reallocation effects of redefining carbon performance from partial to full-scope intensity metrics under California's SB 253 disclosure mandate.

In a standard value-weighted portfolio, investors allocate capital to companies in proportion to their market capitalization. This approach underlies widely followed market indices such as the S&P, MSCI, and FTSE Russell families, which anchor trillions of dollars in public markets. A carbon-efficient variant adjusts portfolio weights to reduce exposure to firms that rank worse and increase exposure to firms that rank better on carbon intensity within their sector. This reshuffling is sector-neutral: it preserves the sector weights of the underlying index while reallocating capital among sector peers. Carbon-tilting strategies reward "best-in-class" companies within each sector and are often viewed as more effective for driving decarbonization than blanket divestment, which excludes entire sectors and reduces diversification.[16] By contrast, divestment strategies can have unintended consequences, shifting ownership without reducing underlying activity and weakening incentives for firm-level change.[17]

We construct a standard value-weighted portfolio of SB 253–eligible companies and two carbon-efficient variants: one based on partial intensity (R(S12/Sales)) and the other on full intensity (R(S123/Sales)). Portfolio construction details are provided in the **Online Methods**. Panel A of Figure 6 presents the sector weights of the standard value-weighted portfolio over our sample period. By construction, the carbon-efficient portfolio variants preserve these sector weights and reallocate weights only within sectors. Investors evaluating these variants therefore do not over- or under-weight sectors relative to the benchmark and do not sacrifice diversification. We assess portfolio performance along two dimensions: financial performance and carbon performance.

We measure financial performance using portfolio returns and portfolio turnover. Portfolio returns are computed as value-weighted returns based on firms' market capitalizations and realized stock returns over the evaluation period. Portfolio turnover measures the extent of year-to-year changes in portfolio weights and serves as a proxy for rebalancing intensity and transaction costs: higher turnover indicates more frequent trading and higher implementation costs for investors. Panel B of Figure 6 shows that both the partial- and full-intensity variants delivered average realized returns of about 15%, comparable to the standard portfolio. Turnover, however, was higher—14% compared to 11% for the standard portfolio—reflecting greater rebalancing intensity and, consequently, higher transaction costs associated with implementing full-scope carbon-intensity tilts.

We measure carbon performance using financed emissions, which attribute a firm's emissions to investors in proportion to their ownership share.[18] For example, an investor with a 1% stake is assigned 1% of that firm's emissions. Expressed in metric tons of CO_2 equivalent per $1 million invested, this metric standardizes a portfolio's carbon footprint relative to invested capital. We compute financed emissions for both partial (Scopes 1 and 2) and full (Scopes 1, 2, and 3) emissions, with details provided in the **Online Methods**.

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[16] Edmans, A., Levit, D. & Schneemeier, J. Socially responsible divestment. *ECGI Finance Working Paper* No. 823/2022 (2022). Available online.

[17] Davies, S. W. & Van Wesep, E. D. The unintended consequences of divestment. *J. Financ. Econ.* 128, 558–575 (2018).

[18] Partnership for Carbon Accounting Financials (PCAF). *The Global GHG Accounting and Reporting Standard: Part A—Financed Emissions*, 2nd ed. (2022).

Panel C of Figure 6 shows that, relative to the standard portfolio, the S12/Sales-tilted variant reduces financed emissions by about 6%, driven by reductions in Scopes 1 and 2, while Scope 3 emissions remain nearly unchanged relative to the standard portfolio. By contrast, the S123/Sales-tilted variant achieves a much larger 45% reduction in total emissions, reflecting a 23% decrease in Scopes 1 and 2 and an almost 50% reduction in Scope 3 emissions. The Scope 3 reduction can be further decomposed into a 17% decrease in upstream emissions and a 55% decrease in downstream emissions relative to the standard portfolio.

In sum, shifting from partial to full carbon-intensity metrics allows investors to track the standard value-weighted portfolio while cutting financed emissions by nearly half. This reduction, however, comes at a cost: the full-intensity portfolio exhibits higher turnover and therefore higher transaction costs, reflecting greater variability in portfolio weights. Relative to prior work on carbon-efficient investing that takes the scope of emissions as given, our analysis focuses on how disclosure mandates that expand the scope of reported emissions reshape relative carbon performance and capital allocation.[19]

SB 253 and Capital Flows

SB 253 will make the full scope of emissions for eligible firms observable. If investors shift from partial- to full-intensity tilts (S12/Sales vs. S123/Sales), a key question is how much capital would be reallocated. We measure this using two complementary metrics: the total reallocation rate (TRR) for the portfolio as a whole and the sector reallocation rate (SRR) within each sector. The TRR captures the overall scale of portfolio adjustment required to move from partial to full-scope tilting. It expresses the share of the portfolio that would need to be reallocated and can be converted into dollar terms for a given level of invested capital. The SRR applies the same logic within sectors, indicating the proportion of capital already allocated to a sector that would be redistributed among sector peers. Detailed definitions are provided in the **Online Methods**.

Figure 7 presents reallocation estimates based on historical data as an indication of what might occur once SB 253 disclosures are in place. Panel A shows a total reallocation rate of 29%, implying that approximately $290,000 would be traded for every $1 million invested—about 2.6 times the annual turnover of the standard benchmark portfolio. Panel B decomposes this total into sector reallocation rates, which by construction sum to the overall reallocation rate when weighted by the benchmark portfolio's sector weights. Reallocation rates vary substantially across sectors, reflecting differences in emissions composition and sector-peer reshuffling. Consumer Discretionary and Telecommunications exhibit the highest rates, ranging from 37% to 44%, consistent with their high reliance on Scope 3 emissions and the substantial reshuffling of rankings when moving from partial to full emissions-intensity metrics. By contrast, Utilities exhibit lower reallocation rates at 16%, reflecting the sector's smaller share of Scope 3 emissions and the more limited reshuffling of sector-peer rankings when value-chain emissions are incorporated.

[19] Dutta, S., Hwang, J. & Patatoukas, P. N. Fundamentals of carbon emissions scaling: implications for sector peer comparisons and carbon-efficient indexing. *Energy Econ.* 143, 108300 (2025).

Taken together, these results show that SB 253's full-scope carbon disclosure mandate would not only alter sector-peer rankings but could also trigger large, systematic reallocations of capital within sectors. Capital could be redirected toward firms with stronger value-chain emissions performance and away from those with weaker performance. We estimate that this effect is more pronounced in sectors where value-chain emissions account for a larger share of the total. We note, however, that because most Scope 3 emissions in our sample are vendor-estimated rather than company-reported, these rates should be viewed as indicative of what might emerge once investors rely on reported value-chain data under California's SB 253.

Conclusion

Until now, climate-conscious investors have relied primarily on Scope 1 and Scope 2 emissions, as disclosures of Scope 3 emissions remain sparse and inconsistent under largely voluntary reporting regimes, even though value-chain emissions often represent a substantial share of firms' total carbon footprints. Reliance on partial emissions-intensity metrics can therefore distort sector-peer comparisons by favoring firms whose emissions fall outside firm-level reporting boundaries, potentially diverting capital toward firms with weaker overall carbon performance but a greater share of emissions embedded in their value chains.

California's SB 253 marks a turning point by mandating full-scope emissions disclosure for large firms that account for a disproportionate share of corporate greenhouse gas emissions. We show that shifting investor focus from partial (Scopes 1–2) to full-scope (Scopes 1–3) emissions-intensity metrics would substantially reorder sector-peer rankings and could trigger large reallocations of capital within sectors, particularly in sectors where value-chain emissions dominate and emissions composition varies widely across firms. This reordering is driven by heterogeneity in emissions composition among sector peers. In the absence of such heterogeneity, partial and full emissions-intensity metrics would yield identical rankings.

