Climate Investment Irreversibility

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Abstract

We examine the irreversibility of corporate climate investments under market and political uncertainty. In response to carbon pricing policies, firms generally increase relatively reversible investments, such as product sourcing. However, when carbon pricing is more stringent or the political environment is more stable, firms undertake more irreversible investments, such as joint ventures and research collaborations. These shifts towards irreversibility are more pronounced for high-cost decarbonization technologies and firms with shorter investment horizons. Regionally, EU firms engage in more irreversible investments during later phases of the EU Emission Trading Scheme. U.S. firms undertake more irreversible investments under the Biden Administration than the Trump Administration, but less so for projects targeted by the Inflation Reduction Act, which is subject to higher regulatory uncertainty. Finally, irreversible investments are followed by larger emission reductions. Overall, our findings highlight the importance of the broader political environment in shaping the structure of corporate climate investments in the low-carbon transition.

Keywords: climate investment, irreversibility, climate solutions, climate change, partnership

JEL classification: Q54, Q55, D81

1 Introduction

The transition to a low carbon economy requires substantial corporate investment, much of which is long-term, capital-intensive, and exposed to significant market, political, and technological uncertainty (Acemoglu et al., 2012, 2016). Firms' decisions to invest in decarbonization are taken in the context of regulatory frameworks—such as carbon pricing, renewable portfolio standards, or disclosure mandates—that alter firms' incentives to shift away from carbon-intensive technologies. Yet, when climate policies are uncertain and prone to reversal, firms may delay or forgo investment, consistent with theories of policy uncertainty and investment risk (Blyth et al., 2007; Noailly et al., 2022; Wang et al., 2026). Such frictions can significantly slow the pace of the low-carbon transition.

A central but understudied dimension of these decisions is the reversibility of corporate climate investments. Economic theory emphasizes that investment irreversibility—when sunk costs or asset specificity limit redeployment—creates an option value of waiting under uncertainty (Bernanke, 1983; Dixit and Pindyck, 1994). Reversible investments, such as supply contracts for readily available low-carbon products, allow firms to adjust flexibly as new information becomes available. By contrast, irreversible investments, such as joint ventures or research collaborations, embed long-term commitments that are costly to unwind. While irreversibility reduces flexibility, it provides benefits: it signals credible long-term commitment, fosters coordination between firms, and supports innovation by lowering the risk of hold-up problems and enabling complementary investments (Klein et al., 1978; Williamson, 1985). In the climate domain, where solutions such as offshore wind, geothermal, or carbon capture demand high upfront costs and long investment horizons, irreversible investments are important to foster meaningful progress. Different from the prior literature that largely treats irreversibility as a fixed and exogenously given characteristic of investments, we conceptualize irreversibility as a firm's strategic choice, and study how this choice for climate investments varies across regulatory and political environments. Our central hypothesis is that climate policies alone primarily encourage reversible climate investments, since firms see these policies as reversible (Biais and Landier, 2022). Only when climate policies are less uncertain, such as under stable political environments, do they reduce the option value of waiting and incentivize firms to undertake irreversible investments. We confirm our hypothesis by focusing on one of the most widely adopted climate policy types globally—carbon pricing.

We construct a novel measure of corporate climate investment irreversibility using data from FactSet Revere, which tracks global business relationships such as suppliers, joint ventures, and research collaborations. Following prior literature (e.g., Gofman et al., 2020; Adelino et al., 2022; Crosignani et al., 2023), we begin by aggregating the raw data to the unique business contract level. In case of selective disclosures (as documented by Shi et al. (ming)), where one contract is only disclosed by one party, we create a mirrored record for the other party so that all contractual relationships are recorded symmetrically between source and target firms. We then identify contracts related to decarbonization using two complementary text-based approaches based on contract keywords: (i) a lexicon method based on the climate solutions dictionary (Cheema-Fox et al., 2021), and (ii) a fine-tuned GPT classifier trained to identify keywords that pertain to climate solutions (Lu et al., 2025b). Combining these approaches mitigates their respective limitations, as the lexicon method captures simple yet relevant keywords (e.g., "recycling" or "biogas") that the GPT model may overlook, while the GPT model captures more context-dependent information not included in the dictionary. We next assign decarbonization-related contracts to specific climate solution topics, such as electric cars or onshore wind turbines. Subsequently, we categorize business relationships of research collaborator, joint venture partner, integrated product partner, and investor or investee as more irreversible investments, while supplier or customer, licensee or licensor, distributor, marketing agent, and manufacturer as more reversible investments. Finally, we aggregate the contract-level classifications to the firm-year level, which forms the basis for our empirical analyses.

Our descriptive analyses provide the first evidence on the prevalence and distribution of climate investment irreversibility. Overall, the prevalence of reversible investments for decarbonization is about twice that of irreversible investments, both increasing over time. However, compared to general corporate investments, decarbonization-related investments are more likely to be irreversible, especially when they come in the form of research and development. This pattern reflects the early-stage, collaborative nature of climate technologies, which often require joint ventures, equity stakes, or research partnerships. We also document significant heterogeneity: around the world, irreversible investments are more common in Europe, consistent with the institutional stability provided by the EU Emissions Trading Scheme (ETS). Across sectors, irreversible investments are most prevalent in construction and least in agriculture, forestry, and fishing, which are inherently more environmentally friendly. Among climate solution topics, they are concentrated in technologies that are more capital-intensive and costlier to abate, such as offshore wind and geothermal, where sunk costs and technological complexity are highest.

We then examine how political stability conditions the effect of regulation on reversible versus irreversible investments. Consistent with our expectations, carbon pricing by itself is positively associated with more climate investments overall, particularly reversible ones. However, when considered in combination with the broader political environment, we find that carbon pricing policies under high political stability are significantly positively associated with more irreversible climate investments, both at the extensive and intensive margin. In other words, regulation alone primarily induces reversible commitments. However, when said regulation is less prone to future reversals, it enables firms to engage more deeply in irreversible, long-horizon climate solutions.

This highlights how regulatory credibility can reduce the option value of waiting, thus making long-term corporate commitments to decarbonization more attractive.

Next, we conduct cross-sectional analyses to explore how this relationship varies across contexts. First, we consider the cost intensity of climate solution technologies. We find that the positive interaction effect between carbon pricing and political stability is larger for irreversible investments in high-cost technologies, such as offshore wind and geothermal, where the risks of long-horizon commitments are greatest. This result is consistent with the view that without political stability, firms would avoid investing in such capital-intensive solutions altogether. Second, we analyze firms' investment horizons proxied by the average duration of assets in place. Firms with shorter long-term asset duration are more responsive to the interaction of carbon pricing and political stability, as their short-term horizons make them more sensitive to climate policy reversals. By contrast, firms with longer-lived capital assets show similar patterns of reversible and irreversible investments, reflecting their need to plan for long-term regulation, regardless of political volatility.

Next, we exploit regional variation to illustrate and validate our measure. In the United States, we observe that irreversibility patterns track presidential cycles and the credibility of climate legislation such as the Inflation Reduction Act. Lastly, we directly validate our climate investment measure by examining changes in emissions intensity after the first decarbonization investment. We find that emissions intensity declines for both investment types, with a larger drop following irreversible than reversible investments.

Taken together, our paper makes three main contributions. First, we contribute to the economics literature on investment under uncertainty and irreversibility. Classic work highlights how irreversible investments create an option value of waiting (Bernanke, 1983; Dixit and Pindyck, 1994; Arrow and Fisher, 1974). Empirical studies demonstrate how uncertainty depresses investment, particularly in capital-intensive settings (Bloom et al., 2007; Gulen and Ion, 2016). We extend this line of inquiry by developing a novel firm-level measure of irreversibility, showing that climate-related investments are systematically more irreversible than other corporate investments, and linking this variation to political and regulatory contexts.

Second, we contribute to the literature on corporate climate and sustainability strategy in finance and accounting. Much of this literature has focused on climate risks, such as how high-emission firms manage exposure to transition or physical risks (e.g., Bolton and Kacperczyk, 2021, 2023). We complement this risk perspective by focusing on climate opportunities, analyzing how firms invest in emerging decarbonization technologies. In doing so, we build on the growing literature on climate solutions that document the increasing engagement of firms in climate-related opportunities (Lu et al., 2025b,a). We add to this line of work by emphasizing the role of policy stability and the irreversibility of investment commitments.

Third, we contribute to the literature on organizational economics and innovation. Research on asset specificity and hold-up problems (Klein et al., 1978; Williamson, 1985) and on directed technical change (Acemoglu et al., 2012, 2016) emphasizes the role of long-term commitments and complementarities in driving innovation. We show that irreversible investments in climate solutions function as credible commitments that stabilize firm strategies and may generate positive externalities, including supply chain coordination and peer spillovers within industries. By documenting where irreversibility arises and how it interacts with regulation and political stability, our study provides new insight into how firms' structural choices shape the resilience of the global climate transition.

2 Literature Review and Conceptual Underpinnings

A well-established literature in economics examines the relationship between policy uncertainty and corporate investment. The general consensus is that when faced with uncertainty about future regulation or policy design, firms often postpone or reduce investment until more information becomes available, consistent with the option value of waiting (Bernanke, 1983; Dixit and Pindyck, 1994). Importantly, this effect is not uniform across all types of investments. Gulen and Ion (2016) show that the negative effect of policy uncertainty is stronger along two dimensions: for investments that are irreversible, and for firms whose operations are more directly dependent on policy. Applying this theory to the environmental setting, Viscusi (1983) shows that when clean technology investments are irreversible, uncertainty over future environmental regulation induces firms to delay action or underinvest.

Climate transition depends on public policies, which also makes policy uncertainty play a larger role in climate investment. Economic theory highlights that climate change creates a double externality problem: in addition to the environmental externality from greenhouse gas emissions, there is an innovation externality that leads firms to underinvest in clean technologies (Jaffe et al., 2005; Acemoglu et al., 2012, 2016). Addressing the environmental externality requires carbon pricing to internalize the cost of pollution (Pigou, 1920; Nordhaus, 2007), where the literature focus on studying the effectiveness of carbon pricing regulations like the EU ETS (Calel and Dechezleprêtre, 2016; Colmer et al., 2025). Addressing the innovation externality requires complementary policies that directly incentivize research, development, and deployment of clean technologies. Hence, consistent with the effectiveness of these instruments shaped by the stability of policy frameworks, prior research documents that firms scale back or delay decarbonization projects when climate policy uncertainty is high (Blyth et al., 2007; Noailly et al., 2022). More broadly, firms also reduce environmental research and development investments under more uncertain environmental policies (Wang et al., 2026).

In this paper, we add to the literature on climate transition by studying a novel aspect: the reversibility of climate investments. Irreversible investments, such as joint ventures in renewable energy infrastructure or research collaboration in battery technology, play a critical role in decarbonization. These investments not only commit resources but also generate knowledge spillovers, create supply chain stability, and catalyze complementary investments across the broader economy. However, because these investments are less reversible, they are especially sensitive to the stability of climate policies. If carbon policies are expected to be temporary or subject to political reversal, firms may prefer reversible commitments, such as short-term supply contracts, for more flexibility. Our main hypothesis is that the interaction between climate policies and political stability is central to understanding whether firms are incentivized to commit to irreversible investments necessary to achieve meaningful decarbonization. To this end, we focus on one of the most prevalent climate policy types around the world—carbon pricing, and expect it to encourage irreversible climate investments only when accompanied by higher policy certainty.

