The Alignment of Corporate Carbon Performance and Shareholder Preferences: Evidence of a Capital Market Separation*

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Abstract.

The growing focus on climate change and sustainability has reshaped financial markets, leading to a separation where firms and investors are clustered based on their environmental performance. This study is the first to empirically test this predicted capital market separation, with climate-conscious investors primarily holding firms with strong carbon performance and financially driven investors retaining those with weaker climate records. Using a large global dataset of stock ownership and carbon metrics from 2004 to 2022, we provide the first large-scale empirical evidence of this phenomenon. We robustly show that green firms consistently concentrate in sustainability-focused portfolios, whereas brown firms remain in traditional investor portfolios. The market separation intensifies over our sample period and differs between geographic regions. Following the Paris Agreement, we observe diverging developments: separation strengthened in the U.S. but became less pronounced in the EU. Our research contributes to the literature by offering novel insights into how shareholders' carbon preferences shape capital allocation, with implications for corporate strategy, investment management, and policy development.

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1 Introduction

The increasing focus on climate change and sustainability has reshaped financial markets, bringing environmental factors to the forefront of investment decision-making. This shift has led to a growing segmentation within the market, where companies are not only differentiated by traditional financial metrics but also by their environmental performance. This phenomenon, referred to as capital market separation, describes the clustering of companies and investors into distinct sub-markets based on environmental preferences. Green companies, which exhibit strong climate performance, tend to be concentrated in the portfolios of environmentally-conscious investors, while companies with weaker environmental records are often held by investors who prioritize financial returns over sustainability (Heinkel et al., 2001; Pastor et al., 2021; Pedersen et al., 2021).

This capital market separation is more than just a theoretical construct—it has significant implications for a wide range of stakeholders. For corporate managers, the types of investors a company attracts can influence its ability to raise capital and its cost of financing. Green firms may benefit from lower capital costs, as investors who prioritize sustainability are willing to accept lower financial returns in exchange for environmental alignment (Zerbib, 2019). For policymakers, the existence of a segmented market based on climate-related factors demonstrates how capital allocation can create incentives for firms to improve their sustainability performance, potentially guiding the transition to a low-carbon economy. In this context, the capital market separation is not just crucial, but a necessary condition for the effective functioning of the impact investing channel through portfolio allocation (Wilkens et al., 2025).

While the concept of market separation is theoretically well-established (Heinkel et al., 2001; Pastor et al., 2021; Pedersen et al., 2021), empirical evidence remains scarce. Most prior research has relied on theoretical models or limited case studies, or aggregated ESG scores, which may obscure the specific role of climate-related factors and vary across providers (Berg et al., 2022). However, to the best of our knowledge, no study has yet rigorously tested this hypothesis using comprehensive capital market data across a broad range of carbon performance metrics. We address this gap using a granular approach with multiple carbon metrics—including total emissions, emissions relative to revenue, enterprise value, and market capitalization —alongside carbon risk measures, including a carbon risk rating and carbon beta. By examining these different measures, we aim to capture both absolute and relative carbon emission data, as well as risk sensitivity to climate-related factors. This multi-faceted approach enhances the robustness of our results by not relying on a single measure of carbon performance.

Our study contributes to the existing literature by providing the first large-scale empirical test of capital market separation based on carbon metrics rather than aggregated ESG scores. We find consistent and significant separation across various measures of carbon performance. Green companies—those with lower carbon emissions or intensities—are concentrated in the portfolios of investors who prioritize climate factors, while brown companies cluster within portfolios of traditional investors. Moreover, we show that this separation is not solely linked to a rising preference for green firms: shareholder preferences for the brownest firms decline the least over time, and even increase for some carbon intensity measures. This provides novel evidence that capital markets reflect not only green or neutral preferences but also a persistent demand for high-emission firms, indicating the presence of sustained brown preferences. Furthermore, we find that the Paris Agreement significantly altered these dynamics. In the United States (U.S.), separation intensified post-Paris, whereas the European Union (EU) experienced a contrasting trend, highlighting the role of regional factors in shaping investor integration of climate considerations.

In the remainder of this paper, we detail the theoretical underpinnings of capital market separation, review the existing literature and formalize three hypotheses in Section 2. Section 3 outlines our data and methodology, while Section 4 presents our empirical results. Section 5 presents robustness checks, including a placebo test, restrictions on emission data quality, investor types, and industry scope, as well as alternative carbon measures. Section 6 concludes with the key implications of the study.

2 Literature Review, Theoretical Framework and Hypothesis Development

The concept of capital market separation builds on the heterogeneity of investor preferences. Traditional asset pricing models such as the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) assume rational investors with homogeneous expectations focused solely on financial returns, resulting in identical portfolio structures aligned with the market portfolio in equilibrium. More recent approaches incorporate non-financial motives, particularly sustainability and climate considerations, showing that investors may derive utility directly from holding certain assets (e.g., Fama and French, 2007; Dreyer et al., 2023). This recognition of heterogeneous sustainability preferences provides the foundation for understanding how sustainability-related factors can influence capital allocation. A central mechanism is that investors with ESG preferences accept deviations from the purely financial risk-return trade-off. Dreyer et al. (2023) describe this as a "warm-glow" effect, where investors gain utility from investing in green assets, thereby driving up their prices and reducing expected returns. Conversely, investor aversion can lower valuations of "sin stocks" such as tobacco, alcohol, and gambling, leading to their outperformance relative to the market (Hong and Kacperczyk, 2009). Such taste-driven dynamics illustrate how preferences beyond financial returns can create systematic differences in asset pricing.

Heinkel et al. (2001) were among the first to model an explicit separation between "green" and "non-green" investors in equilibrium. They argue that environmentally conscious investors divest from polluting firms, reducing such firms' investor base and limiting risk-sharing opportunities. Remaining non-green investors then demand higher expected returns, effectively raising the cost of capital for polluting firms. This mechanism implies that companies face incentives to adopt greener practices if the benefits of accessing a broader investor base exceed the costs of reform. The strength of this incentive depends on the relative size of the green investor segment. However, their conclusions were largely theoretical, as empirical validation of such separation remained elusive at the time.

More recently, . Pastor et al. (2021) formalize sustainable investing by showing that investors with strong ESG "tastes" are willing to pay a premium for responsible firms, reducing their cost of capital, while carbon-intensive firms command a positive risk premium. The model also shows how surges in demand for green assets can generate their outperformance, particularly following unexpected ESG-related developments (see also Görgen et al., 2020). Pedersen et al. (2021) extend this argument by developing an ESG-adjusted capital asset pricing model. They demonstrate that investors with varying ESG motivations perceive distinct efficient frontiers, and that a higher proportion of ESG-motivated investors systematically elevates the valuation of green firms while lowering expected returns. Zerbib (2022) complements this view with a sustainable capital asset pricing model (S-CAPM), which explicitly incorporates heterogeneous preferences and partial segmentation. His framework highlights how taste and exclusion premia affect expected returns and reinforce the segmentation of capital markets along ESG dimensions. Görgen et al. (2025) provide complementary evidence from U.S. stock lending markets, showing that ESG preferences also affect market liquidity. Their results indicate that while both green and brown stocks are more actively borrowed than neutral stocks, only green stocks carry a modest fee premium, consistent with limited lending supply linked to ESG preferences. Together, these models suggest that heterogeneous investor preferences can create structural separation between green and brown submarkets, where ESG-conscious investors gravitate toward greener firms. These dynamics imply that financial markets do not allocate capital purely on risk-return grounds but also reflect non-financial preferences.

Empirical evidence increasingly supports this theoretical foundation. Bolton and Kacperczyk (2021a) show that investors differentiate systematically along carbon risk, with firms exhibiting lower emissions earning lower returns after controlling for established risk factors. This finding aligns with the idea that investor preferences translate into distinct return patterns for green and brown firms. Parallel evidence emerges from bond markets: Zerbib (2019) documents a significant negative green bond premium, Baker et al. (2022) show that U.S. municipal green bonds are disproportionately held by environmentally conscious investors and command price premiums, while Flammer (2021) finds that corporate green bond issuance increases ownership by green investors but does not significantly reduce issuers' cost of capital. These studies confirm that sustainability considerations are priced in financial markets, though often outside equity markets. Despite these advances, a comprehensive analysis of capital market separation across different carbon metrics in equity markets has not yet been conducted. This highlights a notable gap in the literature, given that the empirical validation of theoretical models such as those proposed by Heinkel et al. (2001) and Pastor et al. (2021) is still incomplete.

A significant limitation in existing studies is the reliance on aggregate ESG scores as proxies for sustainability preferences, which may obscure more granular patterns of separation. ESG scores, compiled by rating agencies, combine diverse sustainability factors into a single metric, masking the variability of individual dimensions. Berg et al. (2022) highlight significant divergence in ESG scores across providers, leading to inconsistent conclusions. By contrast, Busch et al. (2022) show that corporate carbon performance data—particularly Scope 1 (direct) and Scope 2 (indirect emissions)—are highly correlated across providers, and consistency improves further when both scopes are aggregated, especially for estimated emissions.

We therefore argue that ESG scores alone fail to capture key dimensions of capital market separation linked to carbon performance. Employing carbon-specific metrics provides a more accurate assessment of environmental impact and risk exposure. While total emissions remain a critical metric (see Bolton and Kacperczyk, 2023), carbon intensity is more appropriate for assessing firm-level performance. As Aswani et al. (2024) note, unscaled emissions reflect a firm's total societal impact, while intensity measures account for firm size, ensuring reduction goals are proportional to a firm's capacity to adapt. Large firms with higher emissions face stronger regulatory pressures, such as carbon taxes per unit, but their revenue base absorbs these costs more efficiently. The authors further argue that intensities capture taste-based investor preferences more effectively. Using unscaled emissions would imply that investors averse to brown firms might exclude only large polluters while still holding smaller firms within the same industry. Carbon intensities, by contrast, create a consistent basis for exclusion, aligning with how some investors systematically avoid sin industries (see Hong and Kacperczyk, 2009). Therefore, carbon intensity—defined as total Scope 1 and 2 emissions relative to revenues—serves as our primary measure of carbon performance.

Building on the theoretical foundation and gaps identified in the literature, our study seeks to empirically test the existence and drivers of capital market separation using a variety of carbon metrics. We formulate three hypotheses. Our first research hypothesis (H1) posits that carbon performance, measured through various metrics, is a significant determinant of investor portfolio composition. Firms with superior carbon performance are expected to attract climate-conscious investors, while firms with poor carbon performance will cluster in portfolios of investors indifferent to climate factors:

H1: Carbon metrics positively relate to shareholder preferences, resulting in the concentration of green firms in the portfolios of green investors and brown firms in the portfolios of traditional investors (capital market separation).