By mandating full-scope emissions disclosure, California's SB 253 will make company-reported data on Scopes 1, 2, and 3 emissions available to investors. This expanded disclosure has the potential to reshape relative carbon performance evaluation, enhance sector-peer comparability among firms with different emissions profiles, and redirect capital toward firms with stronger overall carbon performance, thereby strengthening market-based incentives for decarbonization across value chains. Our analysis provides a timely preview of how California's SB 253 emissions disclosure mandate could fundamentally alter sector-peer rankings and affect capital flows by closing the disclosure gap around value-chain emissions. We caution, however, that our estimates should be interpreted as illustrative of potential capital reallocation under full-scope disclosure, rather than as estimates of the realized causal effects of California's SB 253.

Our evidence is prospective and relies primarily on vendor-estimated Scope 3 emissions data. Vendor estimation models typically rely on industry-level averages and simplifying assumptions, which can attenuate firm-specific differences in emissions profiles. Once firms begin reporting full-scope emissions under mandatory disclosure regimes such as California's SB 253, the contribution of Scope 3 emissions to total emissions is likely to exhibit greater idiosyncratic variation across firms, reflecting differences in upstream supply chains, production technologies, and downstream product use. As a result, the true extent of within-sector heterogeneity—and the associated reordering of sector-peer rankings—is likely to be larger than what we observe in vendor-estimated data.

At the same time, California's SB 253 entails an important tradeoff. While full-scope emissions disclosure can improve comparability across sector peers with different reporting boundaries, it also introduces compliance costs and estimation uncertainty, particularly with respect to Scope 3 emissions. Measurement of Scope 3 emissions involves managerial discretion, modeling assumptions about emissions factors and activity data, and choices over value-chain boundaries. Moreover, under the GHG Protocol, multiple entities may account for the same underlying emissions at different points in the value chain, giving rise to double counting when emissions are aggregated across firms.

These considerations have figured prominently in legal challenges to California's SB 253, which emphasize that Scope 3 estimates reflect approximations rather than purely factual measurements.[20] Our paper does not assess the accuracy of Scope 3 estimates under voluntary reporting regimes. Instead, it provides prospective evidence on how full-scope emissions disclosure could affect relative carbon performance evaluation and capital allocation once firm-reported data become available. Importantly, mandatory disclosure does not merely reveal existing information but changes firms' reporting incentives and the underlying data-generating process. California's SB 253 will require firms to invest in data systems, internal controls, and assurance for full-scope reporting, which is likely to improve consistency and comparability over time.

As the world's fourth-largest economy (behind only the U.S., China, and Germany as of 2024), California's regulatory choices are likely to carry influence beyond its borders, particularly as other jurisdictions advance similar disclosure mandates.[21] Our findings therefore inform ongoing debates about whether full-scope emissions disclosure mandates could reasonably be expected to influence the capital allocation decisions of climate-conscious investors. While necessarily prospective, our evidence highlights the potential magnitude and direction of capital-market effects that may emerge once firm-reported full-scope emissions data become available to investors.

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[20] U.S. District Court for the Central District of California. *Amended Complaint for Declaratory and Injunctive Relief*, Chamber of Commerce of the United States of America et al. v. Randolph et al., No. 2:24-cv-00801-KS (2024). Filed February 22, 2024. Available online.

[21] State of California, Office of the Governor. California Is Now the Fourth Largest Economy in the World. (23 April 2025). Available online.

Online Methods

Portfolio Methodology

We construct carbon-efficient indices following the methodology of Dutta et al. (2025). A standard value-weighted portfolio allocates weights to firms in proportion to their market capitalization. Specifically, the benchmark portfolio weight on firm i in sector s, denoted by w_{is}^b, is equal to its market value MV_{is} divided by the sum of market values of all portfolio firms:

$$w_{is}^b = \frac{MV_{is}}{\sum_{s=1}^{S}\sum_{i=1}^{n_s} MV_{is}},$$

where n_s is the number of firms in sector s and S is the number of sectors.

To construct a carbon-efficient portfolio that is sector-neutral relative to the benchmark, we assign the following weight to firm i in sector s:

$$w_{is} = w_s^b \times \frac{MV_{is}(1 - Rank_{is})}{\sum_{j=1}^{n_s} MV_{js}(1 - Rank_{js})},$$

where $w_s^b = \sum_{i=1}^{n_s} w_{is}^b$ denotes the weight of sector s in the standard benchmark portfolio, and $Rank_{is}$is the carbon intensity rank of firm i from sector s. The weighting scheme ensures that the sector weights in the carbon-efficient portfolio are identical to those of the benchmark portfolio (i.e., $\sum_{i=1}^{n_s} w_{is} = w_s^b$ for each sector s). Within each sector, firms with lower carbon intensity are assigned larger weights relative to their more carbon-intensive sector peers.

We construct two carbon-efficient portfolios: the S12/Sales-tilted portfolio, which reweights firms within each sector based on their carbon intensity rank using Scopes 1 and 2 emissions per dollar of revenue, and the S123/Sales-tilted portfolio, which reweights firms based on their rank using Scopes 1, 2, and 3 emissions per dollar of revenue.

The portfolios are rebalanced annually at the end of June, using the prior fiscal year's data to account for reporting lags. Here, t indexes the portfolio formation year: weights are set at the end of June of year t, and returns are measured from July of year t to June of year $t + 1$. Portfolio returns are defined as:

$$R_{t+1} = \sum_{s=1}^{S}\sum_{i=1}^{n_s} w_{is,t} R_{is,t+1},$$

where $w_{is,t}$ is the portfolio weight of firm i in sector s at time t, and $R_{is,t+1}$ is the stock return of firm i from July t to June $t + 1$ (including distributions).

The annual portfolio turnover rate, which measures rebalancing intensity and proxies for transaction costs, is:

$$Turnover_{t+1} = \frac{1}{2}\sum_{s=1}^{S}\sum_{i=1}^{n_s} | w_{is,t+1} - w_{is,t} |.$$

Portfolio Footprint

The carbon footprint of a portfolio refers to the GHG emissions attributed to an investor's share of ownership in the portfolio firms, based on the amount of capital they have invested in the portfolio. Since one dollar of capital invested in portfolio amounts to investing w_{is} in firm i from sector s, the investor's ownership share in this portfolio firm equals w_{is}/MV_{is}. Calculating the owned emissions from each portfolio firm and summing over portfolio firms yields the carbon footprint in tons of GHG per dollar of investment, as follows:

$$Carbon\ Footprint_t = \sum_{s=1}^{S}\sum_{i=1}^{n_s} \frac{w_{is}}{MV_{is}} \times GHG_{is},$$

where GHG_{is} denotes the annual carbon emissions of firm i in sector s.

We compute the portfolio carbon footprint under two definitions. Partial financed emissions are based on Scopes 1 and 2, covering direct emissions from operations and indirect emissions from purchased energy. Full financed emissions are based on Scopes 1, 2, and 3, with Scope 3 capturing upstream and downstream value-chain emissions. Both measures are expressed in metric tons of CO_2 equivalent (tCO_2e) per $1 million invested,

This decomposition allows us to compare portfolios tilted on partial intensity with those tilted on full intensity, and to estimate the incremental contribution of value-chain emissions to portfolio-level financed emissions. Importantly, SB 253's mandate for full-scope disclosure ensures that investors will have the data needed to move from partial to full financed-emissions metrics, making this distinction directly relevant for capital allocation under the law.

Portfolio Reallocation Rates

To estimate the capital that would move if investors transition from the S12/Sales-tilted to the S123/Sales-tilted portfolio, we first compute the total reallocation rate (TRR):

$$TRR = \frac{1}{2}\sum_{s=1}^{S}\sum_{i=1}^{n_s} | w_{is}^{123} - w_{is}^{12} |,$$

where w_{is}^{12} and w_{is}^{123} denote the weights of firm i in sector s in the S12/Sales-tilted and S123/Sales-tilted portfolios, respectively. TRR, expressed as a fraction of total portfolio

value, represents the minimum gross trading needed to switch between the tilts, assuming sales finance purchases. Multiplying TRR by the invested capital yields the dollar volume of trades required for reallocation.