Our view of irreversibility extends prior economic literature on investment response and political stability. Existing research has largely treated irreversibility as a fixed characteristic of investments, emphasizing that irreversible commitments are more vulnerable to policy uncertainty (Viscusi, 1983; Gulen and Ion, 2016). We adopt a different perspective: we view reversibility as a strategic choice that firms make. In other words, instead of assuming that reversible and irreversible investments are exogenously given, we ask whether firms choose to engage in more reversible or more irreversible climate investments in response to carbon pricing, conditional on the level of policy uncertainty. For instance, when sourcing batteries for electric vehicles, firms can either rely on supplier contracts for readily available products, which are more reversible, or commit to research collaborations and joint ventures to co-develop innovative technologies, which involve longer-term, more irreversible commitments.

3 Data and Sample

Our empirical analysis mainly sources data from FactSet Revere for business relationships, Compustat for firm financial performance, and government websites or public databases for country-level information. We also obtain corporate environmental scores from LSEG Refinitiv and carbon emission data from Trucost.

We use the Revere database to construct a novel measure of the reversibility of firms' climate investments. FactSet Revere data compiles global firm-to-firm relationships from company disclosures, regulatory filings, press releases, and other public sources. The database covers a wide range of contracting types, including suppliers, customers, joint ventures, equity investments, and research collaborations, and spans firms across all major regions and industries.

To measure climate policy, we focus on carbon pricing regulations outside of the European Union Emissions Trading System (EU ETS). We exclude the EU ETS as our primary setting because it offers limited cross-country variation, although we return to it in robustness tests in Section 6. To identify global carbon pricing regulations, we rely on the World Bank Carbon Pricing Dashboard, which provides information on the status, year of implementation, and carbon price (in USD) for all carbon pricing initiatives. We retain only those regulations that have already been implemented, and we restrict the sample to national-level policies. For countries with multiple overlapping initiatives, we keep the earliest national-level implementation. Following these steps, we identify 39 countries with implemented carbon pricing, which we classify into high- versus low-price regimes based on the median carbon price across countries.

To measure the stability of regulatory environment, we collect the cross-country time-series

Political Stability index from the World Bank Worldwide Governance Indicators database. The Political Stability index reflects the likelihood that the national government will be destabilized or overthrown, based on multiple information sources including the Economist Intelligence Unit, the World Economic Forum, and the Political Risk Services. For reference, in 2023, the Political Stability index is the highest in Liechtenstein (1.61, rank 1st) and lowest in Syria (-2.75, rank 193rd), with the United States in the middle (0.03, rank 95th).

Our sample construction process is summarized in Table 1 Panel A. Based on the raw data from FactSet Revere, we first drop records of competitor relationships since they are not contractual relationships reflecting corporate investments, and records of legacy relationship types that are no longer updated by FactSet, such as technology provision and non-identifiable relationships. Since we require GVKEY to merge the business relationships data with financial data from Compustat, We then drop records with missing GVKEY for contract source or target firms, leaving us with 993,500 contracts, and 3,244,191 contract-year observations. Since the same contract may be disclosed more than once by the source and target firms, and repeatedly disclosed in consecutive years, we follow (Gofman et al., 2020; Adelino et al., 2022; Crosignani et al., 2023) to further clean the data as follows. We first remove duplicate records, including contracts reported by both the source and target firms, as well as redundant records from repetitive disclosures, to make sure each observation identifies a unique contract of a target-source firm pair by year. For each unique contract, we ensure keywords disclosed across time are fully captured. Subsequently, in case of selective disclosures where a contract is disclosed by only one party as documented by (Shi et al., ming), we create a mirrored record so that all contractual relationships are recorded symmetrically between source and target firms. This consolidation produces a unique set of 5,617,675 contract-year observations, leading to 415,817 unique source firm-year observations. We further merge this sample with Compustat based on GVKEY to collect firm financial data. After dropping firms not covered by Compustat and observations with unavailable data for regression variables, our final sample arrives at 212,630 source firm-year observations.

4 Climate Investment Irreversibility Measurement and Descriptive Statistics

To classify contracts related to decarbonization, we adopt a two-step procedure using keywords search. In the first step, we use two complementary keyword-based approaches. The first is a lexicon approach that applies the climate solutions dictionary developed by Cheema-Fox et al. (2021). The second is a fine-tuned GPT classifier that determines whether a contract relates to climate solutions (Lu et al., 2025b). Combining these two approaches mitigates their respective limitations: while GPT is better suited to recognize contextual references when specific keywords related to climate solutions are not explicitly mentioned, the lexicon approach ensures that simple but relevant keywords such as "recycling" or "biogas" are not missed.

In the second step, we assign contracts identified as related to decarbonization to specific climate solution topics. Using the fine-tuned GPT model, we map each contract to one of 88 climate solution categories defined by Project Drawdown. When the classifier indicates that a contract is not climate-related, we manually verify and exclude it. For cases that are generic (e.g., references to "sustainability" without a clear technology focus), we classify them into an "other" category. This process yields a comprehensive and robust set of decarbonization contracts that captures both specific technologies and more general sustainability activities.

Lastly, we identify more irreversible contracts as business relationships of the following types: research collaborator, joint venture partner, integrated product partner, and investor or investee. More reversible contracts are business relationships disclosed as supplier or customer, licensee or licensor, distributor, marketing agent, and manufacturer.

Figure 1 Panel A presents the distribution of contract relationship types, comparing overall contracts to those related to decarbonization. Similar as general contracts, decarbonization contracts are less likely to appear in irreversible forms and are more concentrated in supplier relationships. Table 1 Panel B confirms this pattern: while 22% of all contracts are classified as irreversible, 27% of decarbonization contracts fall into this category. However, decarbonization contracts are more likely to be irreversible compared to general contracts, especially in the form of research and development (21% for decarb vs 7% for the overall sample), reflecting many decarbonization projects are in early-stage developments.

Summary statistics for regression variables are presented in Table 2 Panel A. On average, firms have approximately 11 contracts per year, among which 0.27 is related to decarbonization, with 0.09 being irreversible and 0.19 being reversible. 8% firm-year observations in the sample have at least one decarbonization contract, among which 3% of them have at least one irreversible decarbonization contract and 7% have at least one reversible decarbonization contract. Previous studies examining business relationships from FactSet Revere on a global scale typically focus on suppliers and customers (Wang et al., 2020; Dai et al., 2021; Pankratz and Schiller, 2024), whereas we examine a broader set of business relationships. Compare to these studies, firms in our sample are generally smaller but growing faster, with lower profitability as measured by return on assets (ROA). Around 15% of the sample are in countries with effective carbon pricing policies.

Table 2 further present the average statistics of decarbonization contracts by year (Panel B) and industry (Panel C). Over time, we observe that the number of firms with decarbonization contracts substantially increases from 1.7% in 2008 to 11% in 2024, with more firms investing reversible contracts compared to irreversible contracts across years. Consistently, firms on average adopt more decarbonization contracts, from 0.02 in 2008 to 0.4 in 2024, with more reversible than irreversible contracts. The prevalence of decarbonization contracts varies across industries. Transportation and utilities industries have the highest adoption rate for decarbonization contracts, with almost 15% of firms having at least one decarbonization contract, and on average about 0.5 decarbonization contracts per year. In contrast, agriculture, forestry, and fishing industries have the fewest firms investing in decarbonization contracts (1%), with on average 0.1 decarbonization contracts per firm and year. Construction firms have the highest tendency to opt for irreversibility contracts for decarbonization (44%, 0.025 scaled by 0.057), whereas agriculture, forestry, and fishing firms have the least favour for irreversible contracts to decarbonize their business (20%, 0.002 scaled by 0.010). This pattern is intuitive as agriculture, forestry, and fishing firms by nature are more environmentally friendly hence may have the incentives to decarbonize, whereas heavy industries such as transportation, utilities, and construction have more pressure and also more opportunities to engage in climate investments, given the heightened public scrutiny and technology advancement.

Decarbonization contracts are not distributed evenly around the world. Figure 1 Panel B shows regional variation by continents. Decarbonization contracts are more concentrated in Europe, with 26% of decarbonization contracts involving European firms compared to 17% of overall contracts. In contrast, Asia accounts for 48% of overall contracts but only 40% of decarbonization contracts. This pattern is consistent with the larger emphasis on decarbonization in Europe. A more specific breakdown focusing on decarbonization contracts is shown in Table 2 Panel D. Spain ranks the top for decarbonization contract prevalence with 23% firms with at least one decarbonization contract, among which 10% with irreversible ones. In terms of investment intensity, Danish firms on average invest in the most decarbonization contracts at 1.5 per year, while French firms have the most irreversible decarbonization contracts at 0.33 per year. In contrast, Asian countries are lagging in climate investments.

Next, we explore whether irreversible and reversible contracts are options both available to firms such that it is not an investment characteristic given. Figure 2 plots the number of firms with reversible and irreversible decarb contracts, as well as the prior year stats in a 2X2 matrix. Two observations emerge. One is that firms with both reversible and irreversible contracts exist, suggesting these are not mutually exclusive. Second, firms do move between categories over time, switching from reversible to irreversible contracts or vice versa. These descriptive data is consistent with our view that reversibility is not an exogenous characteristic of investments but rather a choice firms make. For example, within airlines, Delta has relied on supplier relationships to procure SAF, whereas Korean Air has engaged in research collaboration partnerships, illustrating how different firms adopt different contractual modes to access the same technology.

Figure 3 presents the distribution of decarbonization contracts by technology topic. Panel A reports the total number of contracts, separated into reversible and irreversible types. The topics with the largest absolute number of irreversible contracts are renewable energy, distributed energy storage, and offshore wind turbines, reflecting areas where firms are making sizable commitments to emerging infrastructure. Panel B ranks topics by the share of irreversible contracts relative to the total number of contracts within each topic. The highest ratios are observed in building retrofitting, sustainable aviation fuel (SAF), and ocean power. These technologies are among the most costly and capital-intensive: for example, SAF remains two to five times more expensive than conventional jet fuel (O'Malley et al., 2023). In contrast, the topics with the lowest share of irreversible contracts are distributed solar and onshore wind turbines, both of which are more mature renewable technologies that have experienced significant cost declines in recent years (Nijsse et al., 2023).

To further examine the factors associated with the irreversibility of climate investment topics, Figure 4 ranks topics based on two additional characteristics. Panel A orders topics by cost per ton of abatement. With a few exceptions, topics that are more expensive per unit of abatement also exhibit higher ratios of irreversible contracts. For example, sustainable aviation fuel (SAF) and offshore wind turbines fall into the high-cost, high-irreversibility category. The main exceptions are electric and hybrid vehicles, which remain relatively costly but are associated with only moderate levels of irreversibility. Panel B ranks topics by prevalence, measured by the average frequency of mentions in firms' 10-K Item 1 disclosures using data from Lu et al. (2025b). This pattern is consistent with vehicle-related topics having lower irreversibility ratios, where greater prevalence makes reversible relationships, such as suppliers, more likely to be available. In contrast, topics with high irreversibility ratios tend to be those that are less commonly mentioned in 10-K Item 1, such as SAF and offshore wind turbines, with the notable exception of nuclear power, which combines high prevalence with high irreversibility.