The Paris Agreement, adopted in 2015, marked a significant milestone in global climate policy, intensifying the focus on sustainability in financial markets. Bolton and Kacperczyk (2023) observe that the post-Paris period witnessed an intensified market penalization of carbon-intensive firms, reflecting a shift in investor awareness toward climate change and an increased carbon premium, particularly in Asia. However, this effect was less pronounced in North America and Europe. They attribute this to the already high level of investor awareness about carbon risk in Europe and the relatively stable beliefs of investors in North America, suggesting that the Paris Agreement did not significantly alter existing attitudes in these regions.

Conversely, empirical research by Monasterolo and De Angelis (2020) demonstrates that the Paris Agreement altered the risk-return profile of low-carbon assets, reducing their perceived risk relative to high-carbon assets. This shift incentivized greater capital allocation to sustainable assets within optimal investment portfolios. While these findings primarily reflect a form of statistical discrimination, it is plausible that they also extend to taste-based discrimination, although the interaction between these two dimensions is not trivial. However, Pedersen et al. (2021) suggest that the relationship between ESG and returns evolves with shifts in investor attitudes, which is most likely the case for the Paris Agreement. Bolton and Kacperczyk (2023) further argue that the effect of higher expected returns for brown firms remains the same, regardless of whether it is driven by risk aversion or a distaste for high-carbon firms, reinforcing the role of investor preferences in shaping capital allocation. Moreover, increased availability and improved quality of firms' carbon-emissions data, especially after the Paris Agreement, further enabled investors to shape their preferences and tilt their investment portfolios accordingly.

Consistent with this, Zerbib (2022) finds an increased taste premium over time, particularly in the post-Paris period. In addition, Borsuk et al. (2024) show that the Paris Agreement also triggered real corporate responses: family firms reduced their emissions more strongly than non-family firms, driven by increased R&D and green innovation. This suggests that the Paris Agreement functioned as a quasi-exogenous shock, particularly in governance-sensitive firms. Based on these insights, we hypothesize that the post-Paris period has seen an amplification of capital market separation, driven by heightened investor awareness and stronger climate-related commitments. This leads to our second hypothesis (H2):

H2: The capital market separation is more pronounced in the post-Paris Agreement period than in the pre-Paris Agreement period.

Regional differences in market structures, regulatory frameworks, and cultural attitudes toward sustainability suggest varying degrees of capital market separation. Several factors indicate that this separation could be more pronounced in the EU than in the U.S. The EU has implemented a comprehensive and standardized regulatory framework aimed at integrating sustainability into financial markets, potentially leading to stronger capital market separation, as investors' tastes for green assets can be more easily translated into investment decisions. Unlike the U.S., where ESG considerations have become increasingly politically polarized (Smith et al., 2024), the EU benefits from broader institutional and societal support for sustainability, reducing the presence of investors who actively oppose green investments.

Amel-Zadeh and Serafeim (2018) underscore these regional differences, indicating that European investors exhibit greater credibility in their ESG commitments, since they are more intrinsically motivated to invest responsibly compared to their U.S. counterparts (see also Gibson Brandon et al., 2022). Building on this, Aswani et al. (2024) highlight that these investors are more concerned with carbon emissions than investors in U.S. firms, leading to a stronger influence on investor demand for low-carbon versus high-carbon stocks. This behavior is reflected in a distaste for specific industries, consistent with the presence of a carbon premium in stock returns. Given these dynamics, it is important to acknowledge that home bias remains a persistent factor in global investment patterns, despite a long-term decline. This pattern continues to be similarly pronounced across different countries, suggesting that investors consistently favor domestic assets regardless of market context (Wallmeier and Iseli, 2022). Given these findings, we can reasonably assume that home bias is also present in our dataset, potentially influencing regional investment preferences and contributing to the observed differences in ESG-related investor behaviour.

Complementing this perspective, Boermans and Galema (2025) document a carbon home bias among European investors, who tend to hold disproportionately more carbon-intensive firms domestically while divesting from such firms abroad. Importantly, they also show that this bias weakens after the Paris Agreement, illustrating how regional and societal contexts influence the pace at which investors adjust their portfolios in response to global climate commitments. Additionally, Bolton and Kacperczyk (2023) argue that in societies which prioritize environmental protection and climate action, investors may demand higher risk premia for holding high-emission assets. Taken together, these factors provide a strong rationale for hypothesizing that capital market separation is more pronounced in the EU than in the U.S. These two markets represent contrasting environments in terms of sustainable finance perspectives and regulatory frameworks, making them ideal for comparative analysis. Thus, we formalize our third hypothesis (H3):

H3: The capital market separation is more pronounced in the European Union than in the United States.

3 Data and Construction of Key Variables

3.1 Assessment of Corporate Carbon Performance

To assess a firm's carbon performance, we employ multiple metrics, with carbon intensity based on total emissions and revenues being the primary indicator. Alternative metrics include total emissions, carbon intensity relative to market capitalization and enterprise value, as well as carbon beta and carbon risk rating. Collectively, these metrics are grouped under the term corporate carbon performance (CCP) and are utilized in robustness tests to ensure the consistency and reliability of our findings. A higher CCP value is negatively associated with the climate impact, as it reflects a stronger potential to contribute to global temperature rise, or an increased carbon sensitivity and carbon risk.

The total carbon emissions measure represents the aggregate Scope 1 and Scope 2 emissions of firm i during period t, expressed in metric kilotons of CO_2-equivalents (kt CO_2e), following the Greenhouse Gas (GHG) Protocol for emissions classification by type. Aggregating these emissions ensures the highest consistency in emission data, as highlighted by Busch et al. (2022). To maximize data availability and ensure the broadest possible coverage of global emissions, we incorporate both reported and estimated emissions in our main analyses. Reported Scope 1 and Scope 2 emissions are directly sourced from corporate disclosures. When firms do not disclose emissions, their values are estimated through a structured multi-step modeling approach. The process first verifies the availability of reported emissions; if none are disclosed, estimates are generated using one of three models: a CO_2 emissions model, an energy-based model, or a sector-specific median approach. These models incorporate the latest available total CO_2 emissions and adjust for key firm characteristics, including company size (measured by employee count and revenue), total energy consumption, and industry classification, ensuring a systematic approximation of unreported carbon emissions. These estimations allow for a more comprehensive assessment of corporate carbon footprints. Furthermore, in the absence of reported emissions, investor preferences and capital allocation decisions—which we are particularly interested in—must inevitably be based on estimated data. Nevertheless, we run robustness checks rigorously dropping all estimated emission, which show unchanged results, thereby confirming the consistency of our main results as well as the assumption that investors derive their preferences from estimated data lacking alternatives.[1] Given the well-documented inconsistencies and duplication issues associated with Scope 3 emissions, we explicitly exclude them from our analysis.

Consistent with the literature and the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD, 2021), we define a firm's carbon emission intensity as its total carbon emissions in metric tons of CO_2-equivalents (t CO_2e) per million USD ($) of revenues (see also Bolton and Kacperczyk, 2021a, 2023; Aswani et al., 2024).[2] Carbon intensity serves as a measure of a company's efficiency of turning emissions into revenue volume, allowing for standardized comparisons across firms of varying sizes, industries, and time periods. The calculation formula for CCP—in this case: carbon intensity—is presented in Equation (1):

$$Carbon\ intensity_{i,t} = \frac{(Scope\ 1 + Scope\ 2\ emissions)\ t\ CO_2e_{i,t}}{\$\ million\ revenues_{i,t}} \tag{1}$$

3.2 Measurement of Shareholder Carbon Preferences

We follow the methodology proposed by Paulus and Rohleder (2022), which avoids categorizing shareholders into predefined groups or making any assumptions about their specific preferences. This approach is broadly applicable to any measurable metric related to shareholder preferences, such as carbon emissions, as demonstrated in this study. Instead of

[1] See Subsection 5.2 for the robustness test based solely on reported emissions.
[2] See Subsection 5.5 for the description of alternative corporate carbon performance measures.

fixed classifications, the method quantifies investor climate preferences on a continuous scale by calculating a portfolio-weighted measure of carbon performance. It then adjusts for firm-specific circularity and aggregates investor preferences based on ownership stakes, providing a comprehensive metric of shareholder climate orientation. Thus, we consider all identifiable shareholders of a company, recognizing that competing preferences may coexist among them. This is particularly relevant in light of the fact that many researchers have focused on particular shareholder segments, viewing their combined ownership as a measure of influence (e.g., Dyck et al., 2019; Chen et al., 2020). While this approach suggests that a larger stake held by a specific group enhances the likelihood of corporate decisions aligning with their interests, it often assumes homogeneity of preferences within that group. However, studies have shown that diverse preferences exist within every shareholder category (e.g., Bushee, 1998; Hoskisson et al., 2002), underscoring the need for a more detailed and individualized analysis of shareholder influence.

Similar to Paulus and Rohleder (2022), the calculation of carbon preferences for investor portfolios is carried out using a multi-step approach. First, the portfolio weights $w_{j,i,t}$ for each investor j are determined based on the proportion of their holdings in a specific company i relative to the total value of their investment portfolio in period t, as presented in Equation (2):

$$w_{j,i,t} = \frac{Company\ holdings\ value_{j,i,t}}{Investor\ portfolio\ value_{j,t}} \tag{2}$$

Subsequently, the investor preference for a given carbon metric is derived using the formula presented in Equation (3):

$$Investor\ preference_{j,t} = \sum_{i=1}^{N^{j,t}} w_{j,i,t}\ CCP_{i,t} \tag{3}$$

This formula aggregates the carbon performance of all companies in the portfolio, weighted by their respective portfolio shares. If we use carbon intensity—our main measure of CCP—in this formula, we essentially obtain the weighted average carbon intensity (WACI), a metric recommended by the TCFD (2021) for comparing equity portfolios. The TCFD advises asset owners and managers to report WACI to their beneficiaries and clients. Consistent with the revealed preference theory of Samuelson (1938, 1948), this approach provides a quantifiable measure of the investor's climate preference, with greater weights assigned to companies with higher carbon performance and larger portfolio allocations, capturing how investors prioritize climate factors in their investment decisions.