At the sector level, we define the sector reallocation rate (SRR) as:

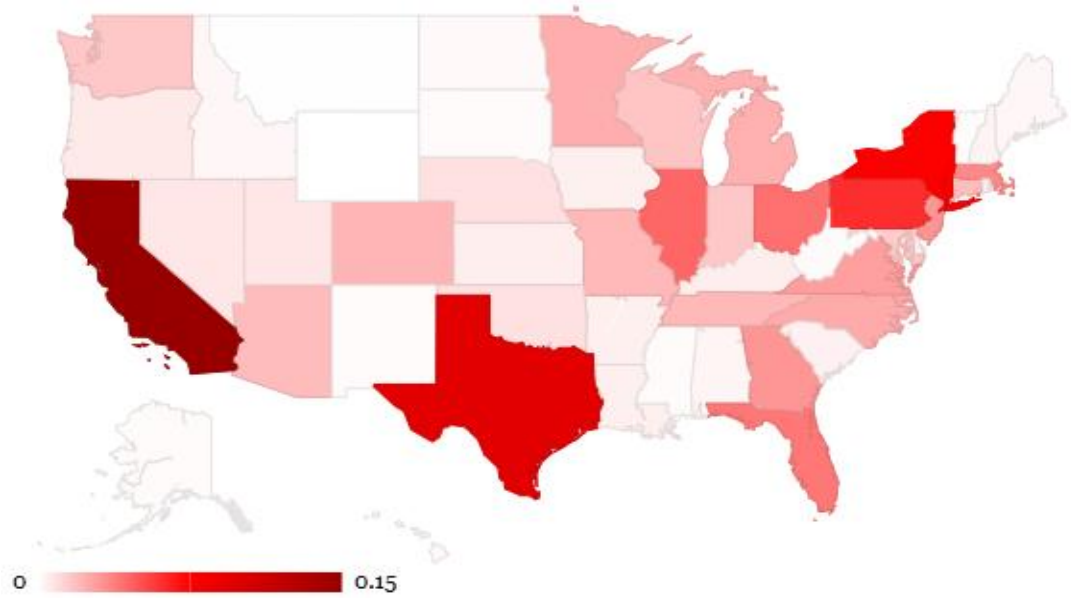
$$SRR_s = \frac{1}{2}\frac{\sum_{i=1}^{n_s} | w_{is}^{123} - w_{is}^{12} |}{w_s},$$

where w_s is the benchmark weight of sector s. This normalization makes SRR directly comparable across sectors of different sizes and answers the question: what share of the capital already allocated to sector s would be redistributed among sector peers under full-scope tilting. By construction, the sector rates aggregate to the total reallocation rate when weighted by the benchmark portfolio sector weights: $TRR = \sum_{s=1}^{S}(SRR_s \cdot w_s)$.

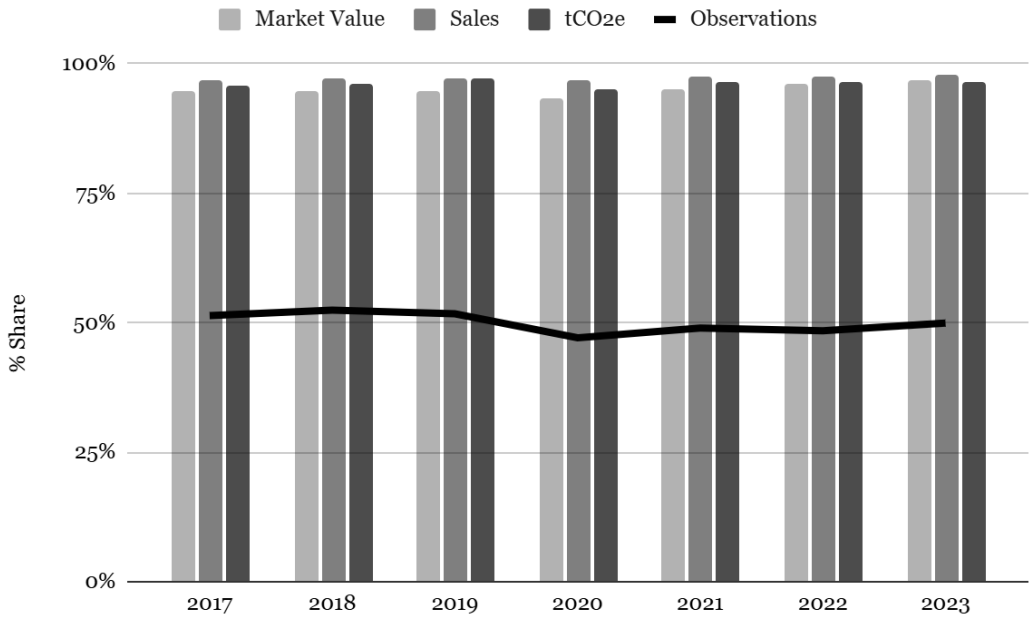
Together, TRR and SRR provide complementary views of SB 253's impact on capital flows: TRR measures the overall scale of reallocation, while SRR shows where in the market the reshuffling would be most concentrated.

Figure 1: Identifying SB 253-Eligible Firms

Panel A: Geographic Distribution of SB-253–Eligible Firms.



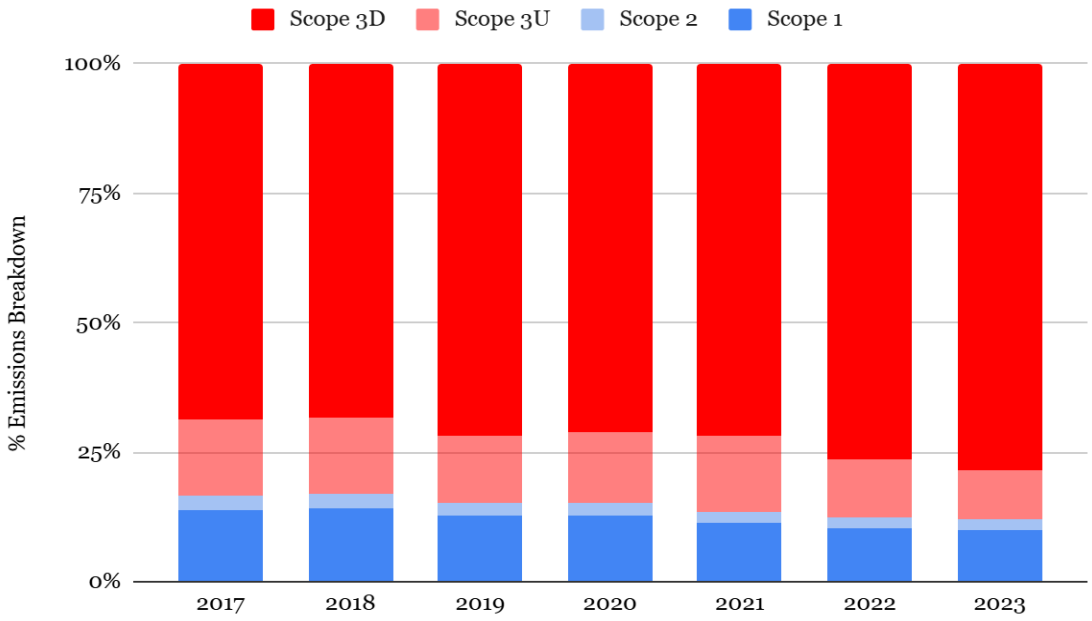
Panel B: Economic and Emissions Footprint of SB-253–Eligible Firms.