Before proceeding with regression analysis, we present univariate correlations among main variables in Table 3. Both the indicator of having at least one decarbonization contract ($\mathbb{1}Decarb$) and the number of decarbonization contracts (*#Decarb*) are positively correlated with the adoption of carbon pricing policies, political stability, with the correlation being higher for irreversible contracts compared to reversible contracts. This result provides preliminary evidence consistent with our expectation that climate policies and stability of the regulatory environment matter for corporate climate investments, especially for more irreversible investments. Firms with higher carbon emission intensity tend to adopt more decarbonization contracts, and receive higher LSEG Refinitiv environmental ratings, which assess both the exposure to and management of environmental risks. Firms are more likely to engage in climate contracts when the contractual item is less costly to execute, but less likely when they have longer investment horizon.

5 Climate Investment Irreversibility and Political Stability

This section presents the main results of our paper. We begin by testing the relationship between carbon pricing policies and firms' reversible and irreversible decarbonization investments. We then examine how political stability shapes this relationship differently for reversible and irreversible decarbonization investments.

5.1 Main Results

We examine how climate regulations provide incentives for firms to invest in reversible and irreversible forms of decarbonization differently. Specifically, climate policies are the outcome of the political process and are subject to reversal, revision, and scaling back in the short to medium term. Therefore, given the large costs associated with unwinding irreversible decarbonization investments, policy changes alone may incentivize primarily reversible investments, as firms may anticipate the future unwinding of these policies. To make it attractive for firms to invest in irreversible projects, climate policy should be linked to a politically stable environment. We start our empirical analysis by running the linear regression 1 below.

$$\textit{Decarbonization Investment}_{i,t} = \beta_1 \textit{Carbon Price}_{i,t} + \mathbf{\Gamma_{i,t}} + \delta_t + \phi_i + \epsilon_{i,t} \quad (1)$$

The main coefficient of interest, β_1, captures the correlation between the exposure to a carbon pricing policy of firm i during year t. The dependent variable, *Decarbonization Investment*$_{i,t}$, captures supply-chain relationships that are related to decarbonization (*Decarb*). We present specifications with total investments, irreversible investments, and reversible investments. $\mathbf{\Gamma_{i,t}}$ is a vector of firm-level controls that could affect the propensity of firms to start decarbonization relationships. These include Size, R&D and Capex Intensity, Leverage, ROA, Tobin's Q, Sales Growth, as well as the Environmental score and emission intensity (provided by Refinitiv), and the logarithm of the GDP of the country where the source firm is headquartered.[1] δ_t and ϕ_i are, respectively, year and firm fixed effects. $\epsilon_{i,t}$ is the standard error, clustered at the firm level. Table 4 shows the results. The

[1]We define two additional indicators for firms where Environmental scores and/or emission intensity are missing. In these cases, we set the continuous variables to zero.

first three columns look at the extensive margin, while the last three columns look at the intensive margin.

Column 1 of Panel A shows that the probability of having business relationships that target decarbonization investments is 4.5% higher for firms exposed to carbon pricing policies. The magnitude is economically meaningful, especially when compared to the unconditional average of 8% of firm-years where there is any decarbonization-related business relationships. When examining the irreversible and reversible relationships separately in columns 2 and 3, the increase is almost twice as large for reversible relationships (4.2%) than for irreversible investments (2.3%). The increase relative to the unconditional probability of having reversible (19%) or irreversible investments (9%) is similar because the mean is also lower for irreversible investments. Nonetheless, this result implies that, both at baseline and when subject to carbon pricing, firms consistently engage less in irreversible decarbonization investments. We find similar patterns when studying the intensive margins in columns 4 to 6. Firms exposed to carbon pricing policies have, on average, 0.31 more decarbonization-related business relationships than other firms. This is again an economically meaningful increase from the unconditional average of 0.27.

In Panel B, we separately examine firms with exposure to high and low carbon prices (split along the median carbon price). Column 1 shows that the overall propensity to engage in decarbonization-related business relationships is similar for these two groups of firms. However, firms from countries with high carbon prices in place are three times more likely to engage in irreversible decarbonization relationships compared to firms facing low carbon prices (the difference between the two coefficients is statistically significant, $p = 0.012$). There is a similar difference in the intensive margin (columns 4 to 6). Firms operating in high (low) carbon price environments have about 0.22 (0.07) more irreversible relationships than firms facing no carbon prices (the difference between the two coefficients is statistically significant, $p = 0.052$). We also find a directionally similar but smaller increase in the number of reversible contracts.

Overall, these findings suggest that carbon pricing incentivizes firms to invest in decarbonization-related relationships. However, only particularly stringent policies incentivize firms to invest in long-term, irreversible relationships.

Next, we ask if climate policy matters most in contexts where the political environment is stable. It is in such contexts that one would expect firms facing stringent climate policies to be most willing to commit to long-term, irreversible business relationships, given that the probability of policy reversals is relatively small. We test for this by interacting *Carbon Price* with an indicator for firms operating in politically stable environments.

To proxy for political stability, we use the political stability score from Worldwide Governance Indicators, which reflects the likelihood of government destablization. We define *High Political Stability* as an indicator for firms from above-median countries in terms of political stability.

Table 5 shows the results. Consistent with the baseline findings, we find that firms domiciled in countries that have installed carbon pricing are more likely to start decarbonization-related business relationships, irrespective of whether the country is politically stable or not. However, once we focus on irreversible relationships in column 2, we see that the positive effect of *Carbon Price* is almost three times larger in countries with high political stability. We draw similar inferences from the intensive margin. While there is a positive interaction effect for the overall sample, the effect is mainly driven by irreversible relationships. Among firms exposed to carbon prices, those from politically stable countries experience a tenfold increase in the number of irreversible decarbonization-related relationships relative to those from politically less stable countries. For the latter group, being exposed to climate pricing policies yields an economically marginal effect relative to the benchmark firms that are not exposed to such policies.

5.2 Cross Sectional Analyses

In this subsection, we examine two sources of heterogeneity in the observed relationship: cost intensity of climate solution technologies, and the investment horizon of firms.

Our first cross-sectional analysis splits contracts based on how costly the relevant technology is. Given that reversing investments in high-cost technologies will be especially expensive, we expect political stability to matter most for these types of contracts. We separate climate solution topics into two groups, *High cost* and *Low cost*, based on whether the cost per abatement for the climate solutions technology is above or below the median, using data from Project Drawdown (Project Drawdown, 2020). We then construct business relationship measures separately for climate solution topics classified as *High cost* and *Low cost*.

Table 6 shows the results, separately for contracts with *High cost* climate solutions (Panel A) and *Low cost* climate solutions (Panel B). Consistent with our expectations, the positive effect of carbon pricing under political stability on firms' propensity to engage in irreversible decarbonization relationships is stronger for more expensive technologies. The magnitude among high cost technologies (0.018) is around twice that of low cost technologies (0.008).

Second, we examine how the investment horizon of firms shapes their reliance on reversible versus irreversible contracts. This test distinguishes our approach from prior literature, which often uses longer investment horizons as a proxy for irreversibility. In contrast, we allow that firms, regardless of their horizon, can choose both reversible and irreversible contract types. The key difference is that for firms with long investment horizons, even reversible contracts may be more costly to unwind because production planning and input commitments extend further into the future. As a result, we expect outcomes to converge across reversible and irreversible contracts in this group. By contrast, among firms with short investment horizons, reversible and irreversible contracts remain more distinct, and we expect stronger differences in how they respond to policy uncertainty. We proxy for investment horizon using the duration of property, plant, and equipment (PPE), calculated as gross PPE divided by depreciation expense.

Table 7 partitions the sample into those with above-median (Panel A) and below-median PPE duration (Panel B). Consistent with our expectations, we find that for firms with long PPE duration, the interaction between carbon pricing and political stability is positive and significant for both irreversible and reversible contracts. In contrast, for firms with short PPE duration, only the effect for irreversible contracts is statistically significant, aligning with the interpretation that firms with shorter investment horizons are more sensitive to the political environment in making their commitment to irreversible projects.

6 Regional Variations in Regulatory Environment

In this section, we exploit regional variations to illustrate and validate our measure for climate investment irreversibility. We study (1) the presidential terms and the Inflation Reduction Act (IRA) in the U.S., and (2) phases of the Emissions Trading Scheme in the European Union (EU ETS). Across settings, we compare extensive (the existence of contracts) and intensive (the quantity of contracts) margins for total, irreversible, and reversible climate investments.

6.1 Within the United States

First, we examine whether firms' decarbonization investments vary across U.S. presidential administrations. Our sample covers three full presidential terms: Obama (2009–2016), Trump (2017–2020), and Biden (2021–2024). Therefore, we treat the pre-2017 years as the benchmark period, and examine how firms vary their climate investments in the subsequent Trump and Biden periods. Given the stronger federal support for decarbonization under the Biden administration, including the stated net-zero goals and the establishment of the IRA, we expect both higher climate investments overall and a comparably larger response in irreversible investments during the Biden years. Effects under the (first) Trump administration are ex-ante unclear, given the rising concerns for climate change during this period, despite the unsupportive policy environment. We test these hypotheses empirically by estimating the following model using the sample of U.S. firms.

$$\begin{aligned} \textit{Decarbonization Investment}_{i,t} = \beta_1 \textit{Trump Administration}_t + \beta_2 \textit{Biden Administration}_t + \\ + \mathbf{\Gamma_{i,t}} + \phi_i + \epsilon_{i,t} \end{aligned} \tag{2}$$

Decarbonization Investment$_{i,t}$ captures the decarbonization investments of firm i in year t (these are either indicators or counts for total, irreversible, or reversible investments, respectively). *Trump Administration*$_t$ is an indicator for the years 2017 to 2020, and *Biden Administration*$_t$ is an indicator for the years 2021 to 2024. $\mathbf{\Gamma_{i,t}}$ are the same control variables as previously specified. Since we focus only on U.S. firms, we include only firm fixed effects (ϕ_i) but not year fixed effects, which would otherwise subsume the main variables of interest that only vary by year. $\epsilon_{i,t}$ are standard errors clustered by firm.

Results are tabulated in Panel A of Table 8. On the extensive margin (columns 1 to 3), both administrations are associated with higher probabilities of engaging in either type of decarbonization contracts, but magnitudes are significantly larger under the Biden administration. The results on the intensive margin are more interesting (columns 4 to 6). Only the Biden period shows an uptick in the quantity of climate investments, and that intensification is statistically significant in irreversible projects. The coefficient on *Biden Administration* for the number of irreversible climate contracts is 0.068 ($p < 0.01$), whereas it is not statistically significant for the number of total or reversible climate contracts. Trump-period extensive margin coefficients are statistically insignificant across the board.

These results are consistent with our conjecture and suggest that firms invest more, especially on the intensive margin, in irreversible climate projects during the administration with a more supportive decarbonization environment.