To mitigate potential circularity between an investor's preferences regarding CCP and the CCP of a focal firm, we compute adjusted investor preferences for each firm $s \neq i$ by excluding the focal firm's own weighted CCP from the calculation. By doing so, a mechanical circularity bias is avoided, where the firm's carbon profile could potentially dominate the preference measure. This means that an investor's preference is slightly different for each firm the investor holds. Although the direct numerical effect of this adjustment is naturally small for single investors, aggregated over all investors of a firm the approach provides a clean methodological separation between firm characteristics and shareholder preference. As a result, the investor preference more accurately reflects the broader motivations and inclinations of investors without being skewed by their holdings in the firm in question, as outlined in Equation (4):

$$Investor\ preference\ (adj)_{j,s,t} = Investor\ preference_{j,t} - \frac{w_{j,s,t}\ (Investor\ preference_{j,t} - CCP_{s,t})}{w_{j,s,t} - 1} \qquad (4)$$

In this framework, the analysis shifts from a general focus on portfolio holdings to a firm-specific examination of shareholder preferences related to CCP. By conceptualizing the company as a “portfolio of owners”, the diverse and sometimes conflicting climate preferences of individual shareholders are consolidated into a single, quantifiable metric. Each investor’s carbon preference is weighted by the number of shares they hold in the firm during a given period, with larger investors exerting proportionally greater influence. As the focal firm is excluded from the calculation at each individual investor, the weighted average excludes the focal firm in its entirety from its own measure of shareholder preference. Thus, this value-weighted aggregation provides an accurate reflection of the collective shareholder stance on the firm’s climate-related performance, highlighting how ownership patterns are associated with corporate decisions concerning climate policies and actions. This relationship is formally captured in Equation (5), where the shareholder preference for firm s in period t is derived as the weighted sum of adjusted investor preferences across all shareholders, scaled by their respective ownership stakes:[3]

$$Shareholder\ preference_{s,t} = \sum_{j=1}^{N^s} \frac{Shares\ held_{j,s,t}}{\sum_j^{J^s} Shares\ held_{j,s,t}}\ Investor\ preference\ (adj)_{j,s,t} \tag{5}$$

3.3 Sample Selection and Summary Statistics

The sample selection for this study starts with a stock universe of 39,804 globally operating firms obtained from Refinitiv Datastream and Worldscope (RDW). Quarterly ownership data for these firms were sourced from the Refinitiv Ownership and Profiles (ROP) database, spanning the period from 2004 to 2022. The complete ownership dataset covers 753,349 distinct owners across 30,723 firms. To ensure data quality and relevance for this study, the sample was restricted to firms with sufficient ownership and emissions data, resulting in a final dataset of 11,811 firms from 53 different countries and 30 industries, covering the full spectrum

[3] Neither CCPs, investor preferences, nor shareholder preferences are strictly divided into green or brown categories, but rather are continuous variables.

of economic activity.[4] The business sectors are defined by Refinitiv's Thomson Reuters Business Classification (TRBC). Summary statistics for the study sample are shown in Table 1.

[Insert Table 1 here.]

The final dataset encompasses 291,358 owners during the sample period and provides comprehensive coverage of the global equity market. The aggregate market capitalization of the firms in the stock dataset averages 76.27% of the global equity market capitalization as reported by the World Bank (2024), with this percentage rising over time to around 90%. The quality of ownership data improves over the sample period, as the share of covered ownership information steadily increases, enhancing the reliability of the findings over time. On average, ownership data account for approximately two-thirds (66.22%) of the market capitalization of the included firms. This high level of coverage is primarily driven by the inclusion of large global firms.

Panel A of Table 2 presents summary statistics for the key variables used in the analysis, covering firm-level carbon performance metrics and investor- and shareholder-level preferences, as well as financial control variables. Revenues, total assets, and leverage are annual variables. In rare cases of missing values between years we applied linear interpolation to avoid data gaps. Return on equity is also reported annually but was not interpolated. At the firm level, the mean total emissions (firm-TE) over all observations amount to 1,948.29 kt CO_2e, with a substantial standard deviation of 7,586.67 kt CO_2e. This reflects the high variability in emissions across firms, a pattern confirmed by the 1st percentile value of 0.05 kt CO_2e and the 99th percentile of 45,200.00 kt CO_2e, indicating that a small number of highly polluting firms significantly influence the overall distribution. Similarly, carbon intensity (firm-CI), defined as emissions relative to revenues, exhibits a mean of 335.27 t CO_2e per

[4] See Tables A1, A2, and A3 in the Appendix for summary statistics on the ownership sample, as well as industry- and country-level statistics.

$ million in revenues, with wide variation (standard deviation = 1,020.35 t CO_2e per $ million). The broad range of firm-CI values, from 0.28 t CO_2e per $ million at the 1st percentile to 6,287.43 t CO_2e per $ million at the 99th percentile, underscores the heterogeneity in carbon efficiency across firms, reflecting diverse operational and sectoral characteristics.

At the investor level, the unadjusted carbon preferences (Investor preference-TE and Investor preference-CI) demonstrate means of 1,927.75 kt CO_2e and 275.84 t CO_2e per $ million, respectively. Shareholder preferences for carbon performance, calculated at the firm level (shareholder preference-TE and shareholder preference-CI), also show notable variation, with means of 3,155.71 kt CO_2e and 199.25 t CO_2e per $ million, respectively. However, these values are generally less extreme than investor preferences due to the aggregation effect, where diverse investor preferences within a firm's ownership structure lead to more balanced shareholder metrics. The difference between firm-level carbon intensity and total emission values compared to investor-level preferences can be attributed to the weighting mechanism employed in calculating investor preferences, which causes firms with substantial carbon emissions to be disproportionately represented in certain portfolios. Notably, the values align exactly with the firm-level metrics when investor preferences are weighted by market capitalization. The disparity with shareholder preferences can additionally be explained by the adjustments made to address circularity concerns in the calculation process.

The distribution of shareholder preferences reveals a predominance of green and neutral shareholders, with relatively few brown shareholders. However, these brown shareholders tend to favor firms with distinctly high levels of carbon intensity, making their preferences significantly more pronounced. This asymmetry results in shareholder preferences at the firm level being less polarized compared to investor-level preferences, a logical outcome of the aggregation process. Firms with diversified ownership structures are likely to exhibit more moderate shareholder preferences, reflecting a blend of green, neutral, and brown investor inclinations.

Panel B of Table 2 reports pairwise Pearson correlation coefficients of key variables and characteristics. Shareholder preference correlates positively with firm-CI and firm-TE, which gives a first hint on a possible capital market separation. Since revenues correlate positively with firm-TE, this underlines the assumption that total emissions may rise with increased output represented by higher values of revenue. This does not apply for firm-CI which displays correlations around zero in this case. Multicollinearity is not a concern, as the correlations between the independent variables in the regression models remain low, ensuring the reliability of the estimated coefficients.

[Insert Table 2 here.]

4 Empirical Findings

4.1 Capital Market Separation

In this subsection, we examine our first research hypothesis (H1) on the existence of capital market separation. Specifically, we investigate whether firms with low carbon intensity are predominantly held by investors with low-carbon preferences, while firms with higher carbon intensity are concentrated in the portfolios of traditional investors. For presentation purposes, we sort firms in each quarter into deciles.[5] This decile-based approach offers a more nuanced perspective compared to a simple classification into green, neutral, and brown firms. Each decile represents a portfolio of firms sorted by their carbon intensity in each quarter. The firms in the first decile (greenest) exhibit the lowest carbon intensity, while those in the tenth decile (brownest) have the highest carbon intensity. For each decile, the corresponding average

[5] The classification of firms into deciles is used solely for the presentation of the results and does not represent a strict categorization of the firms nor does it apply to the subsequent regressions.

shareholder preference and carbon intensity per year is computed. Since shareholder preferences are derived from the ownership structure, they fluctuate quarterly as the weighting of investors—based on the shares they hold—varies over time. Figure 1 shows average values for shareholder preference-CI by firm-CI decile over the study period from 2004 to 2022.

[Insert Figure 1 here.]

The results indicate a clear separation in the capital market. Shareholder preferences systematically differ between green and brown firms, confirming that investors with stronger climate preferences tend to hold shares in firms with lower carbon intensity, whereas firms with higher carbon intensity exhibit ownership structures with a higher tolerance for emissions.

Figure 2 illustrates the relative difference in shareholder preferences between the extreme deciles, providing an overview of how these metrics have evolved throughout the study period. The figure compares the average shareholder preference values of firm-CI deciles 8–10, representing the shareholder preferences of companies with high carbon intensities, to those of deciles 1–3, which represent firms with low carbon intensities. By examining this relative difference over time, we gain valuable insights into the shifting alignment between shareholder preferences and CCP.

[Insert Figure 2 here.]

Despite fluctuations in certain time frames, the difference in shareholder preferences between the brownest and greenest firms has consistently been positive, growing from 19.40% in 2004 to 62.20% in 2022. Specifically, the relative cross-sectional gap in shareholder preferences between the most carbon-intensive firms (deciles 8–10) and the least carbon-intensive firms (deciles 1–3) has increased by 294.06% when comparing the early years (2004–2006) with the recent period (2020–2022). In contrast, the corresponding gap in firm-level carbon intensity has grown by only 173.82%, suggesting that the polarization of investor preferences has intensified more strongly than changes in firms' carbon intensities. This pattern becomes even clearer when comparing relative changes in the absolute size of these gaps: while the gap in shareholder preferences has widened by 128.09%, the gap in firm-level carbon intensities has actually decreased slightly by 5.08%.[6]

Figure 3 provides insight into the shifting alignment between shareholder preferences and firms' carbon performance throughout the study period. It presents the relative change in shareholder preferences for each decile, comparing the average values of the first three years (2004–2006) and the last three years (2020–2022) of our study.

[Insert Figure 3 here.]

An overall shift in investor preferences toward greener investments is evident, as shareholder preferences for all decile groups have become greener over time. However, this transition has been uneven. While firms in deciles 1 to 8 have on average experienced a very similar rate of reductions of about 38.77% in shareholder carbon preferences, the brownest firms (deciles 9 and 10) have only seen reductions of 23.20% and 4.08%, respectively. Even when examining the average shareholder preferences of the most carbon-intensive firms (deciles 9 and 10), the gap between these groups remains the largest, underscoring the persistence of investor demand for high-emission firms. This finding supports the existence of brown preferences alongside green and neutral preferences, indicating that not all investors are aligning with the broader sustainability trend.

These results show that patterns consistent with capital market separation are evident and have become more pronounced over time, although a slight absolute decline has emerged in recent years. While firms are overall improving their carbon efficiency, investor preferences are playing a growing role in reinforcing the divergence between green and brown firms. The

[6] The detailed results for all deciles of the capital market separation are provided upon request.

substantial 32.80% decline in average shareholder preferences from the earliest to the most recent years in the dataset reflects the large-scale capital flows into sustainable investments. However, while firms in deciles 1 to 9 have significantly reduced their carbon intensity, this trend is not observed in decile 10. Across the full sample, firm-level carbon intensity has declined only marginally (8.54%). This suggests that while sustainable investing is associated with capital reallocation toward low-carbon firms, a subset of investors remains committed to high-emission companies. As a result, regulatory measures may be necessary to accelerate the transition of brown firms, which continue to attract this specific investor base despite prevailing shifts in the investment landscape.