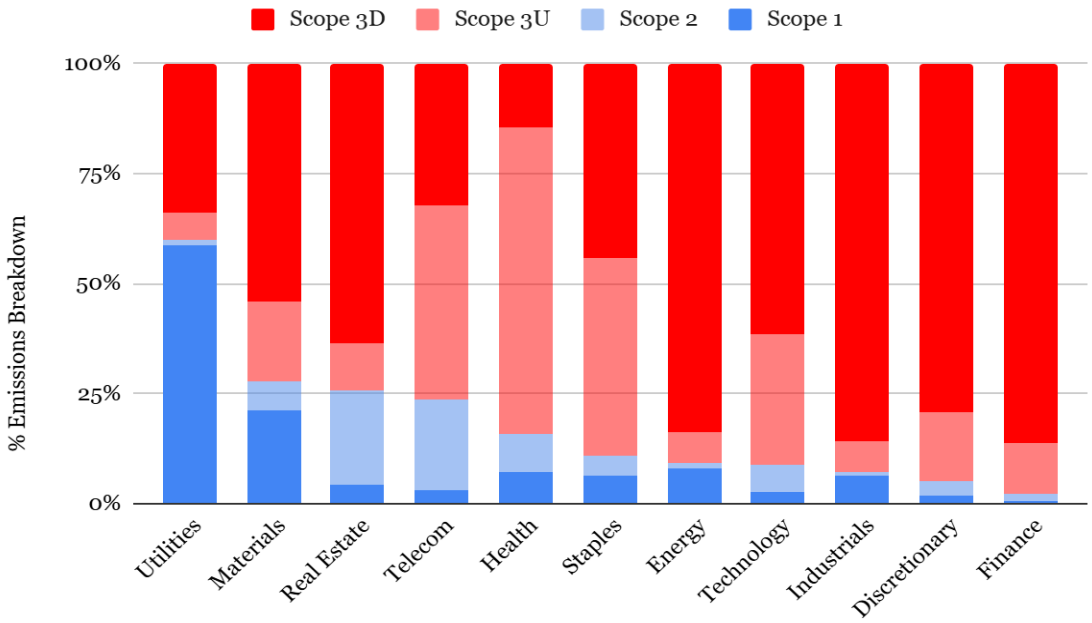
Panel A of this figure maps SB-253–eligible firms by headquarters. The color scale indicates the fraction of SB 253-eligible firms headquartered in each geographic location, expressed as a share of the total number of eligible firms. Panel B shows that SB 253–eligible firms, though less than half of the Sustainable1 dataset, account for the majority of market capitalization, sales, and total GHG emissions measured in tons of CO_2 equivalent (tCO_2e). Total emissions include Scopes 1, 2, and 3 from both upstream and downstream sources.

Figure 2: SB 253 Corporate Emissions Profile

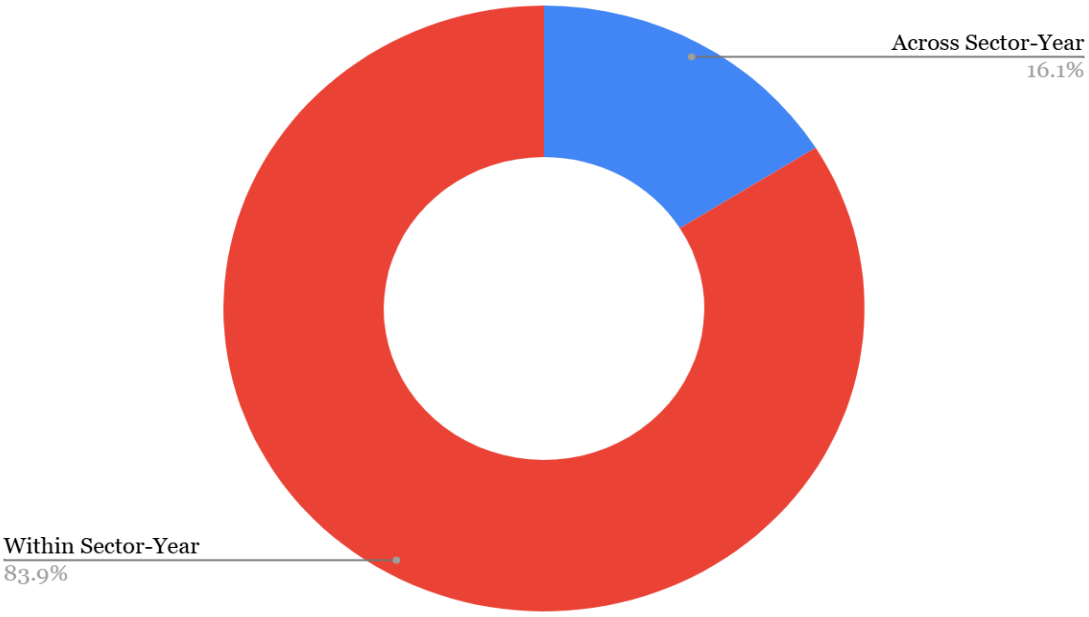
Panel A: Emissions breakdown by year.



Panel B: Emissions breakdown by sector.



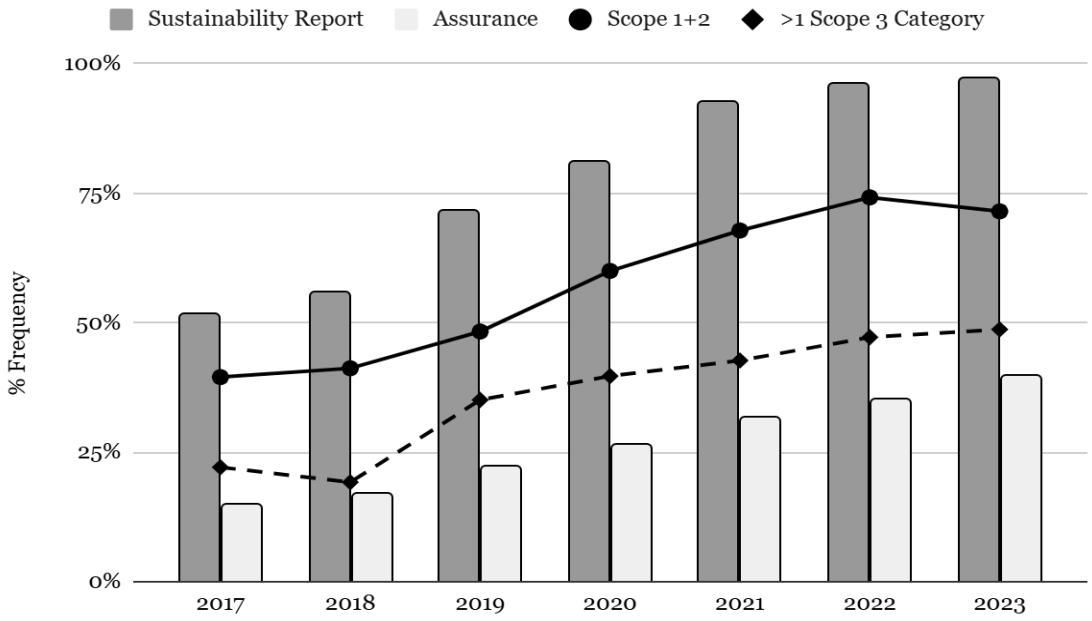
Panel C: Breaking down variation in S12/S123.



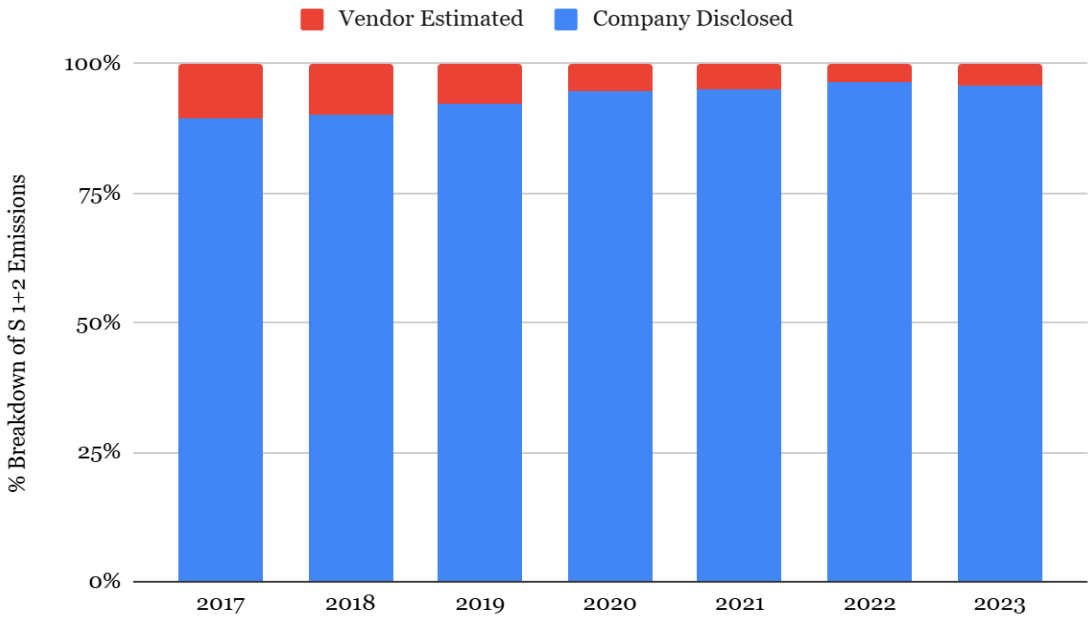
This figure presents the emissions profile of SB 253–eligible firms. Panel A shows the distribution by year, and Panel B by Global Industry Classification Standard (GICS) sector. Between 2017 and 2023, Scopes 1 and 2 together accounted for 14% of total emissions, while Scope 3 made up 86%, underscoring the dominance of value-chain emissions. The share of Scope 3 varies across sectors, ranging from about 50% in Utilities to over 90% in Technology, Consumer Discretionary, and Finance. Panel C visualizes the breakdown of variation in the share of Scopes 1 and 2 relative to total emissions (S12/S123), based on a regression of S12/S123 on sector and year fixed effects. Sector-year effects explain 16% of the variation, with the remaining 84% reflecting within–sector–year firm-level heterogeneity.