Next, we examine the IRA as a policy intervention that provides subsidies to climate technologies that otherwise would be too costly to implement. As suggested by (Viscusi, 1983), firms could be more cautious about initiating irreversible investments compared to reversible investments in the face of environmental policy uncertainty, given that irreversible investments tend to be more capital-intensive and require a longer commitment horizon. As the political environment for decarbonization remains uncertain in the U.S. and the IRA is subject to reversal, we expect this government subsidy to incentivize firms to invest in more reversible projects for targeted technologies such as clean hydrogen and carbon storage. To examine this, we further categorize climate investments based on whether the topics are targeted by the IRA, and estimate the following model for U.S. firms.

$$\textit{Decarbonization Investment}_{i,t} = \beta_1 \textit{IRA}_t + \mathbf{\Gamma_{i,t}} + \phi_i + \epsilon_{i,t} \tag{3}$$

IRA is an indicator for years since 2022, when IRA was introduced. The benchmark period comprises the period up to 2021. The dependent variable, controls, and fixed effects are the same as in the previous specification 2.

Panel B of Table 8 presents results on climate investments with IRA-targeted topics, while Panel C focuses on non-targeted topics. Consistent with our expectation, although firms indeed invest in more projects targeted by IRA, they engage in more reversible projects relative to irreversible ones, both on an extensive and intensive margin, with the difference between reversible and irreversible projects being statistically significant. By contrast, for topics not targeted by IRA (shown in Panel C), we observe similar increase for irreversible contracts and reversible contracts.

6.2 Within the European Union

Next, we explore how the irreversibility of climate investment co-moves with the different phases of the European Union Emission Trading Scheme (EU ETS).

Launched in 2005, the EU ETS established the world's first and, to date, largest carbon market. It operates based on a "cap-and-trade" principle and requires firms to monitor and report their carbon emissions. Since 2005, the EU ETS has operated through four phases, each with increasing stringency and decreasing caps, to align with the EU's climate targets. Phase I (2005-2007) was the pilot period with free allocation of allowances, while Phase II (2008-2012) reduced the caps to align with the Kyoto Protocol and reduced the proportion of free allocated allowances. Phase III (2013-2020) replaced free allocation with auctioning as the default method to allocate allowances and included more sectors. Phase IV, which started in 2021, further tightened the caps and mobilized more resources to support decarbonization, such as through the Market Stability Reserve, the Innovation Fund, and the Modernization Fund. As the increasing stringency of the EU ETS creates a stable policy environment for decarbonization, we expect firms to engage in more climate investments during the later phases, particularly in irreversible climate investments. To this end, we estimate the following model to examine changes in corporate climate investments during the latest three EU ETS phases covered by our sample period for EU firms.

$$\begin{aligned} \textit{Decarbonization Investment}_{i,t} = \beta_0 &+ \beta_1 \textit{EU ETS Phase 2}_{i,t} + \beta_2 \textit{EU ETS Phase 3}_{i,t} \\ &+ \beta_3 \textit{EU ETS Phase 4}_{i,t} + \mathbf{\Gamma_{i,t}} + \delta_t + \phi_i + \epsilon_{i,t} \end{aligned} \tag{4}$$

EU ETS Phase 2[3][4] are indicators for EU firms in years 2008-2012, 2013-2020, and 2021-2024, respectively. The benchmark group is the non-EU firms. To the set of control variables ($\mathbf{\Gamma_{i,t}}$), we now add both firm (ϕ_i) and time (δ_t) fixed effects.

The results are tabulated in Table 8 Panel C. The coefficients on *EU ETS Phase 2* are negative and statistically significant across all columns, suggesting that with the lenient regulation, EU firms invest in fewer climate projects, either reversible or irreversible, compared to their international peers. However, the coefficients become positive and statistically significant for *EU ETS Phase 3*, and their magnitude increases for *EU ETS Phase 4*. The pattern is consistent when we divide climate investments into irreversible or reversible, measured as either the extensive or intensive margin. Notably, the changes from *EU ETS Phase 2* to *EU ETS Phase 3*, and from *EU ETS Phase 3* to *EU ETS Phase 4* are all statistically significant. These results suggest that firms tend to invest in more—especially irreversible—climate projects as the stringency and stability of the EU ETS increase.

Taken together, these results based on regional variations are consistent with the idea that the broader institutional and regulatory contexts shape how firms commit to climate solutions. Specifically, firms are more likely to engage in irreversible decarbonization contracts in the context of stable policy support and a stringent regulatory environment.

7 Validation with Emissions Intensity

While the regional variation analyses in the previous section provide indirect validation by linking decarbonization contracts to major policy initiatives such as the EU ETS and the U.S. IRA, in this section, we directly validate our measures of reversible and irreversible climate investments by testing whether our measures reflect real decarbonization outcomes at the firm level. Specifically, we examine how emissions intensity changes following a firm's first irreversible or reversible decarbonization investment.

To implement this test, we estimate the following difference-in-differences model:

$$\textit{Emissions Intensity}(log)_{i,t} = \beta_1 \textit{Post First Decarb}_{i,t} + \mathbf{\Gamma_{i,t}} + \delta_t + \phi_i + \epsilon_{i,t} \quad (5)$$

Post First Decarbi$, t$ is an indicator equal to one for all years after firm i's first decarbonization investment, and we show results using irreversible or reversible investments separately. The model includes financial firm-level controls and country-level GDP, as well as firm and year fixed effects.

Table 9 reports the results. We find that after a firm's first irreversible decarbonization investment, emissions intensity decreases by approximately 1.8%, while after its first reversible investment, the decrease is about 1.0%. When both variables are included jointly, only the coefficient on *Post First Irreversible Decarb* remains statistically significant, corresponding to a 1.6% reduction in emissions intensity.

Figure 5 plots firms' average emissions intensity in years relative to their first decarbonization investment, separately for irreversible and reversible investments. The figure shows that firms that undertake irreversible investments tend to have higher emissions intensity prior to the investment, suggesting they start from a more carbon-intensive baseline. Following the year of decarbonization investment, emissions intensity declines for both investment types, but the reduction is larger among firms making irreversible investments, consistent with the results in the regression analysis.

In summary, these results validate that our measures of decarbonization investments capture real emissions-reducing activity and further show that irreversible investments are more strongly associated with subsequent declines in emissions intensity.

8 Conclusion

This paper studies how the irreversibility of corporate climate investments responds to climate policies and political environment. Using global firm-to-firm business relationship data, we construct a novel measure that differentiates relatively irreversible forms of investments, such as via joint ventures and research collaborations, from more reversible arrangements such as via supplier contracts. Descriptively, we show that decarbonization-related investments are, on average, more irreversible than other corporate investments, with irreversibility concentrated in capital-intensive technologies and more prevalent in Europe,consistent with the technological and institutional features of the transition.

Our main empirical results underscore the importance of regulatory environment and its stability. Exposure to carbon pricing is associated with a higher likelihood and intensity of both reversible and irreversible climate investments. However, this association is particularly pronounced for irreversible investments when carbon prices are more stringent or when the political environment is more stable, consistent with the view that the irreversibility of policy support shapes the irreversibility preferences of corporate climate investments.

Cross-sectional analyses provide further support. The increase in irreversible investments in response to carbon pricing policies under a stable political environment is stronger in higher-cost decarbonization technologies, where unwinding commitments is especially expensive. Firms with shorter investment horizons, where reversible and irreversible investments are more distinct, also exhibit greater responsiveness in adjusting irreversible investments. Regional evidence is consistent with these patterns.

In the United States, the Biden period is associated with a significant increase in the intensity of irreversible climate investments. However, given the uncertainty of climate policies in the U.S., firms tend to increase investments in irreversible projects not directly targeted by the Inflation Reduction Act (IRA), which is subject to reversals. In the European Union, increasing stringency of the EU Emissions Trading Scheme (ETS) from Phases 2 to 4 coincides with progressively more irreversible and reversible investments, with the increase in irreversible investments more consistent over time. Finally, we find that irreversible investments are more effective in low-carbon transition, with the reduction in emission intensity following irreversible investments significantly significantly larger than reversible investments.

Taken together, the evidence highlights the enabling role of broader political support for corporate decarbonization efforts. Climate regulation alone primarily induces flexible, reversible commitments, whereas regulation embedded in politically stable environments enables firms to undertake deeper, long-horizon, and harder-to-reverse investments. Overall, our results contribute new evidence that the structure of firms' climate investments—specifically, the choice between reversible and irreversible modes—mediates the effectiveness of climate policy. Stable policy frameworks are thus central not only to spurring participation in the transition but also to shifting the composition of corporate investments toward long-term commitments, which are more effective for low-carbon transition.

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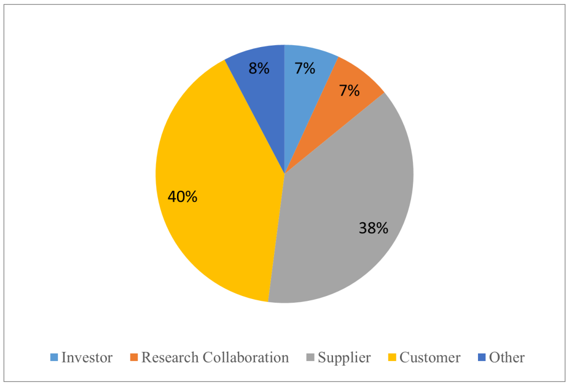
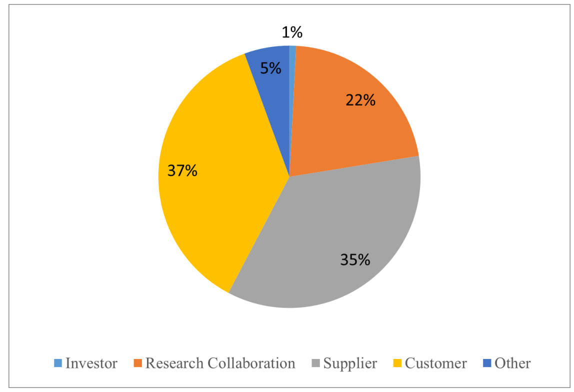
Figure 1: Contract Relationship Descriptive Summary

Panel A: By Relationship Types

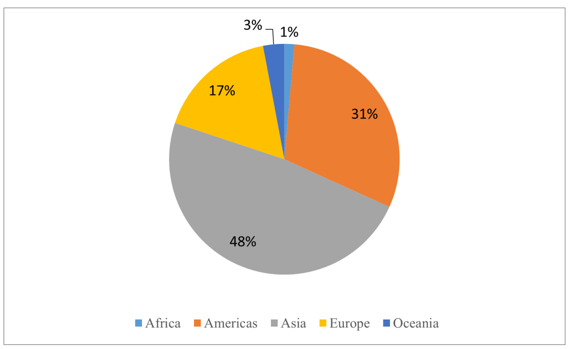


Overall

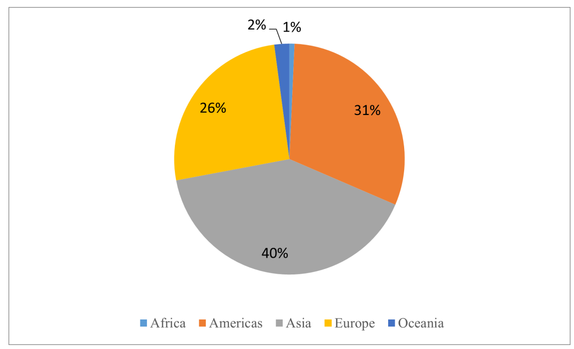


Decarbonization-related

Panel B: By Continents



Overall



Decarbonization-related

This figure plots descriptive summary of the business relationships. Panel A shows the distribution of different relationship types, for all contracts and for those decarbonization-related contracts. Panel B shows the distribution of different continents, for all contracts and for those decarbonization-related contracts.