Our descriptive analysis confirms the presence of capital market separation based on carbon intensity, demonstrating that firms with lower carbon intensity are predominantly owned by investors with low-carbon preferences. However, to rule out the possibility that the observed separation is driven by other confounding factors, we further test hypothesis H1 using a series of regression analyses. Specifically, we estimate the effect of carbon intensity on shareholder preferences while controlling for additional firm-level characteristics. As highlighted in the literature review, capturing the heterogeneity within investor types is a far better option than predefining investor categories and assuming uniform preferences within them (e.g., Bushee, 1998; Hoskisson et al., 2002). Nevertheless, our analysis includes separate variables for 17 investor types, representing the respective proportions of a firm's ownership held by the different investor categories to control for variations in ownership composition. Specifically, we calculate the ownership share ($Ownership\ share_{k,s,t}$), which captures the relative ownership stake of investor type k in firm s at time t. This measure ensures a comprehensive representation of shareholder structure by normalizing the ownership stakes of each investor type within a firm. The calculation of ownership share is presented in Equation (6):

$$Ownership\ share_{k,s,t} = \frac{Shares\ held_{k,s,t}}{\sum_{k=1}^{17} Shares\ held_{k,s,t}} \tag{6}$$

To avoid perfect multicollinearity, we omit a reference category from the model. Selecting an appropriate reference category is essential to ensure meaningful interpretation of the results. Ideally, the reference category should be widely represented across firms, such as the investor type "Bank and Trust", which serves this purpose effectively, as it does not systematically favor either high- or low-carbon firms and is not overly concentrated in specific industries or regions.[7] Therefore, it is chosen as the reference group. This approach allows us to assess how different investor types influence shareholder preferences relative to the reference group.

To test our primary hypothesis (H1) on the existence of capital market separation, we estimate multiple panel regressions of shareholder preference as a function of firms' CCP in period t, using carbon intensity as the primary carbon measure. We utilize the most frequently available data for each variable, up to a quarterly level. The regression model is presented in Equation (7), where λ_s captures the firm fixed effects, and τ_t represents the time fixed effects, respectively:

$$Shareholder\ preference_{s,t} = \alpha + \beta_1\ CCP_{s,t} + \eta'\ Controls_{s,t} + \lambda_s + \tau_t + \varepsilon_{s,t} \tag{7}$$

Our model specifications incorporate key firm-level financial metrics, including firm size, capital structure, profitability, and market performance. Firm size is measured as the natural logarithm of total assets, as larger firms tend to attract greater public attention and face increased scrutiny from stakeholders, which is a key driver of ESG performance—potentially attracting either green or brown investors depending on media sentiment (Zhao et al., 2023). Profitability is controlled for using return on equity (ROE), calculated as net income after preferred stock dividends divided by common equity, reflecting a firm's ability to generate

[7] See Table A4 in the Appendix for summary statistics on the different investor types.

earnings from its equity. We account for leverage, defined as the ratio of total debt to total financing, to capture the potential role of creditors in monitoring management and their impact on agency costs (Jensen and Meckling, 1976; Myers, 1977). Additionally, quarterly stock returns are included as an indicator of capital market performance, as they may influence investor preferences and capital allocation dynamics. To mitigate the influence of outliers, all variables are winsorized at the 1% and the 99% level, except for the ownership shares. Our empirical specification accounts for potential confounding factors by incorporating firm fixed effects and applying clustered standard errors at the firm level to ensure robust inference. The results are displayed in Table 3.

[Insert Table 3 here.]

The results consistently demonstrate a significant relationship between firm-CI and shareholder preference-CI, providing strong empirical support for our hypothesis H1. These findings underscore the existence of capital market segmentation based on climate-related factors even after accounting for several financial metrics, ownership composition, as well as firm and time fixed effects.

By excluding mechanical circularity—i.e., removing a firm's own holdings from the calculation of investor carbon preferences—we ensure that the measured preferences are not automatically influenced by the firm's carbon performance.[8] This adjustment strengthens the validity of our preference metric and reduces potential circularity in the classification of green and brown firms and investors. However, even after this adjustment, we cannot establish causality. It remains unclear whether observed capital market separation is driven by investor preferences or by other unaccounted factors. Therefore, the results should be interpreted as correlations rather than causal effects.

[8] See Subsection 5.1 for evidence in the form of a placebo test using randomized carbon intensities.

4.2 Temporal and Regional Capital Market Separation

Having established the presence of capital market separation in the overall sample, we now examine whether specific events or structural differences across regions relate to this separation over time. In particular, we analyze whether the Paris Agreement of 2015, a landmark event in global climate policy, is associated with a stronger alignment between CCP and shareholder preferences (H2). Furthermore, we assess whether capital market separation differs between the EU and the U.S., given their distinct approaches to sustainable finance and investor attitudes toward climate-related factors (H3).

To test the impact of the Paris Agreement, we split the sample into two periods—pre-Paris (before 2016) and post-Paris (2016 onward)—and re-estimate our regressions separately for both subperiods. The results presented in Table 4 indicate that capital market separation becomes significantly stronger in the post-Paris period, whereas no significant effect is observed before. This suggests that the Paris Agreement may have heightened investor awareness of climate risks and strengthened the link between firm-level carbon intensity and shareholder preferences. As shown in Figure 2, this shift is also descriptively reflected in the data, with a weakening of capital market separation between 2013 and 2016, followed by a reversal of this trend in the subsequent years.

[Insert Table 4 here.]

Next, we examine potential regional differences by comparing the EU and the U.S. As highlighted in Section 2, these markets differ significantly in their regulatory frameworks, institutional norms, and investor preferences toward sustainability. The results of these regression analyses are also displayed in Table 4. Our findings show that capital market separation is significant throughout the sample period only in the U.S., but not in the EU. However, the dynamics of this separation differ by region. In the U.S., where market-driven mechanisms dominate, capital market separation was not significant in the pre-Paris period. However, after the Paris Agreement, it became strongly pronounced, suggesting that the policy shift coincides with a greater role of investor climate preferences in capital allocation. This indicates that, prior to the Paris Agreement, climate-related investor preferences appear to have played little role in U.S. capital flows, likely due to lower overall awareness of climate change. In contrast, in the EU, capital market separation was highly significant before the Paris Agreement, reflecting the region's stronger focus on sustainability. However, this separation effect disappears post-Paris.

These results align with the findings of Bolton and Kacperczyk (2021b), who highlight that emissions have a stronger effect on stock returns in North America than in the EU. They attribute this to differences in environmental policies—arguing that the EU's standardized regulatory framework reduces disparities in firms' emissions, leading to more uniform ESG integration. In contrast, the U.S. regulatory environment allows firms greater autonomy in their climate strategies, resulting in stronger investor differentiation based on carbon performance.[9] This is consistent with the findings of Dreyer et al. (2023), who show that U.S. investors have developed a growing "taste for green" investing over time. This shift in investor preferences has contributed to the underperformance of green assets, as the increasing willingness to pay a premium for sustainability drives up asset prices and lowers expected returns. Their study, based on data up to 2015, indicates that this preference had been strengthening since the financial crisis—a trend that likely continued beyond the Paris Agreement. Furthermore, Bardos et al. (2025) suggest that green firms are more distinct and favored by climate-conscious investors in environments with weaker political support for climate action, higher exposure to physical climate risks, and more carbon-intensive areas. They argue that in such contexts, investor preferences play a larger role in capital allocation, while brown firms face relatively

[9] See the unpublished version of Bolton and Kacperczyk (2023) for these insights.

higher financing costs due to the potential for increased transition risks from future climate policy changes. This aligns with our observation that U.S. markets, characterized by these features, exhibit stronger capital market separation following the Paris Agreement.

Overall, these studies suggest that the divergence between the EU and U.S. markets could stem from differences in regulatory frameworks and investor behavior. The U.S. market, with its fragmented ESG disclosure landscape and broader heterogeneity of investor preferences, enables a stronger separation effect as investors freely allocate capital according to divergent climate views—both pro- and anti-sustainability. As a result, the post-Paris period has witnessed a pronounced bifurcation in capital flows, with climate-conscious investors concentrating in green firms and skeptical investors maintaining positions in high-carbon firms. By contrast, the EU market is shaped by standardized ESG reporting, regulatory mandates, and institutional support for sustainability. These factors have likely reduced the dispersion in firm-level carbon performance and fostered a more uniform investor base, moderating the separation effect. Bolton and Kacperczyk (2021b) argue that the gradual formation of an EU "single market" for sustainable finance—with harmonized reporting standards and stricter regulatory requirements—reduces cross-sectional heterogeneity in firm-level carbon performance. Consequently, the differentiation between green and brown firms in investor portfolios has diminished over time.

To empirically test whether climate policy stringency itself explains these patterns, we use the Climate Policy Score (CPS) and the Overall Score from the Climate Change Performance Index (CCPI), published annually by Germanwatch, the NewClimate Institute, and the Climate Action Network (Burck et al., 2025). The CPS provides a comparative assessment of climate policy ambition and implementation across countries, allowing us to classify them into low, medium, and high policy terciles for each year from 2007 to 2022.[10] The results of these regression analyses are displayed in Table 5.

[Insert Table 5 here.]

When comparing firms located in countries with high- versus low-CPS, we find no significant differences in the strength of capital market separation. In both groups, the separation effect is insignificant before the Paris Agreement but becomes significant afterward. This finding indicates that climate policy ambition, as captured by the CPS, does not directly explain the observed regional differences in capital market separation between the U.S. and the EU. Analyses using the CCPI Overall Score confirm the robustness of this finding.[11] Consequently, we can rule out the climate policy channel as the main driver of the divergence in capital market separation.[12]

Since regulatory stringency alone does not predict the extent of capital market segmentation, other institutional and behavioral factors—such as shifting investor sentiment and market-driven ESG dynamics—play a more decisive role. Previous research shows that the link between political orientation and climate change beliefs varies across countries and within U.S. states (e.g., Hornsey et al., 2018; Mildenberger et al., 2017). Building on this, Chan and Tam (2023) demonstrate that political divides on climate change are stronger in societies and states with higher individualism and fossil fuel dependence. Such cultural and socio-ecological factors are essential for understanding regional differences in climate-related

[10] The CCPI, available from 2007 onward, provides a comparative assessment of climate performance across four categories—greenhouse gas emissions, renewable energy, energy use, and climate policy—resulting in an Overall Score that captures both policy ambition and implementation outcomes. The Climate Policy Score itself is based on annual expert surveys, in which the strength and effectiveness of national and international government climate measures are evaluated.

[11] See Table IA1 in the Internet Appendix for regression results based on the CCPI Overall Score.

[12] Although our analysis is based on global data, EU countries in our sample consistently exhibit higher climate policy ambition, with a mean CPS of 10.95 compared to 5.69 in the U.S., and an CCPI Overall Score of 55.52 versus 37.95, respectively. Most countries in the EU are consistently classified as high-policy regions, while the U.S. remains predominantly in the low tercile.

opinions and behavior. Mani et al. (2018) document distinct regional reactions to the Paris Agreement, indicating that political and social contexts shape how climate policies are received.