Figure 3: SB 253 Corporate Disclosure Frequencies

Panel A: Disclosure frequencies.



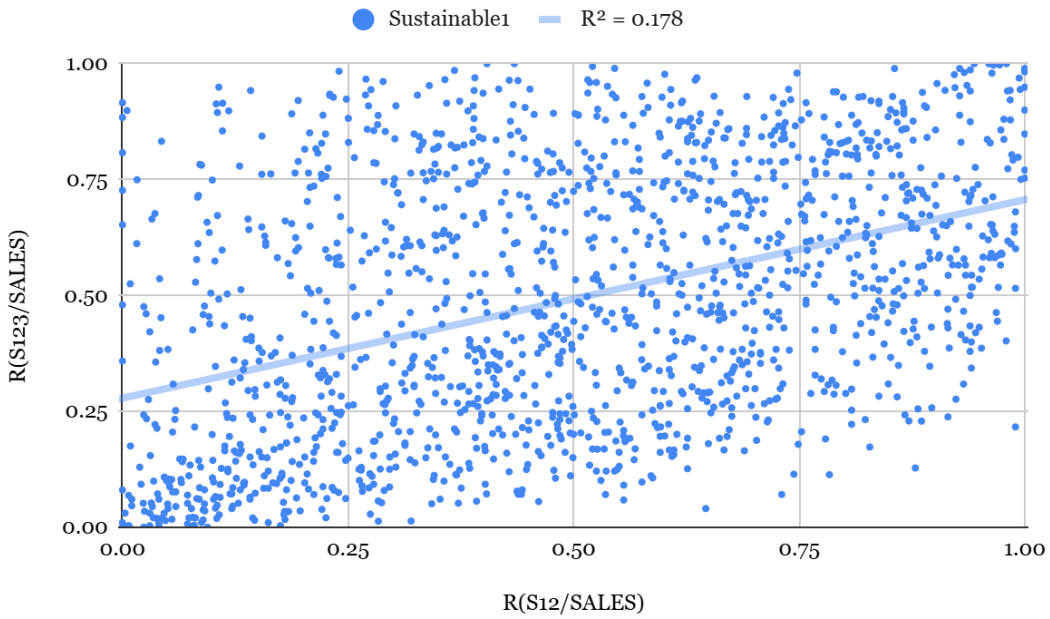
Panel B: Concentration of disclosed Scope 1+2 emissions.



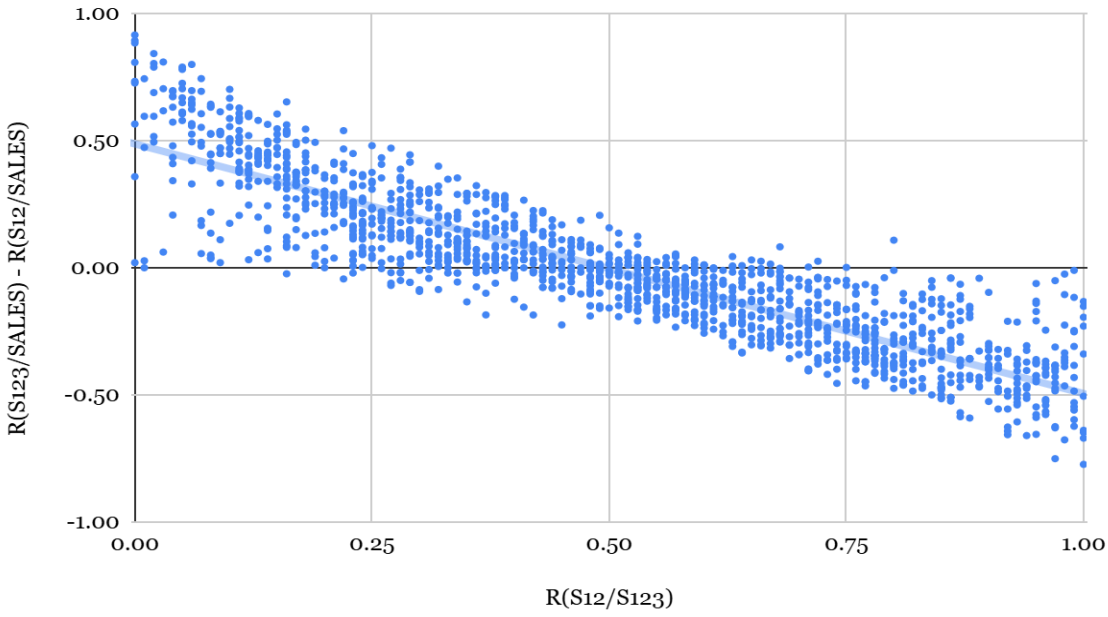
This figure examines disclosure coverage to infer where the incremental compliance costs of SB 253 are likely to arise. Panel A shows that the share of firms issuing sustainability reports rose from 52% in 2017 to 97% in 2023, while assurance increased from 15% to 40%, though typically limited to Scopes 1 and 2. By 2023 nearly three-quarters of firms disclosed Scopes 1 and 2 and about half disclosed at least one Scope 3 category. Panel B shows that disclosing firms accounted for 96% of aggregate Scope 1 and 2 emissions, leaving only a small residual covered by vendor estimates. Together, these patterns suggest that compliance costs will be relatively low for Scopes 1 and 2 but higher for Scope 3, where disclosure remains incomplete and inconsistent.

Figure 4: SB 253 Partial-to-Full Intensity Reshuffling

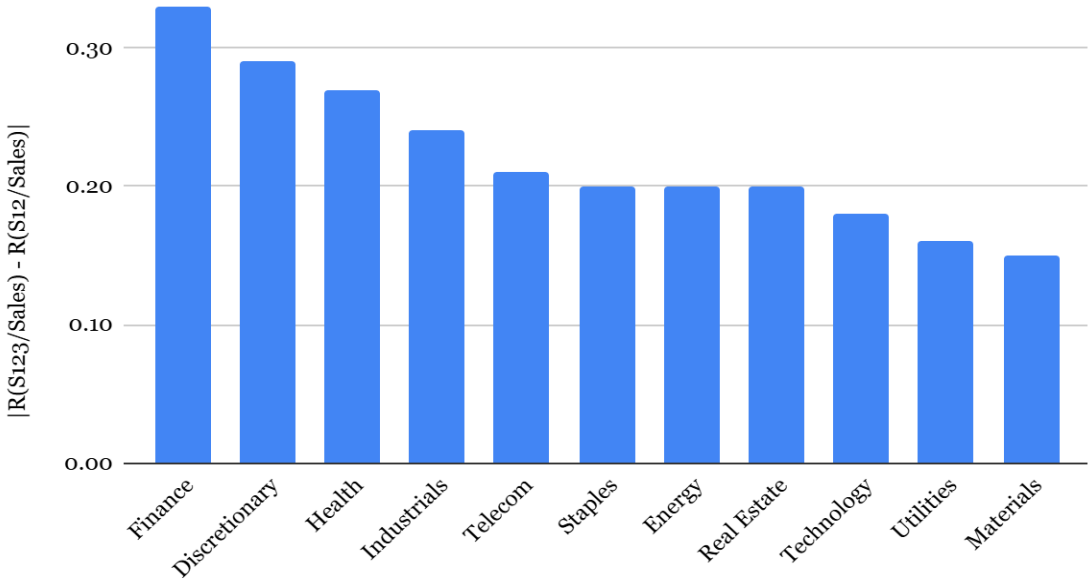
Panel A: Reshuffling in within-sector intensity ranks.