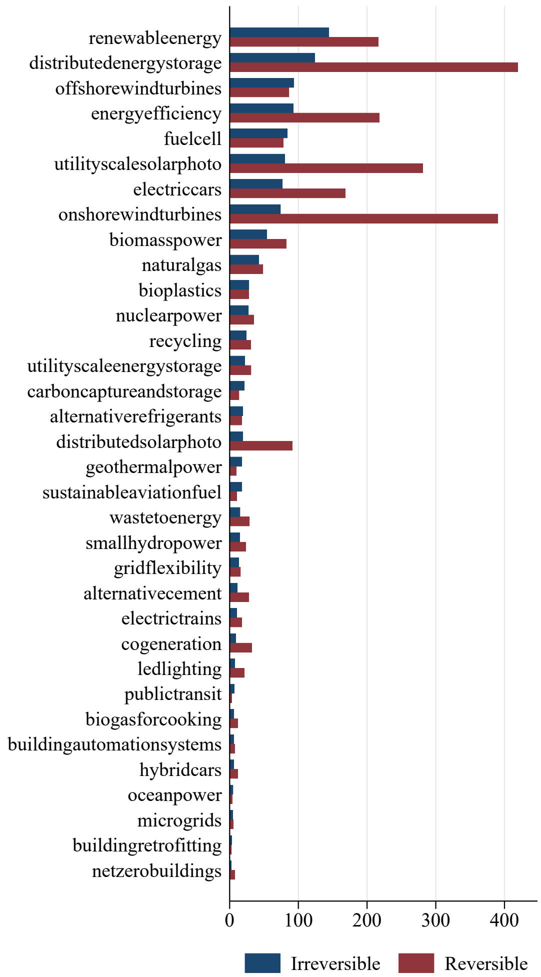
Figure 2: Changes in Climate Investment Irreversibility

		Current Year	
		Irreversible	**Reversible**
Prior Year	**Irreversible**	4,756	3,319
	Reversible	3,340	10,948
Column totals row		**N (firm-year):**	**17,651**

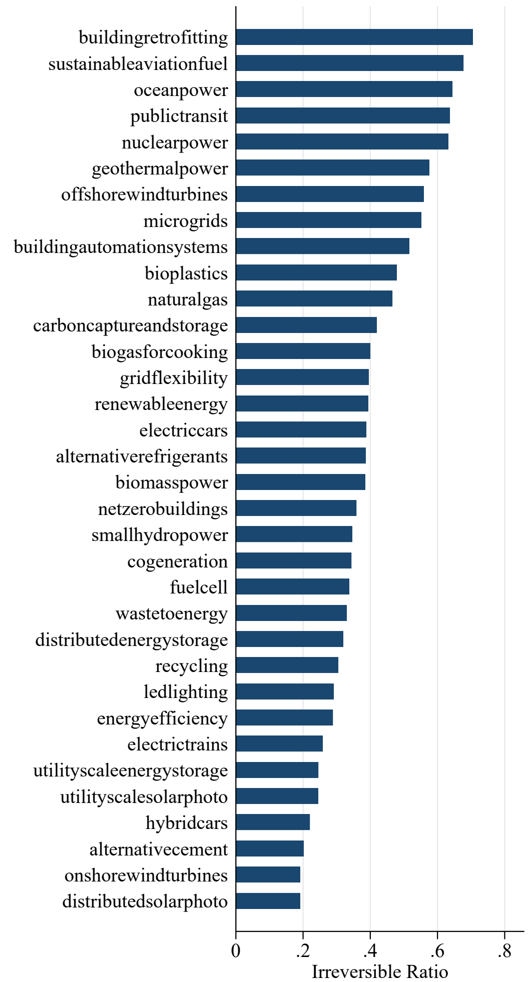
This figure displays a 2×2 matrix comparing firm-year observations with current and prior year decarbonization contracts. We provide a detailed description of the variables in Appendix A.

Figure 3: Decarb Contracts by Topics

Panel A: Number of Contracts

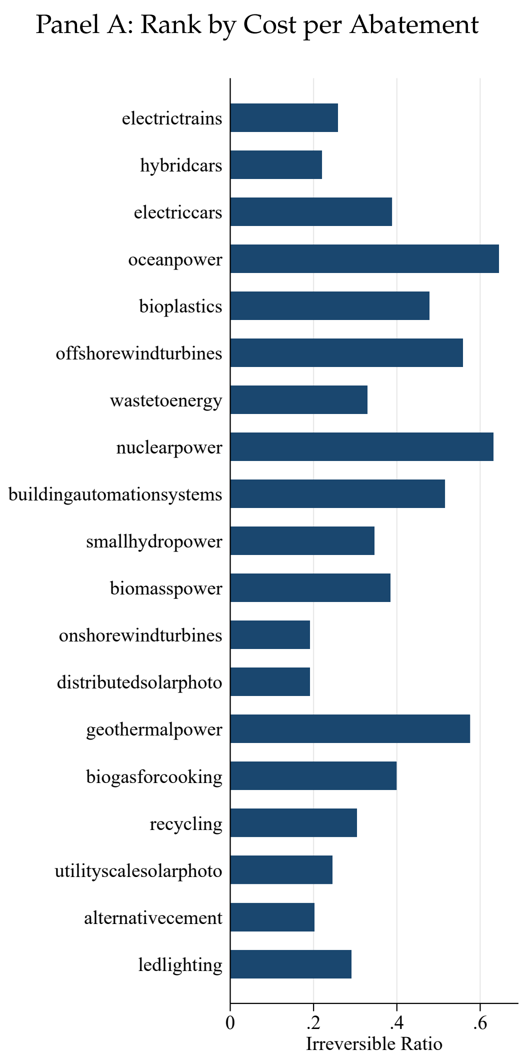


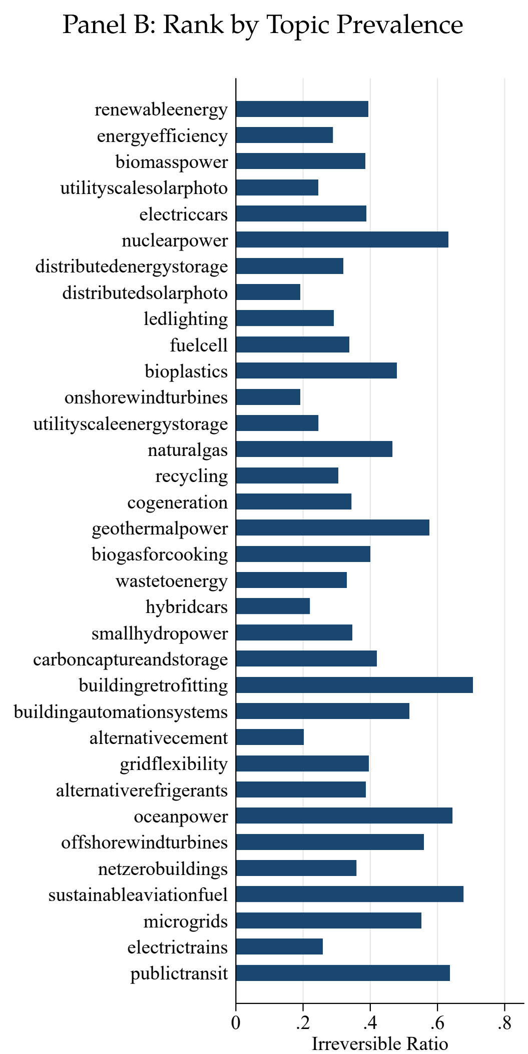
Panel B: Ratio of Irreversible Contracts



This figure plots the decarbonization contracts by topic, retaining topics with over 100 observations. Panel A shows the average number of reversible and irreversible contracts for each topic over the years. Panel B shows the average ratio of irreversible contracts to the total number of contracts for each topic over the years.

Figure 4: Irreversible Ratio by Topics

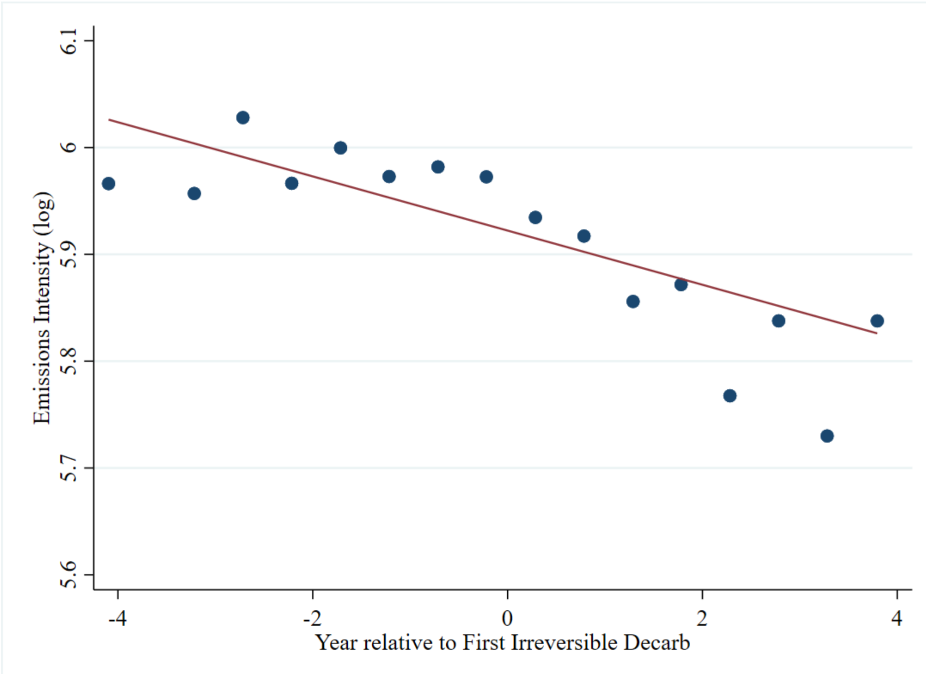




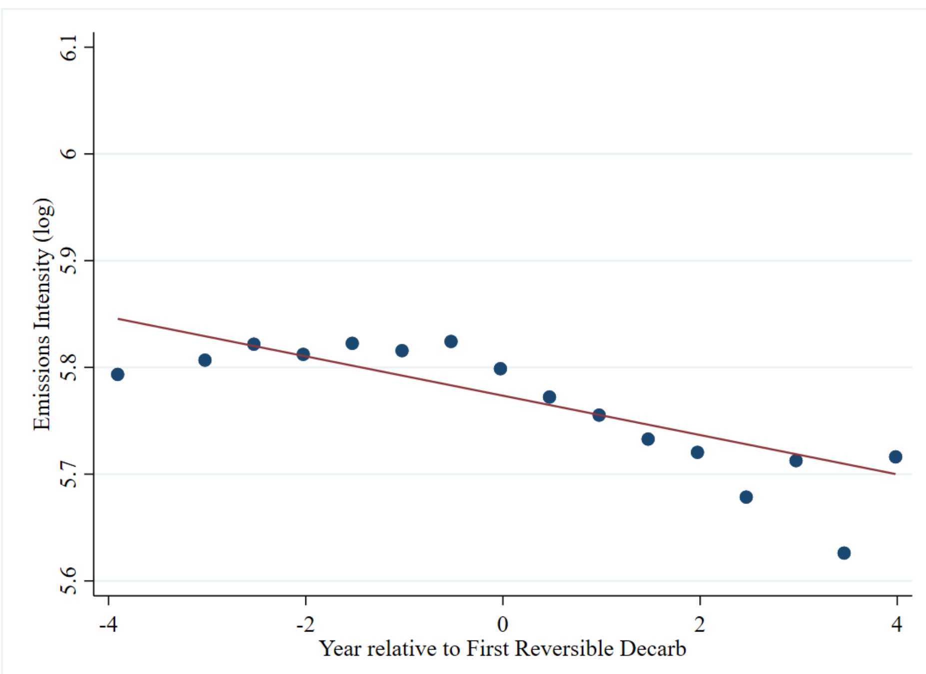
This figure plots the average ratio of irreversible contracts to the total number of contracts for each topic over the years, retaining topics with over 100 observations. Panel A ranks observations by cost per abatement, from highest at the top. Panel B ranks observations by topic prevalence from Lu et al. (2025b), from highest at the top. Topics without data are not shown.