While our results show that differences in climate policy stringency do not themselves generate variation in capital market separation, the broader political environment may nonetheless strongly influence how prominently green preferences are expressed in individual investment strategies. In regions with weak political support for sustainable investing but substantial exposure to the impacts of climate change—like the U.S.—investors may develop stronger personal preferences and act more proactively (Bardos et al., 2025). Conversely, in countries or regions with clear political signals that support the climate transition—like the EU—investors may rely more heavily on regulatory momentum and adopt a more passive stance. However, this does not imply that low climate policy stringency automatically leads to stronger market separation: awareness, financial capacity, and local investment culture may all constrain green investment behavior, for instance in developing markets. Such regional differences in investor actions are therefore intertwined with globally varying political and institutional environments.

In the U.S. specifically, the ESG debate has become increasingly polarized (Smith et al., 2024), with distinct investor segments either embracing or rejecting climate-conscious strategies. This polarization corresponds with stronger capital market separation, as opposing investor groups allocate capital along both ideological and financial lines. In contrast, investment practices in the EU embed sustainability more deeply, leading to broader but more moderate preferences for greener firms. Our findings for the U.S. market align with Görgen et al. (2025), who offer complementary evidence of capital market separation from U.S. stock lending data based on a post-Paris sample, demonstrating an additional micro-level channel through which investor preferences drive market segmentation. The Paris Agreement likely acted as a catalyst, accelerating pre-existing trends that had not yet resulted in significant market segmentation before 2016 in some regions.

Taken together, these results provide empirical support for our hypothesis H2, which posits stronger capital market separation post-Paris, but only for the full sample and the U.S. Our hypothesis H3, which posits that separation is stronger in the EU than in the U.S., is not supported. Capital market separation was highly significant in the EU before the Paris Agreement but lost significance afterward. In contrast, in the U.S., separation was not significant pre-Paris but became strongly pronounced post-Paris. However, analyses using the CCPI scores reveal no significant differences in capital market separation across different levels of climate policy stringency, implying that regulatory factors alone do not explain these regional dynamics.

5 Robustness Analyses

5.1 Placebo Test Using Randomized Carbon Intensities

To further test the robustness of our findings, we conduct a simulation by randomly assigning actual carbon intensities from our dataset to firms. This serves as a placebo test to assess whether the observed separation of green and brown firms across investor portfolios is a function of carbon preferences or merely based on systematic flaws in our methodology. In this simulation, the correlation between shareholders' carbon preferences and the reassigned carbon intensities should approach zero.

To implement this test, we randomly draw firm-CI values from the empirical distribution with replacement and assign them to firms while maintaining the original ownership structures of investor portfolios. This procedure is repeated 100 times,[13] using data from all four quarters of 2022, as this year exhibits one of the strongest capital market

[13] The numbers already converged after 20 repetitions.

separations in our main results and offers the most comprehensive emissions data coverage. While the test is conducted using 2022 data, the results can be generalized to other years, given that the same mechanism of random allocation applies across different periods. The results are displayed in Figure 4.

[Insert Figure 4 here.]

The results of the simulation exhibit no systematic differences between shareholder preference-CI across firm-CI deciles, whereas firms still display notable variation in their carbon intensities. The correlation between shareholder preference-CI and firm-CI is zero—as expected. This contrasts sharply with the observed empirical results, where firms with lower carbon intensities are systematically owned by investors with greener preferences, and vice versa. By confirming that the observed capital market separation is not a statistical artifact of our specific methodology, this placebo test strengthens the credibility of our findings and highlights the role of investor preferences in shaping market dynamics.

5.2 Emission Data Quality

Although we assume that investor preferences and capital allocation decisions—our main variables of interest—must inevitable be based on estimated emissions lacking reported data, a key concern in the literature is the reliability of carbon emission data, especially when model-estimated values are included alongside company-reported figures. Prior studies conclude that estimated emissions may introduce measurement error and bias and often fail to identify the worst emitters (Kalesnik et al., 2022). Others argue that estimated data may be used in cross-sectional analyses—which is the case in our study—without much bias whereas changes over time should be used with caution (Rohleder et al., 2022). Nevertheless, to address this concern, we rerun the main analyses after excluding firms that do not report Scope 1 and 2 emissions directly. The results, summarized in Table 6, remain highly significant and consistent with our primary findings. This indicates that the observed capital market separation is not driven by estimation noise in the emission data.

[Insert Table 6 here.]

5.3 Investor Type Composition

Another concern raised is that aggregating all shareholder types—ranging from institutional investors to governments or insiders—may dilute the interpretation of carbon preferences. Some investors, such as state owners of energy companies, may not plausibly reflect climate concerns, while persistent strategic holdings may not result from portfolio rebalancing. To address this issue, we restrict the sample to investor types that are plausibly motivated to align their portfolios with carbon-related preferences. These include investment advisors and hedge funds, pension funds, insurance companies, endowment funds, venture capital funds, and private equity funds. As shown in Table 7, the results remain strongly significant and consistent with our baseline results, suggesting that capital market separation is not driven by strategic or legacy holdings.

[Insert Table 7 here.]

5.4 Industry Scope

Moreover, one may question whether capital market separation is equally relevant across all industries, given that carbon emissions are not first-order in many sectors. To account for this, we restrict the sample to the most carbon-intensive TRBC business sectors—Basic Materials (Chemicals, Mineral Resources, Applied Resources), Energy (Energy - Fossil Fuels, Renewable Energy, Uranium), and Utilities—where emissions are economically most relevant.[14] Table 8 presents the results of this restricted sample. The findings again remain significant and consistent with our baseline results.

[Insert Table 8 here.]

5.5 Alternative Carbon Metrics

In our primary analysis, we have focused on carbon intensity as the key measure of CCP. To further test the robustness of our findings, we extend our analysis by incorporating total emissions alongside carbon intensity. While carbon intensity captures a firm's emissions relative to its financial scale, total emissions provide an absolute measure of a company's carbon footprint. By considering both relative and absolute emissions, we ensure that capital market separation is not solely driven by firm size effects but reflects broader investor preferences for carbon performance. Additionally, we examine alternative relative emission measures by replacing revenues with either market capitalization or enterprise value as the denominator. Enterprise value, as defined by Refinitiv, is calculated as the sum of market capitalization at the fiscal year-end date, preferred stock value, minority interest, and total debt, minus cash. We also test measures of risk sensitivity to climate-related factors, including carbon beta and the carbon risk rating.

In line with Görgen et al. (2020), the carbon beta (BMG beta) is constructed as the sensitivity of a stock's returns to a Brown-Minus-Green (BMG) factor, which represents the return differential between carbon-intensive (brown) and carbon-efficient (green) firms. The BMG factor is calculated by sorting firms into portfolios based on a carbon metric, such as carbon intensity, and computing the return difference between portfolios of high-emission (brown) and low-emission (green) companies. To estimate the carbon beta, we employ a multi-factor model incorporating the BMG factor alongside other standard risk factors, using a rolling

[14] See Table A2 in the Appendix for a comparison of industry-specific firm-CI.

regression over a 36-month window. Specifically, we extend the six-factor model of Fama and French (2018) by adding the BMG factor, ensuring that our analysis accounts for the most prominent return determinants in asset pricing beyond carbon risk. The regression in each window is specified in Equation (8):

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,MKT}\left(R_{MKT,t} - R_{f,t}\right) + \beta_{i,SMB}\, SMB_t + \beta_{i,HML}\, HML_t + \beta_{i,RMW}\, RMW_t + \beta_{i,CMA}\, CMA_t + \beta_{i,WML}\, WML_t + \beta_{i,BMG}\, BMG_t + \varepsilon_{i,t} \quad (8)$$

Here, $R_{i,t}$ denotes the return of stock i at time $t, R_{f,t}$ is the risk-free rate, and $R_{MKT,t}$ is the market return. The additional factors—Small-Minus-Big (SMB), High-Minus-Low (HML), Robust-Minus-Weak (RMW), Conservative-Minus-Aggressive (CMA), Winner-Minus-Loser (WML), and Brown-Minus-Green (BMG)—capture size, value, profitability, investment behavior, momentum, and carbon-specific risk, respectively. The coefficients are estimated using a 36-month rolling window, allowing for dynamic sensitivity assessments of stock returns to the factors over time.[15] Regarding the factor of interest—BMG—a positive beta indicates exposure to the effects of accelerated low-carbon transition-, while a negative beta reflects exposure to the effects of a decelerated transition.

The carbon risk rating, sourced from Sustainalytics via Morningstar Direct, employs a forward-looking methodology and evaluates a company's unmanaged carbon risk on a scale from 0 to 100 by considering both exposure and management dimensions. Exposure reflects the materiality of carbon risks across the value chain, including supply chains, operations, and products or services. Management assesses a firm's ability to mitigate these risks through effective policies and practices. The carbon risk rating ultimately represents the residual carbon risk after accounting for the company's mitigation efforts, distinguishing between

[15] The remaining six factors are sourced from the Kenneth R. French Data Library.

unmanageable risks and those that could be controlled but remain unaddressed (Morningstar, 2018).

Across all alternative carbon measures, we find consistent and robust evidence of capital market separation, further reinforcing our primary findings. After controlling for financial characteristics and ownership structure, the separation remains significant at the 1% level for all CCP measures, except for the carbon risk rating, which is only significant at the 10% level. When comparing the relative magnitudes of separation across different measures, we observe that it is most pronounced when scaling emissions by market capitalization and least for the carbon risk rating.[16] This suggests that the observed separation is more closely linked to investor preferences (taste) for green companies rather than differences in risk considerations. Notably, for the carbon intensity measure scaled by enterprise value, the degree of separation increased most significantly over time. Interestingly, while we find a capital market separation for the carbon risk rating, this separation does not increase over time. Moreover, across all CCP measures, shareholder preferences of the brownest firms have exhibited the smallest decline over time for all deciles, and in the case of the two alternative carbon intensity measures, shareholder preferences have even increased. This provides further evidence that capital markets do not only reflect green or neutral preferences but also a persistent demand for high-emission firms, supporting the existence of brown preferences.

However, several limitations related to the choice of carbon measures and data availability may affect the comparability of these results. Total emissions are highly correlated with firm size, which may conflate carbon preferences with size-based effects. Likewise, the carbon risk rating may be affected by selection bias, since Sustainalytics determines which firms receive ratings, potentially shaping the observed degree of separation. Furthermore, the

[16] See Figures IA1–IA15 for descriptive statistics and Tables IA2–IA6 in the Internet Appendix for regression results based on the alternative carbon performance metrics.

carbon risk rating and the carbon beta are available only from 2013 onward, leading to shorter observation periods compared to other CCP measures.