Panel B: Reshuffling and within-sector heterogeneity in S12/S123.



Panel C: Cross-sector variation in absolute reshuffling.



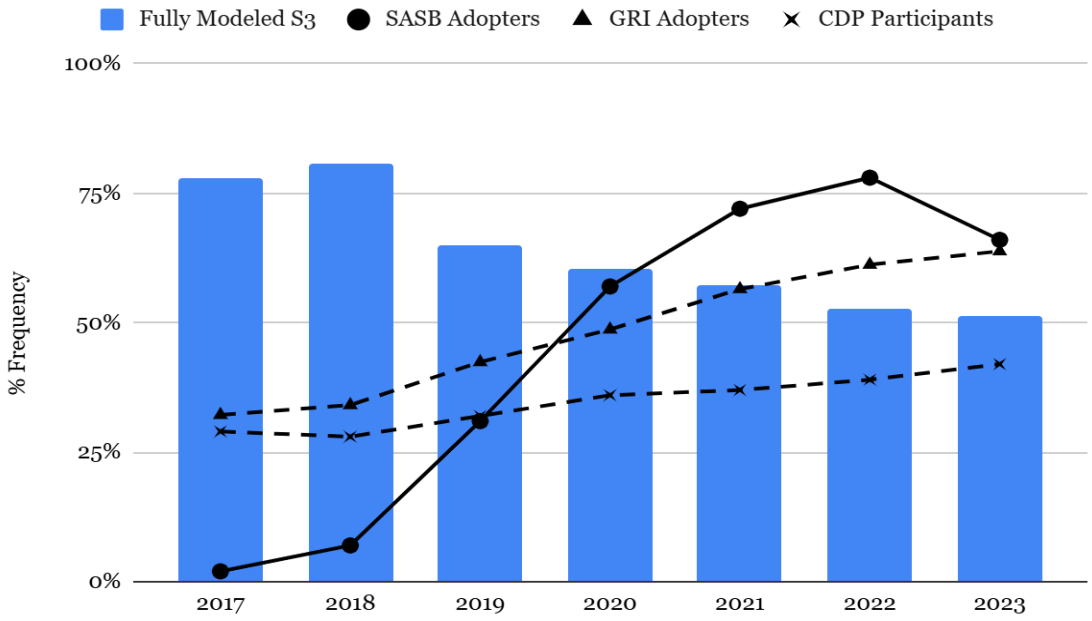
Panel D: Determinants of reshuffling.

	Dependent Variable = R(S123/Sales) − R(S12/Sales)	
	Model 1	Model 2
R(S12/S123)	-0.962***	-0.960***
	(-15.37)	(-15.80)
R(Sales)	.	0.030*
		(2.34)
R(Profit Margin)	.	-0.041*
		(-2.09)
R(Asset Turnover)	.	-0.031*
		(-2.33)
R(Leverage)	.	-0.025
		(-1.43)
R(Valuation Multiple)	.	0.022
		(1.18)
Sector FE	No	Yes
Year FE	No	Yes
Adjusted R^2	77.5%	77.6%
Observations	8,158	8,158

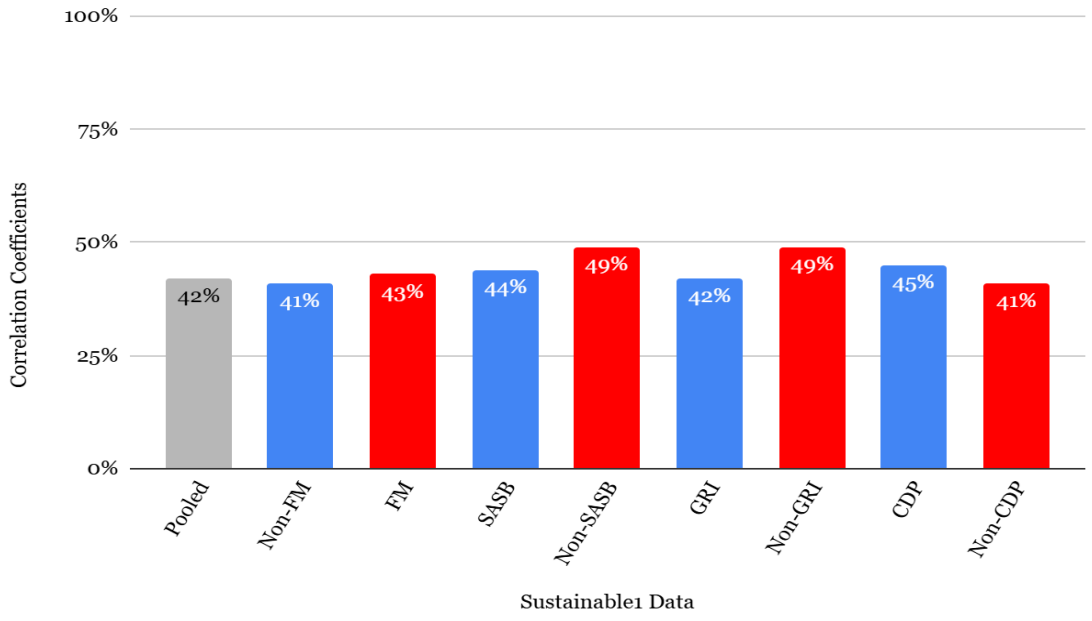
This figure shows the impact of shifting from partial carbon intensity (Scopes 1+2 per sales) to full carbon intensity (Scopes 1+2+3 per sales) for sector-peer comparisons for our sample of SB 253–eligible firms between 2017 and 2023. Panel A shows large deviations from the 45-degree line, with a Pearson correlation of 42% and an average spread of 23 percentile points between partial- and full-intensity ranks, indicating significant reshuffling. Panel B shows that this reshuffling is systematically related to firms' emissions mix (S12/S123). Panel C reports average rank spreads ranging from about 15 percentile points for Utilities to about 30 percentile points for Consumer Discretionary and Finance. Panel D reports cross-sectional regressions of the spread between full and partial intensity ranks on the share of Scopes 1 and 2 in total emissions (S12/S123), controlling for sector and year fixed effects and firm fundamentals, including percentile ranks of firm sales, profit margins (gross profits to sales), asset turnover (sales to total assets), leverage (total liabilities to total assets), and valuation multiples (market value to book value). We report t-statistics based on two-way clustered standard errors by sector and year in parentheses below the regression coefficient estimates. ***, and * denote statistical significance at the 1% and 10% levels (two-tailed), respectively.