Figure 5: Climate Investment Reversibility and Emissions Intensity

Panel A: Irreversible Investment



Panel B: Reversible Investment



This figure plots the changes in emissions intensity in years relative to the first decarbonization contract. Panel A uses the first irreversible contract and Panel B uses the first reversible contract. Both figures include firm fixed effects. A detailed description of the variables is in Appendix A.

Table 1: Sample Composition

Panel A: Sample Construction	
Businss Relationships from FactSet Revere	3,023,336
Drop: Competitor Relationships	(519,682)
Drop: Legacy Relationships	(44,154)
Drop: Missing GVKEYs in Source and Target Firms	(1,120,851)
Total Contracts	993,500
Total Contract-year Observations	3,244,191
Drop: Duplicate Contracts	(201,602)
Add: Standardize to Symmetric Source-Target Contracts	2,575,086
Total Contract-year Observations	5,617,675
Total Source Firm-year Observations	415,817
Drop: Unavailable in Compustat	(116,536)
Drop: Missing Values in Regression Variables	(86,651)
Total Source Firm-year Observations in Final Sample	212,630

Panel B: Contracts by Business Relationships

Relationship Type	**All Contracts**	**Ratio**	**Decarb Contracts**	**Ratio**	**% Decarb/ All Contracts**
Irreversible					
Investor	49,845	6.42%	112	0.81%	0.22%
Research Collaborator	52,663	6.78%	2,960	21.45%	5.62%
Investee	50,559	6.51%	117	0.85%	0.23%
Joint Venture Partner	14,617	1.88%	561	4.06%	3.84%
Integrated Product Partner	1,316	0.17%	25	0.18%	1.90%
Subtotal Irreversible	**169,000**	**21.77%**	**3,775**	**27.35%**	**11.81%**
Reversible					
Supplier	275,296	35.46%	4,825	34.96%	1.75%
Customer	291,982	37.61%	5,025	36.41%	1.72%
Licensor	14,239	1.83%	66	0.48%	0.46%
Licensee	14,116	1.82%	62	0.45%	0.44%
Distributor	7,466	0.96%	19	0.14%	0.25%
Marketing Agent	2,680	0.35%	10	0.07%	0.37%
Manufacturer	1,565	0.20%	20	0.14%	1.28%
Subtotal Reversible	**607,344**	**78.23%**	**10,027**	**72.65%**	**6.28%**
Total	776,344	100.00%	13,802	100.00%	1.78%

This table shows the sample composition. Panel A shows the sample construction process. Panel B shows the number of unique contracts in the final sample by relationship types. A detailed description of the variables is in Appendix A.

Table 2: Summary Statistics

Panel A: Summary Statistics

	N	Mean	SD	P25	P50	P75	Min	Max
#Decarb	212630	0.27	1.87	0.00	0.00	0.00	0.00	168.00
#Irreversible Decarb	212630	0.09	0.84	0.00	0.00	0.00	0.00	100.00
#Reversible Decarb	212630	0.19	1.36	0.00	0.00	0.00	0.00	131.00
$\mathbb{1}$Decarb	212630	0.08	0.28	0.00	0.00	0.00	0.00	1.00
$\mathbb{1}$Irreversible Decarb	212630	0.03	0.17	0.00	0.00	0.00	0.00	1.00
$\mathbb{1}$Reversible Decarb	212630	0.07	0.25	0.00	0.00	0.00	0.00	1.00
Carbon Price	212630	0.15	0.35	0.00	0.00	0.00	0.00	1.00
Carbon Price High	212630	0.05	0.21	0.00	0.00	0.00	0.00	1.00
Carbon Price Low	212630	0.10	0.30	0.00	0.00	0.00	0.00	1.00
Size	212630	8.42	2.93	6.42	8.32	10.34	0.18	15.60
R&D Intensity	212630	0.03	0.07	0.00	0.00	0.02	0.00	0.49
Leverage	212630	0.15	0.17	0.01	0.09	0.24	0.00	0.88
CAPX Intensity	212630	0.04	0.05	0.01	0.03	0.05	0.00	0.33
ROA	212630	-0.02	0.26	-0.00	0.03	0.06	-3.43	0.31
Tobins Q	212630	26.17	79.92	0.86	1.57	8.76	0.08	602.71
Sales Growth	212630	0.14	0.65	-0.05	0.06	0.18	-1.00	5.77
GDP (log)	212630	28.75	1.61	27.77	28.90	30.32	19.03	30.95
#Contracts	212630	11.05	31.12	1.00	4.00	10.00	0.00	1845.00
Political Stability	187038	0.28	0.68	-0.26	0.42	0.89	-2.81	1.66
Refinitiv E Score	58919	4.81	2.16	3.21	4.60	6.28	0.01	10.00
Emission Intensity	107572	558.83	2107.79	93.17	199.38	432.75	15.16	423080.20
Cost Per CO2 High	212630	0.00	0.07	0.00	0.00	0.00	0.00	1.00
Cost Per CO2 Low	212630	0.01	0.08	0.00	0.00	0.00	0.00	1.00
PPE Duration Long	201689	0.44	0.49	0.00	0.00	1.00	0.00	1.00
PPE Duration Short	201689	0.56	0.49	0.00	0.00	1.00	0.00	1.00

Continued on following page

Table 2 (continued)

Panel B: Mean by year

	N	Indicator Decarb	Indicator Irreversible	Indicator Reversible	# Contracts Decarb	# Contracts Irreversible	# Contracts Reversible
2008	715	0.017	0.004	0.013	0.020	0.004	0.015
2009	4542	0.016	0.004	0.013	0.020	0.004	0.015
2010	4949	0.027	0.010	0.020	0.043	0.016	0.026
2011	5816	0.061	0.027	0.047	0.155	0.058	0.097
2012	7582	0.075	0.029	0.063	0.210	0.064	0.146
2013	8628	0.078	0.030	0.067	0.218	0.067	0.151
2014	9362	0.081	0.032	0.068	0.218	0.066	0.151
2015	12640	0.070	0.023	0.059	0.178	0.051	0.127
2016	14212	0.074	0.026	0.062	0.198	0.057	0.141
2017	15618	0.077	0.026	0.065	0.216	0.061	0.156
2018	16387	0.080	0.028	0.067	0.228	0.064	0.164
2019	16813	0.081	0.029	0.068	0.253	0.069	0.184
2020	17689	0.080	0.030	0.066	0.261	0.074	0.187
2021	18278	0.086	0.032	0.071	0.304	0.096	0.209
2022	19028	0.095	0.039	0.078	0.361	0.128	0.233
2023	20419	0.113	0.048	0.092	0.463	0.171	0.293
2024	19952	0.108	0.043	0.088	0.417	0.148	0.270
Total	212630	0.083	0.032	0.069	0.273	0.088	0.185

Panel C: Summary Statistics by Industry

	N	Indicator Decarb	Indicator Irreversible	Indicator Reversible	# Contracts Decarb	# Contracts Irreversible	# Contracts Reversible
Agriculture, Forestry, Fishing	885	0.010	0.002	0.008	0.011	0.003	0.008
Mining	15847	0.097	0.035	0.076	0.234	0.090	0.144
Construction	38434	0.057	0.025	0.045	0.179	0.079	0.100
Manufacturing	53478	0.116	0.044	0.098	0.443	0.124	0.319
Transportation & Utilities	20944	0.149	0.064	0.124	0.478	0.156	0.322
Wholesale & Retail Trade	18739	0.054	0.015	0.046	0.129	0.039	0.089
Finance, Insurance, Real Estate	10641	0.027	0.006	0.021	0.033	0.007	0.026
Services	23172	0.022	0.006	0.018	0.042	0.011	0.030
Public Administration	5577	0.072	0.018	0.065	0.167	0.042	0.125
Nonclassifiable	24913	0.153	0.052	0.144	0.875	0.222	0.653
Total	212630	0.083	0.032	0.069	0.273	0.088	0.185

Continued on following page

Table 2 (continued)