6 Conclusion and Implications

Our study provides strong empirical evidence for capital market separation, moving beyond theoretical assumptions by demonstrating that differences in corporate carbon performance shape investor preferences and are associated with distinct ownership patterns between green and brown companies. Such segmentation is a crucial precondition for the effectiveness of the impact channel via portfolio allocation, as it shows that investors do not just express preferences in theory but translate them into actual capital flows. For firms positioned at the boundary between green and brown markets, this implies that improving climate performance can strategically attract sustainability-focused investors, potentially lowering costs of capital. For policymakers, understanding the mechanisms behind capital market separation is crucial for designing incentives that enhance sustainable investment practices.

Our results indicate that overall investors' tastes for climate-related factors increased over the sample period. The Paris Agreement, however, had divergent effects on capital market separation across regions. In the U.S., where no significant separation was present before 2016—likely due to lower awareness of climate risks—a pronounced separation emerged post-Paris, potentially driven by increased polarization in investor preferences. Conversely, in the EU, capital market separation was already evident before 2016, reflecting a higher baseline awareness of climate risks.

Despite the robustness of our findings, some limitations must be acknowledged. First, while our dataset covers the largest and most significant ownership stakes in firms, averaging approximately two-thirds of total ownership over the observed period, investor preferences cannot be perfectly captured. This is primarily due to the absence of reporting obligations for small (private) investors, leading to gaps in the ownership data. However, institutional investors, such as mutual funds, largely reflect the aggregated preferences of their underlying investors, mitigating some of these concerns. Second, despite the comprehensive nature of our dataset, a significant number of firms are not required to report their emissions. This limits the overall data availability, particularly for Scope 3 emissions, and may introduce a bias toward firms with greater disclosure incentives. Nevertheless, it is noteworthy that our results remain robust despite these data constraints, reinforcing the validity of our findings on capital market separation. Third, although we employ multiple carbon metrics and also observe separation when considering risk-based measures, we do not investigate the motivation behind investor preferences, as such aspects cannot be directly inferred from capital market data. Our study does not distinguish between investors who prioritize climate factors based on taste or impact motives versus those driven purely by risk-return optimization, as our analysis is limited to measuring preferences reflected in portfolio choices. However, this distinction is not essential for establishing the existence of capital market separation.

Future research should explore the long-term implications of capital market separation, particularly in relation to financing costs and corporate sustainability transitions. Moreover, survey-based or experimental studies could provide valuable evidence on the underlying drivers behind investor preferences, thereby deepening our understanding of the evolving role of sustainability in financial decision-making. Ultimately, understanding the dynamics of capital market separation is essential for policymakers aiming to design incentives that promote sustainable investment practices, as well as investors, and corporations seeking to navigate the transition to a more sustainable global economy. Our results contribute to this growing body of knowledge by providing empirical evidence of how investor preferences translate into capital allocation patterns, revealing a key mechanisms through which sustainable finance can drive meaningful change.

Appendix

Table A1: Global market capitalization and ownership coverage of the ownership sample

Year	Global market capitalization (World Bank)	Aggregated market capitalization in stock dataset		Ownership data			
	$ Trillion	$ Trillion	As % of global market capitalization	Number of owners	Number of firms held	Value held in $ trillion	Covered ownership share
2004	36.54	33.07	90.50%	105,850	15,744	18.72	56.60%
2005	40.51	37.66	92.96%	129,311	17,135	22.16	58.84%
2006	50.07	46.28	92.42%	147,411	17,666	27.81	60.09%
2007	60.46	55.98	92.60%	166,621	18,596	34.82	62.21%
2008	32.42	29.75	91.77%	171,573	18,524	19.88	66.83%
2009	47.47	42.75	90.05%	175,728	18,697	27.14	63.48%
2010	54.26	49.20	90.68%	178,492	19,072	32.48	66.02%
2011	47.52	43.41	91.35%	183,314	19,170	28.46	65.56%
2012	54.50	49.42	90.67%	178,106	19,245	32.55	65.86%
2013	64.37	58.82	91.38%	177,906	19,405	39.87	67.79%
2014	67.18	59.65	88.79%	178,092	19,393	40.83	68.44%
2015	62.27	61.89	99.39%	193,313	20,219	42.66	68.93%
2016	65.12	63.74	97.88%	203,201	20,268	44.15	69.26%
2017	79.50	77.95	98.05%	211,662	20,523	54.32	69.68%
2018	69.03	66.86	96.86%	222,807	20,466	47.20	70.60%
2019	79.41	83.91	105.66%	222,887	20,287	59.55	70.97%
2020	95.20	98.06	103.01%	215,742	20,352	69.18	70.55%
2021	111.16	111.19	100.03%	223,712	19,573	79.53	71.53%
2022	93.69	89.02	95.02%	221,670	19,042	63.00	70.77%
Mean	63.72	60.98	94.69%	184,600	19,125	41.28	66.53%
Count				753,349	30,723		

This table shows summary statistics for the yearly coverage of global market capitalization and ownership data for our ownership sample from 2004 to 2022. Global market capitalization is the worldwide market value of common equity according to World Bank (2024). Aggregated market capitalization is the aggregated market value at each year-end out of our sample of 30,723 firms. The values exceeding 100% in certain years arise due to reporting discrepancies across countries in the World Bank's dataset. We report ownership data, including the number of owners observed, the number of firms held, the value held in $ trillion, and the covered ownership share, expressed as a proportion of aggregate market capitalization. The data are from the RDW database, ROP database, and World Bank (2024).

Table A2: Summary statistics by industry

Industry	Number of firms	Covered ownership share	Firm-TE	Firm-CI	Shareholder preference -TE	Shareholder preference -CI
Academic & Educational Services	44	78.91%	32.44	40.44	2,508.57	156.02
Applied Resources	140	71.60%	2,018.09	404.80	3,146.43	231.99
Automobiles & Auto Parts	252	67.06%	870.77	110.51	2,907.42	158.38
Banking & Investment Services	1,275	64.01%	77.43	24.22	3,247.51	199.11
Chemicals	365	65.93%	3,621.17	565.03	3,519.70	196.38
Collective Investments	63	46.59%	112.46	239.23	2,522.68	175.12
Consumer Goods Conglomerates	54	60.23%	2,772.46	226.11	3,471.32	245.23
Cyclical Consumer Products	420	74.40%	355.08	69.39	2,973.68	161.94
Cyclical Consumer Services	553	74.40%	286.88	108.91	2,567.03	152.71
Energy - Fossil Fuels	623	66.79%	6,566.70	869.15	4,075.45	306.57
Financial Technology (Fintech) & Infrastructure	33	70.46%	26.19	38.34	2,049.94	119.92
Food & Beverages	490	69.55%	832.37	150.78	2,692.41	175.96
Food & Drug Retailing	132	68.14%	1,264.29	55.40	2,885.02	168.82
Healthcare Services & Equipment	482	77.26%	174.43	64.43	2,786.19	164.23
Industrial & Commercial Services	658	70.69%	724.31	112.00	3,165.20	180.19
Industrial Goods	666	70.53%	303.01	54.06	3,346.09	174.95
Insurance	272	71.12%	73.56	33.72	3,445.31	183.05
Investment Holding Companies	53	63.94%	766.72	324.26	3,949.40	159.68
Mineral Resources	652	62.13%	6,692.22	1,299.00	3,196.84	270.32
Personal & Household Products & Services	90	73.99%	602.82	80.08	3,003.94	153.61
Pharmaceuticals & Medical Research	849	70.49%	142.53	250.42	2,201.99	168.82
Real Estate	795	71.25%	180.89	157.44	2,661.18	170.48
Renewable Energy	71	69.93%	592.46	342.89	3,059.84	165.10
Retailers	365	79.09%	271.85	54.74	2,769.74	165.06
Software & IT Services	777	76.41%	111.93	29.85	2,578.57	146.26
Technology Equipment	627	69.36%	413.93	78.40	3,023.86	163.54
Telecommunications Services	220	68.25%	1,141.59	115.75	3,476.67	233.81
Transportation	377	65.44%	3,487.42	478.49	3,715.70	222.84
Uranium	15	46.86%	117.81	1,158.96	2,253.60	214.84
Utilities	399	65.81%	14,777.19	2,251.49	5,166.86	375.66

This table shows descriptive statistics by business sector, based on the Thomson Reuters Business Classification (TRBC) over the sample period from 2004 to 2022. It reports ownership details, including the number of firms per industry and the mean covered ownership share, expressed as a proportion of aggregate market capitalization. Additionally, it provides information on carbon emissions data, such as the mean firm-TE (in kt CO_2e), the mean firm-CI (in t CO_2e per $ million revenues) per firm within each industry, and the mean shareholder preferences for total emissions and carbon intensity.