Figure 5: Robustness to Reporting Quality and Alternative Data Providers

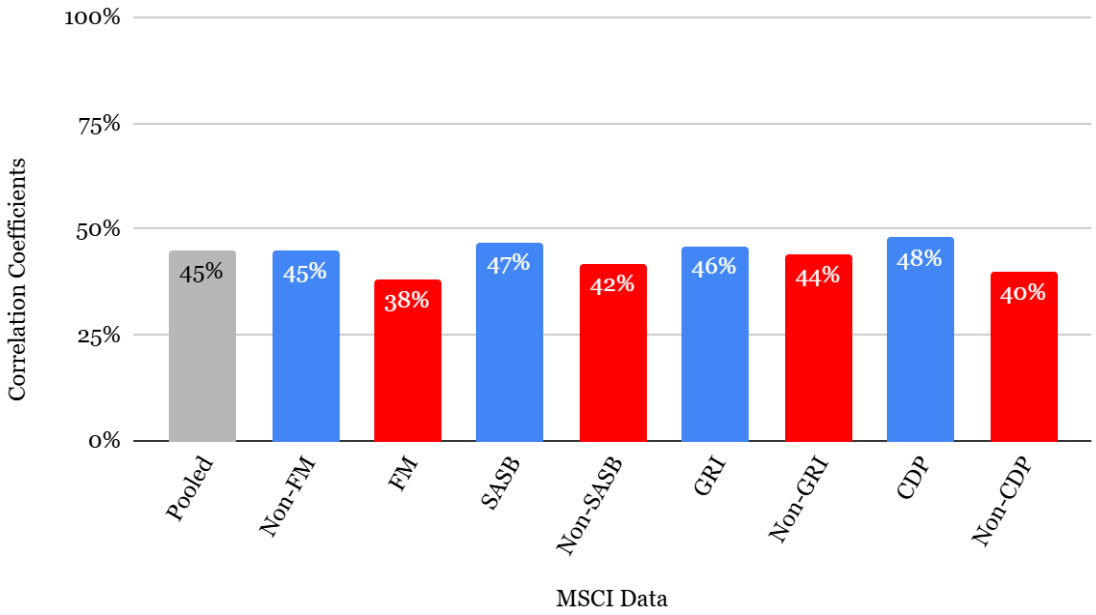
Panel A: Reporting quality indicators.



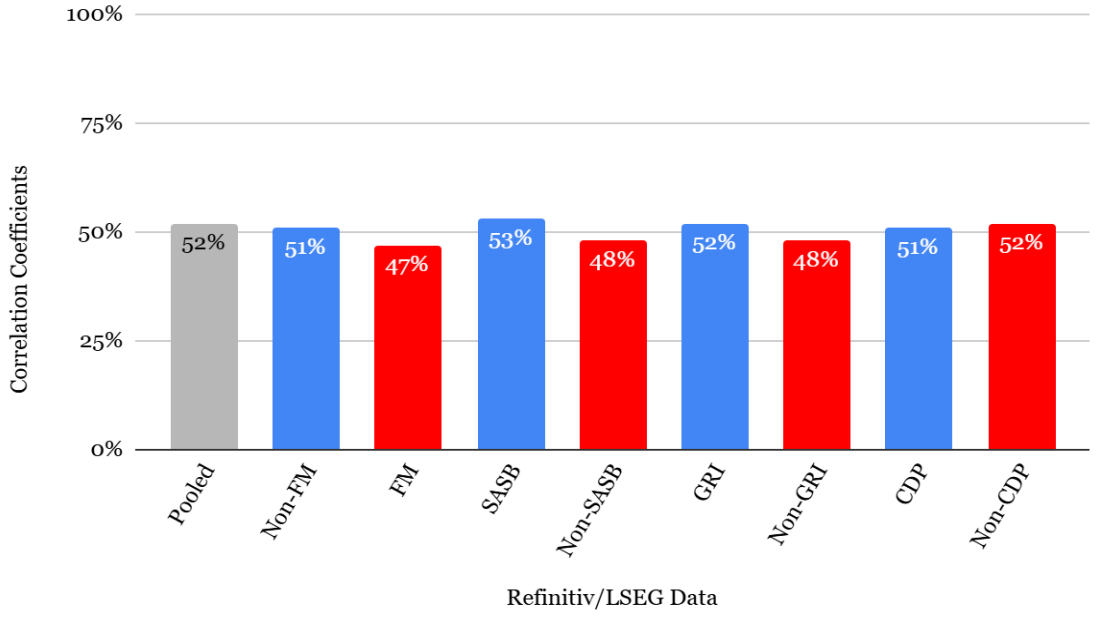
Panel B: Partial-full intensity correlation — Sustainable1.



Panel C: Partial-full intensity correlation — MSCI.



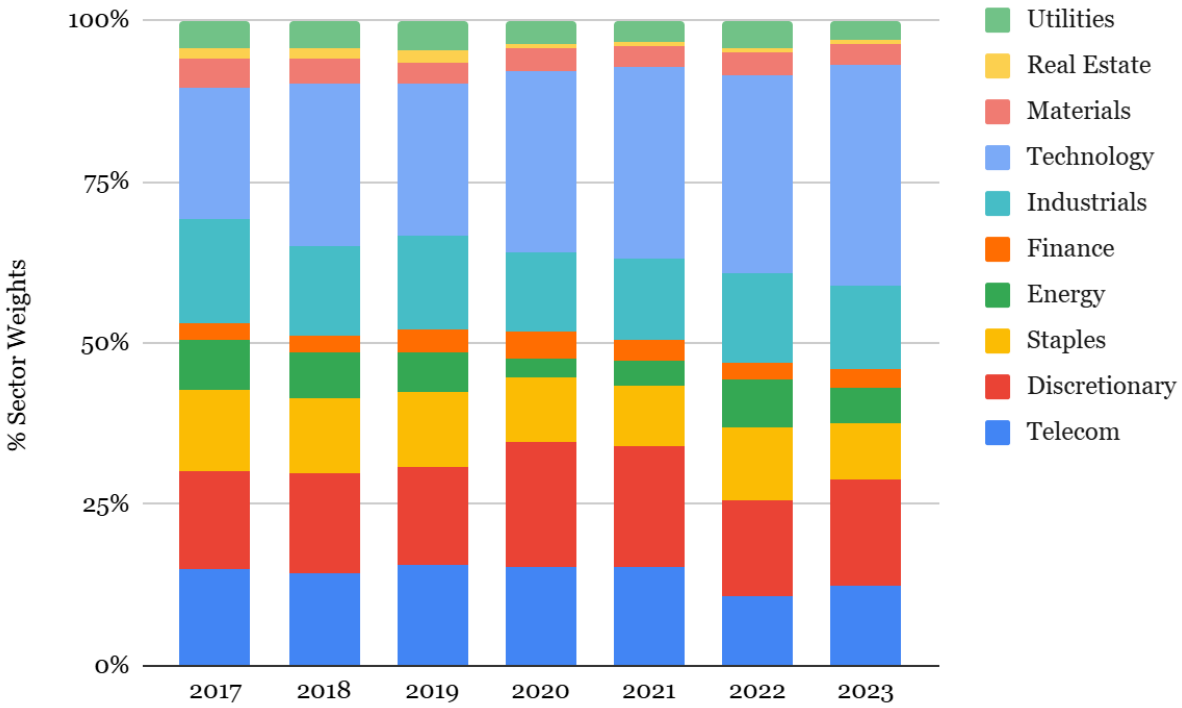
Panel D: Partial-full intensity correlation — Refinitiv/LSEG.



This figure shows robustness of the reshuffling in sector-peer rankings from partial to full carbon-intensity metrics to differences in reporting quality and emissions data providers. Panel A reports time-series variation in four reporting-quality indicators for SB 253–eligible firms: (a) FM vs. non-FM, identifying firms with fully modeled Scope 3 emissions (all Scope 3 categories vendor-estimated) versus firms disclosing at least one Scope 3 category under the GHG Protocol; (b) SASB vs. non-SASB, identifying firms reporting under Sustainability Accounting Standards Board standards; (c) GRI vs. non-GRI, identifying firms reporting under the Global Reporting Initiative framework; and (d) CDP vs. non-CDP, identifying firms responding to the CDP survey. Panel B reports the Pearson correlation between partial (S12/Sales) and full (S123/Sales) sector-peer carbon-intensity ranks across reporting-quality partitions, showing that the estimated correlation remains close to the full-sample value. Panels C and D replicate the analysis using emissions data from MSCI and Refinitiv/LSEG. Across all reporting-quality partitions and data providers, the overlap between partial and full intensity ranks remains tightly centered around a 45% correlation, indicating that the reshuffling documented in the paper reflects underlying heterogeneity in emissions composition rather than differences in reporting quality or idiosyncrasies of any single emissions data provider.