Panel D: Summary Statistics by Country

		Indicator			# Contracts		
	N	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Australia	5031	0.055	0.023	0.043	0.138	0.052	0.087
Belgium	685	0.133	0.070	0.102	0.375	0.178	0.197
Bermuda	515	0.033	0.000	0.033	0.033	0.000	0.033
Brazil	2213	0.110	0.056	0.080	0.256	0.106	0.150
Canada	5933	0.080	0.032	0.068	0.244	0.078	0.166
Chile	1174	0.081	0.014	0.077	0.184	0.026	0.158
China	22717	0.085	0.023	0.073	0.254	0.047	0.206
Denmark	624	0.115	0.050	0.101	1.554	0.171	1.383
Finland	932	0.168	0.085	0.142	0.696	0.262	0.435
France	3552	0.145	0.080	0.117	0.813	0.330	0.483
Germany	3623	0.184	0.081	0.158	0.983	0.295	0.687
Greece	709	0.056	0.024	0.038	0.114	0.032	0.082
Hong Kong SAR	5671	0.058	0.023	0.044	0.117	0.035	0.082
India	8137	0.078	0.024	0.068	0.211	0.041	0.169
Indonesia	3169	0.026	0.010	0.017	0.037	0.017	0.021
Ireland	661	0.071	0.038	0.057	0.254	0.110	0.144
Israel	2077	0.034	0.011	0.027	0.064	0.015	0.048
Italy	1740	0.114	0.060	0.089	0.393	0.166	0.227
Japan	24722	0.065	0.032	0.050	0.247	0.128	0.119
Korea, Rep.	9550	0.089	0.023	0.078	0.236	0.043	0.194
Malaysia	2574	0.059	0.030	0.038	0.107	0.048	0.059
Mexico	913	0.073	0.009	0.067	0.117	0.023	0.094
Netherlands	895	0.187	0.072	0.162	0.625	0.235	0.390
New Zealand	575	0.087	0.030	0.068	0.153	0.052	0.101
Norway	1156	0.176	0.087	0.140	0.689	0.322	0.368
Pakistan	1031	0.019	0.004	0.016	0.020	0.004	0.016
Philippines	905	0.128	0.036	0.110	0.234	0.071	0.164
Poland	1472	0.096	0.041	0.073	0.213	0.086	0.126
Russia	1091	0.077	0.037	0.046	0.140	0.086	0.054
Saudi Arabia	840	0.027	0.017	0.020	0.094	0.062	0.032
Singapore	2456	0.050	0.016	0.039	0.093	0.027	0.066
South Africa	1202	0.062	0.017	0.050	0.161	0.028	0.133
Spain	982	0.230	0.103	0.210	1.228	0.325	0.903
Sri Lanka	609	0.036	0.000	0.036	0.057	0.000	0.057
Sweden	2866	0.084	0.031	0.069	0.218	0.079	0.139
Switzerland	1674	0.120	0.051	0.097	0.349	0.098	0.251
Thailand	2478	0.088	0.042	0.065	0.216	0.109	0.107
Turkiye	1520	0.034	0.007	0.030	0.043	0.008	0.036
United Kingdom	6859	0.100	0.037	0.085	0.311	0.111	0.200
United States	42775	0.082	0.028	0.070	0.251	0.066	0.184
Viet Nam	856	0.043	0.009	0.039	0.055	0.013	0.042
Other Country	33466	0.085	0.034	0.069	0.300	0.104	0.196
Total	212630	0.083	0.032	0.069	0.273	0.088	0.185

This table shows the summary statistics. A detailed description of the variables is in Appendix A.

Table 3: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$\mathbb{1}$Decarb	1.000															
$\mathbb{1}$Irreversible Decarb	0.619***	1.000														
$\mathbb{1}$Reversible Decarb	0.855***	0.278***	1.000													
#Decarb	0.459***	0.458***	0.448***	1.000												
#Irreversible Decarb	0.338***	0.545***	0.215***	0.753***	1.000											
#Reversible Decarb	0.413***	0.266***	0.484***	0.887***	0.364***	1.000										
Carbon Price	0.115***	0.099***	0.096***	0.100***	0.088***	0.080***	1.000									
Carbon Price High	0.154***	0.138***	0.130***	0.136***	0.117***	0.111***	0.516***	1.000								
Carbon Price Low	0.031***	0.023***	0.024***	0.025***	0.024***	0.018***	0.817***	-0.073***	1.000							
Political Stability	0.027***	0.040***	0.019***	0.034***	0.043***	0.017***	0.198***	0.164***	0.117***	1.000						
Refinitiv E Score	0.270***	0.202***	0.237***	0.179***	0.135***	0.158***	0.020***	0.077***	-0.029***	0.092***	1.000					
Emission Intensity	0.243***	0.198***	0.192***	0.109***	0.100***	0.084***	0.089***	0.045***	0.073***	-0.064***	0.126***	1.000				
Cost Per CO2 High	0.344***	0.358***	0.334***	0.744***	0.654***	0.594***	0.094***	0.111***	0.035***	0.030***	0.123***	0.074***	1.000			
Cost Per CO2 Low	0.348***	0.339***	0.338***	0.757***	0.470***	0.741***	0.061***	0.094***	0.008***	0.019***	0.141***	0.098***	0.267***	1.000		
PPE Duration Long	0.091***	0.080***	0.064***	0.028***	0.039***	0.012***	0.185***	-0.012***	0.223***	-0.052***	-0.046***	0.248***	0.012***	0.036***	1.000	
PPE Duration Short	-0.091***	-0.080***	-0.064***	-0.028***	-0.039***	-0.012***	-0.185***	0.012***	-0.223***	0.052***	0.046***	-0.248***	-0.012***	-0.036***	-1.000	1.000

This table shows the correlation matrix. A detailed description of the variables is in Appendix A. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Effect of Carbon Pricing Policies on Climate Investments

Panel A: Effect of Carbon Price						
	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price	0.045***	0.023***	0.042***	0.311***	0.105***	0.205***
	(8.57)	(6.06)	(8.53)	(6.33)	(4.87)	(5.45)
Size	0.009***	0.003***	0.009***	-0.002	-0.017***	0.015
	(5.97)	(2.79)	(5.97)	(-0.13)	(-2.69)	(1.23)
R&D Intensity	0.067***	0.013	0.070***	-0.030	-0.120**	0.090
	(4.09)	(0.95)	(5.47)	(-0.27)	(-2.13)	(0.95)
Leverage	-0.014**	-0.018***	-0.007	-0.251***	-0.152***	-0.099**
	(-2.17)	(-4.12)	(-1.19)	(-4.85)	(-6.69)	(-2.37)
CAPEX Intensity	0.009	-0.003	0.020	0.061	-0.053	0.114
	(0.57)	(-0.23)	(1.25)	(0.60)	(-1.15)	(1.39)
ROA	-0.004*	-0.000	-0.003	0.006	0.008	-0.002
	(-1.78)	(-0.24)	(-1.50)	(0.37)	(1.60)	(-0.16)
Tobins Q	0.000	-0.000	0.000	-0.000	-0.000	-0.000
	(1.20)	(-0.67)	(1.19)	(-1.47)	(-0.69)	(-1.34)
Sales Growth	0.001	0.001	0.000	0.006	0.004*	0.002
	(1.03)	(1.10)	(0.52)	(1.43)	(1.70)	(0.69)
GDP (log)	-0.029***	-0.035***	-0.018**	-0.258***	-0.264***	0.006
	(-3.67)	(-5.92)	(-2.36)	(-3.47)	(-6.58)	(0.11)
Refinitiv E Score	0.001	0.001	0.001	0.004	-0.001	0.004
	(0.67)	(1.20)	(0.99)	(0.45)	(-0.15)	(0.67)
Non-missing E Score	0.002	-0.001	-0.002	-0.029	-0.007	-0.022
	(0.45)	(-0.36)	(-0.34)	(-0.83)	(-0.42)	(-0.81)
Emission Intensity	0.000	0.000	-0.000	-0.000	-0.000	-0.000
	(0.19)	(0.39)	(-0.99)	(-1.51)	(-1.05)	(-1.56)
Non-missing Emission	-0.028***	-0.019***	-0.022***	-0.045*	-0.028**	-0.017
	(-9.93)	(-10.42)	(-8.43)	(-1.73)	(-2.54)	(-0.91)
Contracts				0.030***	0.011***	0.019***
				(6.50)	(4.97)	(6.25)
N	212630	212630	212630	212630	212630	212630
Adj. R-squared	0.511	0.420	0.493	0.594	0.430	0.585
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

Continued on following page

Table 4 (continued)

Panel B: Effect of High Carbon Price

	(1)	(2)	(3)	(4)	(5)	(6)
		Indicator			# Contracts	
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price High	0.034***	0.042***	0.034***	0.553***	0.221***	0.332***
	(3.14)	(4.61)	(3.20)	(3.96)	(3.06)	(3.62)
Carbon Price Low	0.048***	0.016***	0.045***	0.233***	0.069***	0.165***
	(8.08)	(4.08)	(8.04)	(4.76)	(3.28)	(4.24)
N	212630	212630	212630	212630	212630	212630
Adj. R-squared	0.511	0.420	0.493	0.594	0.431	0.586
F test p-value	0.229	0.012	0.377	0.033	0.052	0.088
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

This table shows results of OLS regressions of firms' decarbonization-related business relationships on firms' exposure to carbon pricing policies. The dependent variable in column 1 is an indicator for firms having any decarbonization-related relationship. Columns 2 and 3 look only at irreversible or reversible relationships, respectively. The dependent variable in columns 3 to 6 is instead the count of such relationships. The main explanatory variable in Panel A captures firms that are exposed to carbon pricing policies. In Panel B, we differentiate between firms that operate in countries where the carbon prices are high (above median) or low. All specifications control for firm-level controls as well as time and firm fixed effects. The sample covers all global firms in FactSet Revere from 2005 to 2024. A detailed description of the variables is in Appendix A. t-statistics, based on standard errors clustered at the firm level, are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Effect of Carbon Pricing Policies and Political Stability on Climate Investments

	(1)	(2)	(3)	(4)	(5)	(6)
		Indicator			# Contracts	
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price × High Political Stability	0.013	0.030***	0.006	0.315***	0.213***	0.101*
	(1.55)	(4.74)	(0.76)	(3.50)	(4.56)	(1.76)
Carbon Price	0.040***	0.011***	0.040***	0.191***	0.024*	0.167***
	(7.16)	(3.08)	(7.41)	(4.46)	(1.67)	(4.73)
High Political Stability	0.008**	-0.000	0.008**	0.025	-0.012	0.037*
	(1.99)	(-0.16)	(2.12)	(0.89)	(-0.85)	(1.76)
N	212593	212593	212593	212593	212593	212593
Adj. R-squared	0.511	0.420	0.493	0.594	0.431	0.586
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

This table shows results of OLS regressions of firms' decarbonization-related business relationships on firms' exposure to carbon pricing policies interacted with an indicator for firms that operate in countries with a high political stability. The dependent variable in column 1 is an indicator for firms having any decarbonization-related relationship. Columns 2 and 3 look only at irreversible or reversible relationships, respectively. The dependent variable in columns 3 to 6 is instead the count of such relationships. The main explanatory variable is the interaction between *Carbon Price*, an indicator for firms exposed to carbon pricing policies, and *High Political Stability*, an indicator for firms operating in countries with stable political environments. All specifications control for firm-level controls as well as time and firm fixed effects. The sample covers all global firms in FactSet Revere from 2005 to 2024. A detailed description of the variables is in Appendix A. t-statistics, based on standard errors clustered at the firm level, are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Climate Investment Reversibility, Political Stability, and the Cost of Climate Solutions

Panel A: High Cost						
	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price × High Political Stability	0.010 (1.52)	0.018*** (3.51)	0.007 (1.10)	0.169*** (3.16)	0.103*** (3.55)	0.073* (1.83)
Carbon Price	0.022*** (5.36)	0.009*** (3.19)	0.024*** (5.92)	0.119*** (4.21)	0.026*** (2.71)	0.121*** (4.16)
High Political Stability	0.007** (2.13)	0.002 (0.87)	0.005* (1.81)	0.017 (1.01)	0.001 (0.16)	0.023 (1.41)
N	212593	212593	212593	212593	212593	212593
Adj. R-squared	0.472	0.400	0.462	0.512	0.372	0.540
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm
Mean (Dependent Var)	0.038	0.016	0.033	0.103	0.039	0.080