Table A3: Summary statistics by country

Country	Number of firms	Covered ownerhip share	Firm-TE	Firm-CI	Shareholder preference -TE	Shareholder preference -CI
Argentina	55	44.40%	1,454.67	931.20	1,915.59	728.37
Australia	534	47.71%	780.57	398.09	2,128.84	181.89
Austria	39	64.03%	2,052.03	344.42	2,583.47	128.91
Belgium	56	56.80%	900.32	301.41	3,369.30	132.73
Bermuda	52	78.81%	539.82	469.03	3,397.75	277.08
Brazil	145	69.51%	2,390.18	387.40	3,404.36	215.09
Canada	538	55.44%	1,193.17	552.05	2,958.46	258.93
Cayman Islands	12	77.71%	194.61	374.14	2,488.98	154.67
Chile	43	82.13%	3,117.08	858.58	1,959.41	388.84
China	1,130	65.05%	3,759.28	406.70	2,061.70	165.58
Colombia	23	79.57%	2,700.43	575.98	1,922.44	345.76
Cyprus	13	72.39%	299.06	205.85	1,949.27	111.31
Denmark	65	50.78%	2,409.08	143.74	4,177.31	161.43
Egypt	14	62.39%	330.10	163.71	966.55	67.81
Finland	82	57.04%	1,242.25	203.69	3,243.41	226.62
France	175	63.64%	4,002.47	217.31	4,722.96	146.84
Germany	292	62.34%	3,299.60	168.46	3,079.65	132.10
Greece	37	53.64%	2,262.43	499.11	3,247.50	250.56
Guernsey	18	64.47%	18.73	492.74	2,994.15	179.95
Hong Kong	179	69.70%	2,653.21	716.57	2,125.13	203.04
India	453	77.38%	3,657.41	727.56	4,538.32	516.58
Indonesia	68	74.19%	2,032.08	869.05	1,275.37	225.30
Ireland	61	74.15%	1,152.63	166.44	3,916.86	183.39
Israel	41	60.38%	496.12	148.69	1,455.89	84.49
Italy	116	62.33%	3,738.07	342.33	5,234.12	163.47
Japan	502	50.44%	2,252.47	203.81	3,283.28	164.73
Jersey	11	68.69%	267.38	826.95	2,672.55	165.25
Korea; South	172	61.42%	1,924.53	147.67	2,709.32	120.80
Kuwait	14	51.55%	140.48	86.60	2,092.48	97.30
Luxembourg	38	70.91%	5,763.65	372.00	3,761.54	162.32
Malaysia	205	76.48%	1,504.28	560.14	2,227.35	396.40
Mexico	67	52.92%	2,458.62	342.05	2,169.55	123.15
Netherlands	93	58.14%	798.77	127.63	3,696.23	164.69
New Zealand	62	44.04%	279.33	298.61	1,384.22	151.86
Norway	87	68.38%	1,828.74	372.86	3,225.09	171.88
Peru	31	76.09%	357.79	595.95	1,235.56	292.90
Philippines	31	69.91%	1,087.35	637.97	1,031.47	203.30
Poland	42	76.65%	3,868.92	764.14	4,508.00	507.26
Portugal	17	70.07%	3,379.09	732.09	2,464.19	143.62
Qatar	44	45.44%	174.32	226.38	2,138.94	234.48
Russia	56	62.51%	13,031.41	1,191.02	5,843.63	326.16
Saudi Arabia	39	50.69%	4,998.09	501.89	11,035.53	361.94
Singapore	111	62.74%	1,424.00	326.29	2,060.84	162.56
South Africa	151	76.89%	1,256.15	525.23	3,621.71	329.03
Spain	90	59.94%	3,212.77	340.56	3,089.67	158.04
Sweden	311	65.05%	281.50	155.86	1,785.03	115.88
Switzerland	214	58.32%	1,429.91	150.55	3,023.22	136.93
Taiwan	174	51.39%	1,234.57	286.97	2,524.09	215.91
Thailand	136	58.45%	2,840.83	597.29	2,790.27	270.47
Turkey	88	71.57%	2,282.52	743.45	1,177.94	142.68
United Arab Emirates	24	63.12%	803.75	137.86	1,487.33	101.38
United Kingdom	768	76.22%	1,592.25	229.42	4,189.48	184.88
United States of America	3,992	85.13%	1,499.82	264.05	3,347.12	189.30

This Table shows the number of firms, mean covered ownership share as a proportion of aggregate market capitalization over the sample period from 2004 to 2022. Additionally, it provides information on carbon emissions data, such as the mean firm-TE (in kt CO_2e), the mean firm-CI (in t CO_2e per $ million revenues) per firm within each country, and the mean shareholder preferences for total emissions and carbon intensity. The country refers to the location of the firm's headquarters.

Table A4: Portfolio characteristics by investor type

Investor type	Number of investors	Value held in $ tsd.	Number of firms held	Portfolio return	Investor preference -TE	Investor preference -TE (SD)	Investor preference -CI	Investor preference -CI (SD)
Bank and Trust	950	1,429,629	127.19	3.00%	1,635.39	2,266.57	295.08	551.41
Corporation	31,171	695,576	2.27	2.30%	462.62	1,674.08	322.92	976.60
Endowment Fund	34	906,634	25.72	3.60%	1,319.74	2,826.26	359.29	1,012.25
Hedge Fund	2,348	825,826	53.81	4.50%	607.79	1,094.07	268.74	562.35
Holding Company	556	2,342,312	5.53	3.00%	502.30	1,639.77	350.05	937.42
Individual Investor	236,248	31,026	1.12	2.80%	378.01	1,564.50	270.16	886.48
Institutions	144	48,341	1.07	1.20%	233.06	907.82	217.34	615.09
Insurance Company	370	3,654,766	70.81	3.00%	944.96	1,570.70	246.86	483.71
Investment Advisor	12,035	2,122,312	144.30	3.70%	1,191.49	1,579.89	251.11	408.44
Investment Adv./Hedge F.	2,298	6,770,919	251.50	4.00%	1,116.22	1,605.83	278.26	427.50
Other Insider Investor	2,590	1,335,590	1.14	2.80%	255.24	1,318.57	255.34	911.41
Others	816	9,696,400	10.64	2.80%	1,043.53	2,517.98	406.36	828.03
Pension Fund	394	6,074,558	274.06	3.40%	1,053.09	1,485.75	313.29	608.81
Private Equity	696	663,942	5.25	3.20%	345.31	1,298.11	357.29	1,092.56
Research Firm	275	5,405,366	327.72	3.00%	869.54	1,324.72	224.76	404.75
Sovereign Wealth Fund	52	26,104,863	258.66	3.10%	1,620.65	2,546.92	440.02	870.33
Venture Capital	381	360,574	6.67	3.20%	108.15	544.72	320.88	1,160.96

This table shows summary statistics of portfolio characteristics categorized by the Refinitiv's predefined typology. Portfolio characteristics are shown as mean values or standard deviations (SD) within each investor type over the sample period from 2004 to 2022. Investor preference-TE is displayed in kt CO_2e. Investor preference-CI is displayed in t CO_2e per $ million revenues.

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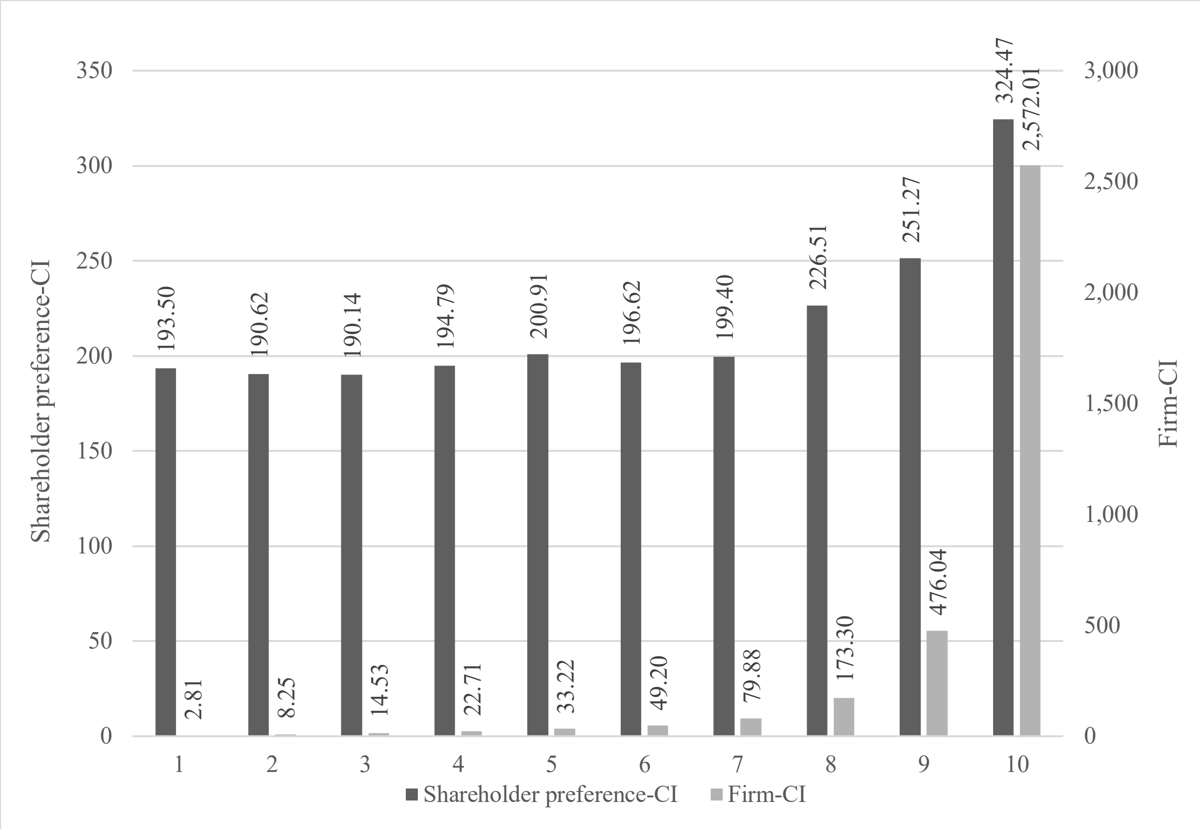
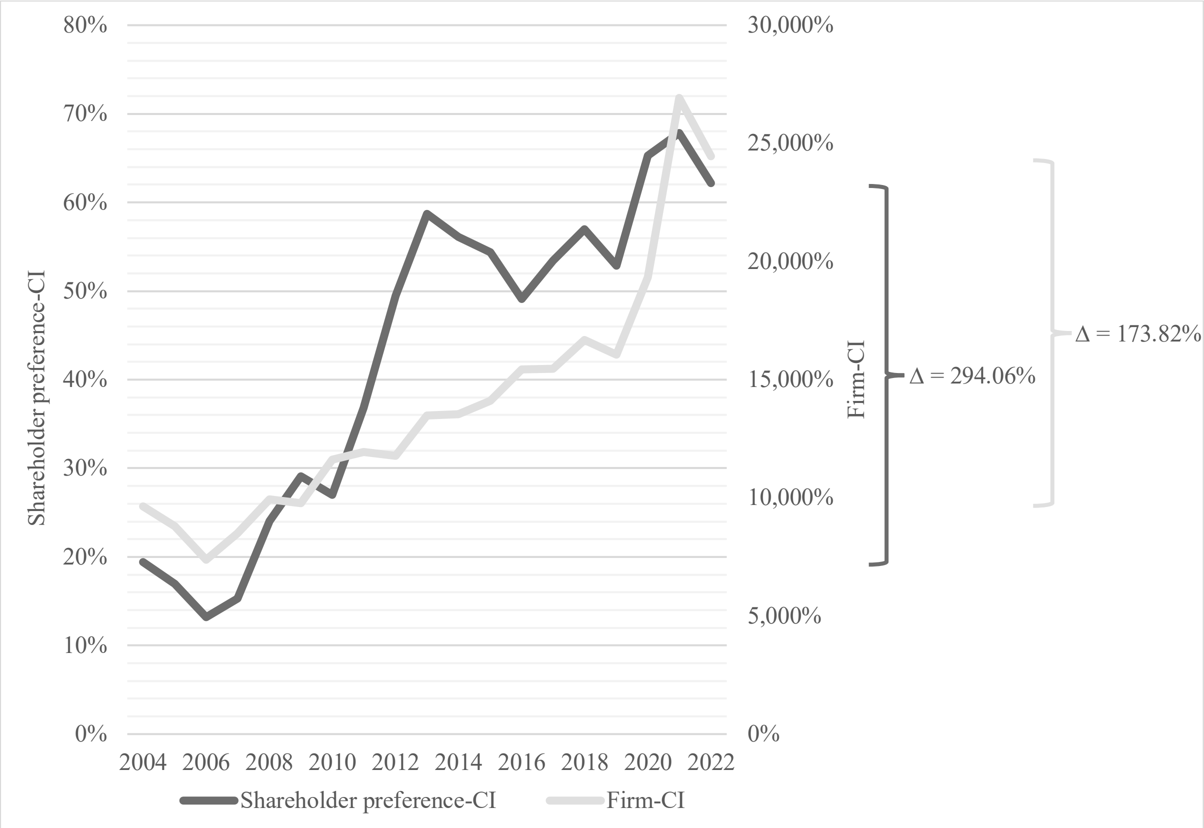
Figures