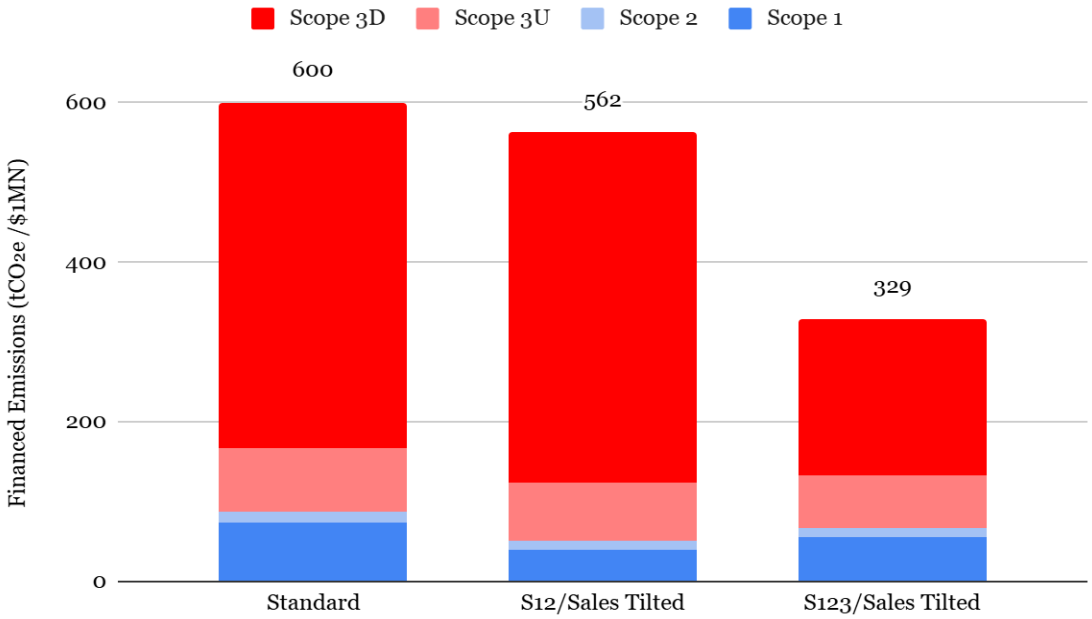
Figure 6: Partial vs. Full Carbon-Efficient Portfolios

Panel A: Sector weights.



Panel B: Financial performance.

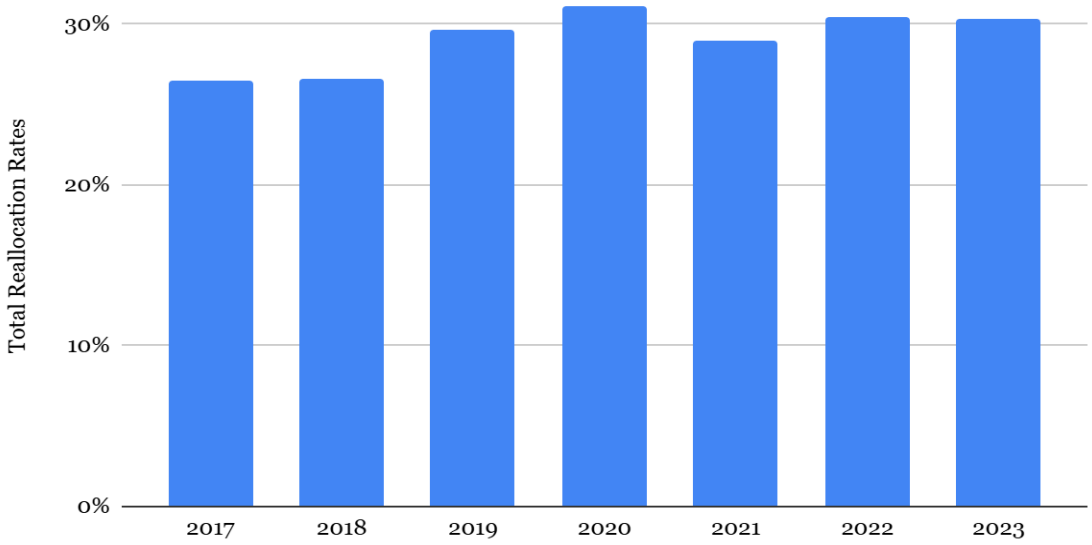
Panel C: Financed emissions (tCO_2e /$1MN).



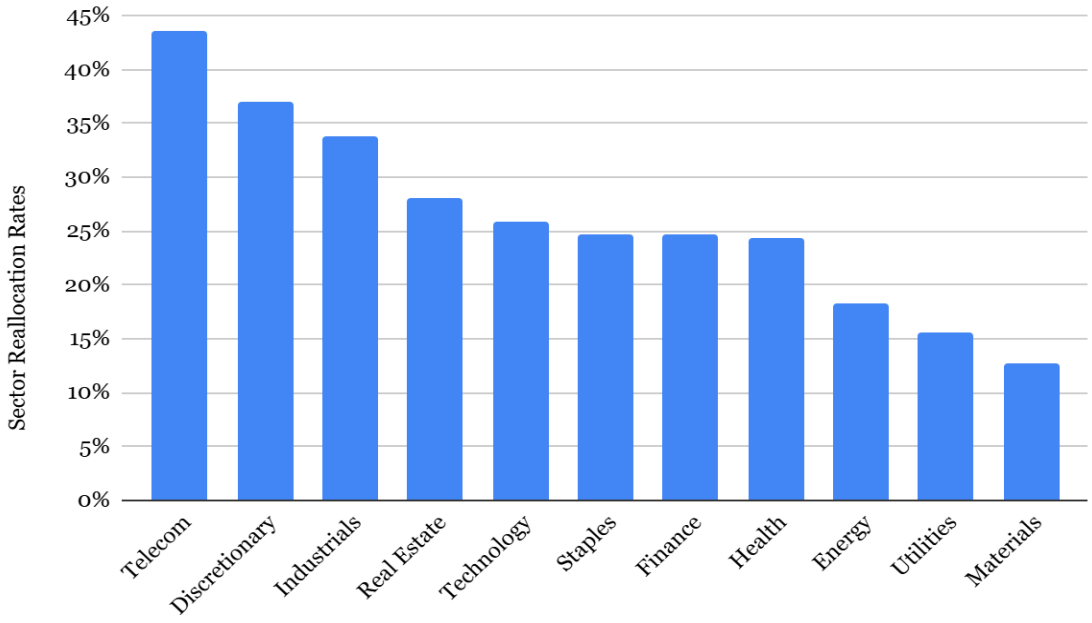
This figure shows, for our sample of SB 253–eligible firms between 2017 and 2023, the performance of standard and carbon-efficient portfolio variants. The S12/Sales-tilted portfolio reweights firms within sectors based on Scopes 1 and 2 intensity, while the S123/Sales-tilted portfolio reweights firms based on full-scope intensity including Scope 3. Panel A presents the sector weights of the standard portfolio, which are preserved in both carbon-efficient variants, with adjustments occurring only within sectors. Panel B shows that the partial- and full-intensity variants delivered returns close to the benchmark but with higher turnover, implying greater transaction costs. Panel C shows that the S12/Sales tilt reduced financed emissions by about 6%, while the S123/Sales tilt reduced financed emissions by 45%, including a 23% reduction in Scopes 1 and 2 and nearly a 50% reduction in Scope 3, driven largely by downstream emissions.

Figure 7: SB 253 Capital Reallocation Rates

Panel A: Total reallocation rates.



Panel B: Sector reallocation rates.



This figure shows, for our sample of SB 253–eligible firms between 2017 and 2023, the scale of capital reallocation implied by a shift from partial-intensity tilts (S12/Sales) to full-intensity tilts (S123/Sales). Panel A shows that the annual total reallocation rate averaged 29%, or about $290,000 traded for every $1 million invested, with all reallocations occurring within sectors. Panel B reports sector reallocation rates, ranging from 16% in Utilities to 37–44% in Consumer Discretionary and Telecom, with Technology at 26%. These results indicate that SB 253 disclosures could trigger large, systematic reallocations of capital within sectors, directing funds toward firms with stronger value-chain emissions performance.