Panel B: Low Cost						
	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price × High Political Stability	0.004 (0.71)	0.008* (1.88)	0.004 (0.67)	0.080* (1.94)	0.031** (2.05)	0.049 (1.48)
Carbon Price	0.019*** (4.99)	0.005** (2.29)	0.018*** (4.96)	0.079*** (4.06)	0.009 (1.60)	0.070*** (4.04)
High Political Stability	0.002 (0.69)	-0.003 (-1.38)	0.003 (1.18)	0.004 (0.28)	-0.010* (-1.73)	0.014 (1.09)
N	212593	212593	212593	212593	212593	212593
Adj. R-squared	0.485	0.372	0.464	0.548	0.389	0.548
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	Firm	Firm	Firm	Firm	Firm	Firm
Mean (Dependent Var)	0.039	0.013	0.032	0.102	0.028	0.074
F test high vs low	0.998	0.058	0.249	0.742	0.020	0.326

This table shows the cross-sectional analysis of political stability and cost of climate solutions. We separate contracts into low and high cost climate solutions based on the median climate solutions topic. A detailed description of the variables is in Appendix A. T-statistics, reported in parentheses, are based on standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Climate Investment Reversibility, Political Stability, and Investment Horizon

Panel A: Long Horizon

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price ×	0.030**	0.029***	0.025**	0.431***	0.254***	0.178**
High Political Stability	(2.26)	(2.85)	(1.96)	(3.27)	(3.64)	(2.15)
Carbon Price	0.034***	0.008	0.034***	0.061	-0.023	0.084**
	(4.29)	(1.47)	(4.30)	(1.04)	(-0.84)	(2.11)
High Political Stability	0.013**	0.004	0.010*	0.055	-0.001	0.056**
	(2.11)	(0.79)	(1.68)	(1.43)	(-0.06)	(2.05)
N	89351	89351	89351	89351	89351	89351
Adj. R-squared	0.533	0.435	0.508	0.626	0.443	0.675
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm
Mean (Dependent Var)	0.098	0.039	0.081	0.309	0.107	0.202

Panel B: Short Horizon

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Carbon Price ×	0.234**	0.176***	0.057	0.164*	0.154***	0.010
High Political Stability	(1.97)	(3.48)	(0.67)	(1.65)	(3.56)	(0.14)
Carbon Price	0.338***	0.043*	0.295***	0.280***	0.024	0.255***
	(4.04)	(1.94)	(4.25)	(3.68)	(1.20)	(3.96)
High Political Stability	-0.000	-0.028*	0.028	0.013	-0.024*	0.038
	(-0.00)	(-1.91)	(0.79)	(0.36)	(-1.72)	(1.18)
N	112338	112338	112338	112338	112338	112338
Adj. R-squared	0.564	0.439	0.559	0.621	0.479	0.603
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm
Mean (Dependent Var)	0.072	0.026	0.060	0.246	0.073	0.172
F test high vs low	0.823	0.000	0.068	0.272	0.039	0.161

This table shows the cross-sectional analysis of political stability and carbon price. Sample is partitioned based on the median PPE as a proxy for investment horizon. A detailed description of the variables is in Appendix A. T-statistics, reported in parentheses, are based on standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Regional Variations in Regulatory Environment

Panel A: U.S. Presidential Terms

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
Trump Administration	0.048***	0.017***	0.043***	-0.028	0.011	-0.039
	(7.84)	(4.24)	(7.36)	(-0.35)	(0.62)	(-0.55)
Biden Administration	0.067***	0.032***	0.057***	0.084	0.068***	0.016
	(8.67)	(5.67)	(7.63)	(1.20)	(3.34)	(0.27)
N	44346	44346	44346	44346	44346	44346
Adj. R-squared	0.520	0.424	0.506	0.587	0.443	0.534
F test p-value	0.000	0.000	0.002	0.000	0.000	0.027
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

Panel B: Topics Targeted by U.S. Inflation Reduction Act

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
IRA	0.014***	0.008***	0.014***	0.107***	0.045***	0.069***
	(3.46)	(2.75)	(3.41)	(3.18)	(2.74)	(3.13)
N	44346	44346	44346	44346	44346	44346
Adj. R-squared	0.537	0.473	0.502	0.653	0.527	0.626
F test p-value	0.094			0.043		
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

Panel C: Topics Not Targeted by U.S. Inflation Reduction Act

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator			# Contracts		
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
IRA	0.009***	0.006***	0.006**	0.028***	0.017***	0.011**
	(3.54)	(3.59)	(2.47)	(3.77)	(3.08)	(2.50)
N	44346	44346	44346	44346	44346	44346
Adj. R-squared	0.336	0.270	0.338	0.338	0.308	0.248
F test p-value	0.841			0.691		
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

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Table 8 (continued)

Panel D: EU Emission Trading Scheme						
	(1)	(2)	(3)	(4)	(5)	(6)
		Indicator			# Contracts	
	Decarb	Irreversible	Reversible	Decarb	Irreversible	Reversible
EU ETS Phase 2	-0.070**	-0.059*	-0.059*	-0.662**	-0.386***	-0.276
	(-2.22)	(-1.91)	(-1.89)	(-2.36)	(-2.62)	(-1.30)
EU ETS Phase 3	0.094***	0.059*	0.128***	0.956**	0.448***	0.508*
	(2.60)	(1.66)	(3.01)	(2.36)	(2.72)	(1.69)
EU ETS Phase 4	0.194***	0.123***	0.203***	3.164***	1.660**	1.504***
	(4.63)	(2.74)	(4.06)	(2.94)	(2.45)	(2.75)
N	25275	25275	25275	25275	25275	25275
Adj. R-squared	0.540	0.468	0.518	0.632	0.507	0.619
F test p-value Phase 2 vs.3	0.000	0.001	0.000	0.010	0.001	0.106
F test p-value Phase 3 vs.4	0.002	0.044	0.040	0.015	0.040	0.010
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm	Firm	Firm	Firm

This table provides robustness results based on regional variations in regulatory environment. A detailed description of the variables is in Appendix A. T-statistics, reported in parentheses, are based on standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Climate Investments and Emissions Intensity

	(1) Emissions Intensity (log)	(2) Emissions Intensity (log)	(3) Emissions Intensity (log)
Post First Irreversible Decarb	-0.018***		-0.016***
	(-2.94)		(-2.60)
Post First Reversible Decarb		-0.010**	-0.007
		(-2.04)	(-1.50)
Size	0.006**	0.006**	0.006**
	(2.30)	(2.34)	(2.29)
R&D Intensity	0.014	0.015	0.015
	(0.32)	(0.32)	(0.33)
Leverage	0.019*	0.020*	0.019*
	(1.69)	(1.73)	(1.68)
CAPEX Intensity	-0.307***	-0.307***	-0.307***
	(-9.17)	(-9.18)	(-9.17)
ROA	-0.068***	-0.068***	-0.068***
	(-8.43)	(-8.44)	(-8.42)
Tobins Q	-0.000	-0.000	-0.000
	(-1.46)	(-1.47)	(-1.47)
Sales Growth	-0.007***	-0.007***	-0.007***
	(-4.34)	(-4.35)	(-4.34)
GDP (log)	0.000	0.001	0.001
	(0.05)	(0.14)	(0.07)
#Contracts	-0.000***	-0.000***	-0.000***
	(-2.91)	(-3.23)	(-2.74)
N	114262	114262	114262
Adj. R-squared	0.946	0.946	0.946
Firm Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
S.E. Clusters	Firm	Firm	Firm

This table provides validation for the decarbonization contracts data, showing how emissions intensity changes after the first reversible and first irreversible decarbonization contracts. A detailed description of the variables is in Appendix A. T-statistics, reported in parentheses, are based on standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix A: Variable Definitions

Variable	Description	Source
#Decarb	The number of contracts with at least one decarbonization keyword of a firm within a year	Revere
#Irreversible Decarb	The number of irreversible contracts with at least one decarbonization keyword of a firm within a year	Revere
#Reversible Decarb	The number of reversible contracts with at least one decarbonization keyword of a firm within a year	Revere
$\mathbb{1}$Decarb	Equal to 1 if the firm has at least one contract that contains decarbonization keywords	Revere
$\mathbb{1}$Irreversible Decarb	Equal to 1 if the firm has at least one irreversible contract that contains decarbonization keywords	Revere
$\mathbb{1}$Reversible Decarb	Equal to 1 if the firm has at least one reversible contract that contains decarbonization keywords	Revere
Post First Irreversible Decarb	Equal to 1 starting the year when the firm has the first irreversible contract that contains decarbonization keywords	Revere
Post First Reversible Decarb	Equal to 1 starting the year when the firm has the first reversible contract that contains decarbonization keywords	Revere
Size	The log of the firm's total assets	Compustat
R&D Intensity	Research and development expense scaled by total assets	Compustat
Leverage	Long-term debt scaled by total assets	Compustat
CAPEX Intensity	Capital expenditures scaled by total assets	Compustat
ROA	Income before extraordinary items scaled by total assets	Compustat
Tobins Q	The market value of assets relative to their replacement cost	Compustat
Sales Growth	Year-over-year change in sales	Compustat
GDP (log)	Natural logarithm of a country-year's real GDP	World Bank
#Contracts	The number of contracts	Revere
Political Stability	The perceptions of the likelihood of political instability and/or politically-motivated violence (including terrorism)	World Bank WDI
High Political Stable	Equal to one if the political stability is higher than the median, zero otherwise	World Bank WDI
Refinitiv E Score	Industry-relative percentile score summarizing a company's environmental performance from publicly reported data, aggregated from three categories—Resource Use, Emissions, and Environmental Innovation—with category weights varying by industry.	Refinitiv
Non-missing E Score	Equal to one if the Refinitiv E Score is not missing, zero otherwise	Refinitiv

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Appendix A, continued

Variable	Description	Source
Emission Intensity	The sum of scope 1, scope 2, and scope 3 upstream emission intensity, where emission intensity is the absolute amount of emissions over the reporting year scaled by sales revenue.	Trucost
Non-missing Emission	Equal to one if the Emission Intensity is not missing, zero otherwise	Trucost
Carbon Price	Equal to one if the carbon price policy is effective, zero otherwise	World Bank
Carbon Price High	Equal to one if the carbon price is higher than median, zero otherwise	World Bank
Carbon Price Low	Equal to one if the carbon price is lower than median, zero otherwise	World Bank
Cost Per CO2 High	Equal to one if the topic's first cost divided by abatement potential CO2 is higher than median, zero otherwise	Project Drawdown 2020 Report
Cost Per CO2 Low	Equal to one if the topic's first cost divided by abatement potential CO2 is lower than median, zero otherwise	Project Drawdown 2020 Report
PPE Duration Long	Equal to one if average total useful life (in years) of a firm's fixed assets is higher than median, zero otherwise	Compustat
PPE Duration Short	Equal to one if average total useful life (in years) of a firm's fixed assets is lower than median, zero otherwise	Compustat
Trump Administration	Equal to one if a U.S. observation falls within the years 2016 to 2020, zero otherwise	/
Biden Administration	Equal to one if a U.S. observation falls within the years 2020 to 2024, zero otherwise	/
IRA	Equal to one if the IRA is effective, zero otherwise	/
Emissions Intensity (log)	The natural logarithm of one plus the sum of scope 1, scope 2, and scope 3 upstream emission intensity, where emission intensity is the absolute amount of emissions over the reporting year scaled by sales revenue.	TruCost

This table provides the descriptions and sources of variables used in this paper.