Figure 1: Mean shareholder preference-CI and firm-CI sorted by firm-CI deciles



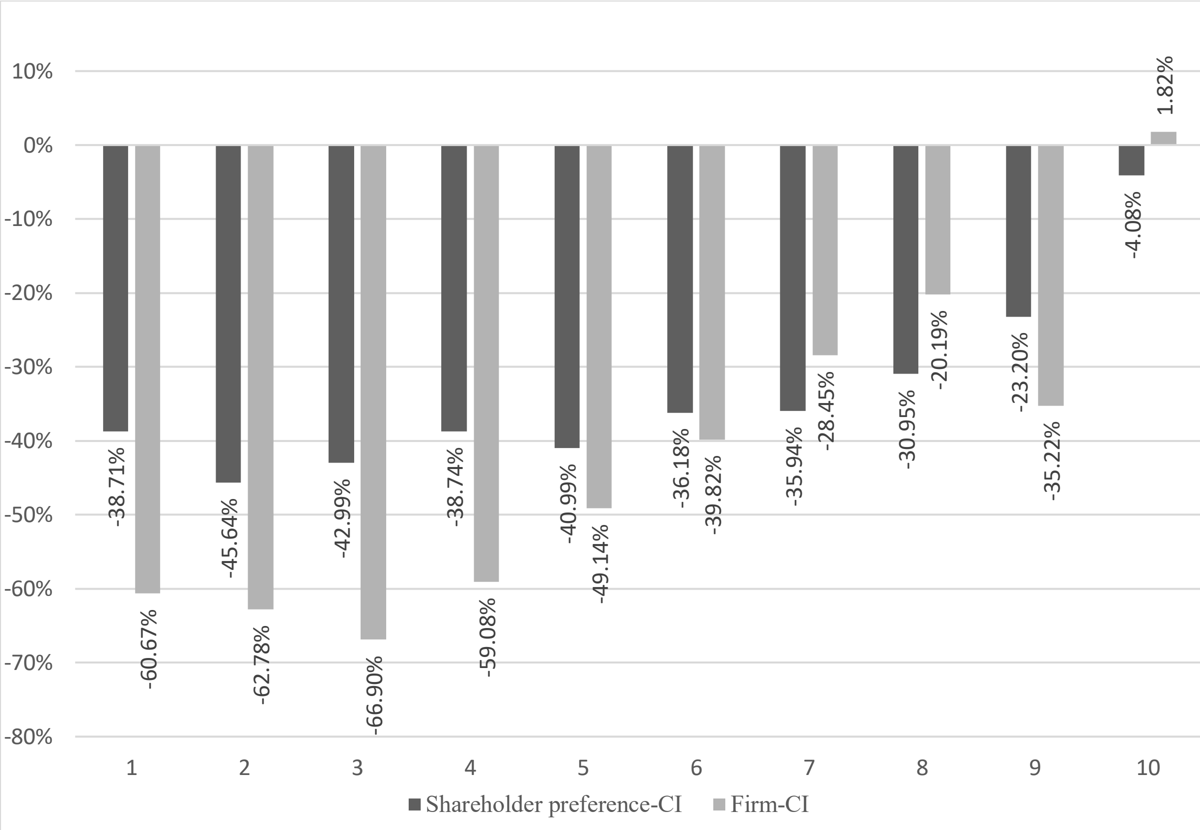
This figure shows mean values for shareholder preference-CI and firm-CI sorted by firm-CI deciles over the study period from 2004 to 2022. CI denotes carbon intensity, measured as total emissions scaled by revenues (in t CO_2e per $ million revenues). Decile 1 represents the values for firms with the lowest carbon intensities, while decile 10 represents those with the highest carbon intensities.

Figure 2: Temporal development of the relative difference between the mean shareholder preference-CI and firm-CI of high-carbon firms (deciles 8–10) and low-carbon firms (deciles 1–3)



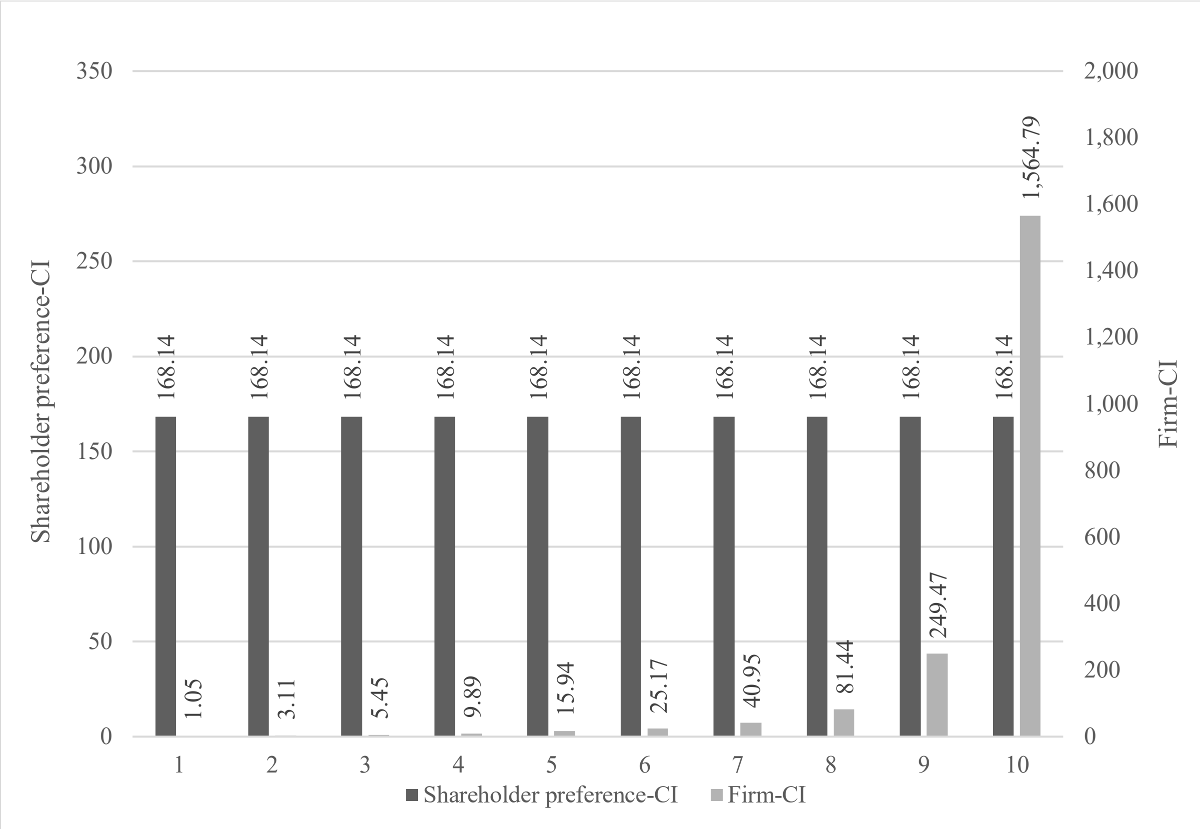
This figure shows the relative difference (in percent) in mean shareholder preference-CI and firm-CI between high-carbon firms (deciles 8–10) and low-carbon firms (deciles 1–3) over the study period from 2004 to 2022, including the relative difference (in percent) between the first three years (2004–2006) and the last three years (2020–2022) of the study period. CI denotes carbon intensity, measured as total emissions scaled by revenues (in t CO_2e per $ million revenues).

Figure 3: Relative changes in shareholder preference-CI and firm-CI sorted by firm-CI deciles



This figure shows the development of shareholder preference-CI and firm-CI for each decile, comparing the relative changes (in percent) between the first three years (2004–2006) and the last three years (2020–2022) of the study period. CI denotes carbon intensity, measured as total emissions scaled by revenues (in t CO_2e per $ million revenues). Decile 1 represents the values for the companies with the lowest carbon intensities, while decile 10 represents the values for the firms with the highest carbon intensities.

Figure 4: Robustness—Mean shareholder preference-CI and firm-CI sorted by firm-CI deciles (randomized firm-CI)



This figure shows mean values for shareholder preference-CI and firm-CI sorted by firm-CI deciles for the year 2022, based on the placebo test using randomized carbon intensities. CI denotes carbon intensity, measured as total emissions scaled by revenues (in t CO_2e per $ million revenues). Decile 1 represents the values for firms with the lowest carbon intensities, while decile 10 represents those with the highest carbon intensities.

Tables

Table 1: Global market capitalization and ownership coverage of the study sample

Year	Global market capitalization (World Bank)	Aggregated market capitalization in stock dataset		Ownership data			
	$ Trillion	$ Trillion	As % of global market capitalization	Number of owners	Number of firms held	Value held in $ trillion	Covered ownership share
2004	36.54	19.99	54.71%	20,733	1,418	11.10	55.50%
2005	40.51	25.35	62.57%	27,822	1,864	14.29	56.40%
2006	50.07	32.16	64.22%	30,724	2,046	18.49	57.50%
2007	60.46	38.48	63.65%	33,825	2,238	23.94	62.20%
2008	32.42	23.14	71.38%	37,894	2,568	15.35	66.35%
2009	47.47	33.02	69.56%	41,654	2,966	20.63	62.49%
2010	54.26	38.45	70.86%	45,486	3,508	25.07	65.21%
2011	47.52	34.97	73.59%	48,032	3,758	22.54	64.47%
2012	54.50	40.17	73.70%	47,227	3,874	26.01	64.74%
2013	64.37	47.61	73.97%	47,614	3,976	31.77	66.72%
2014	67.18	46.88	69.79%	47,815	3,993	31.89	68.02%
2015	62.27	47.87	76.88%	60,127	4,632	33.21	69.38%
2016	65.12	51.38	78.90%	76,658	5,467	36.06	70.18%
2017	79.50	66.45	83.58%	90,634	6,571	46.90	70.58%
2018	69.03	59.21	85.78%	100,833	7,335	42.24	71.34%
2019	79.41	76.58	96.43%	113,585	8,345	55.13	71.99%
2020	95.20	91.48	96.10%	124,876	9,493	65.35	71.43%
2021	111.16	104.08	93.63%	133,658	9,724	75.19	72.24%
2022	93.69	84.16	89.83%	137,414	9,910	60.17	71.50%
Mean	63.72	50.78	76.27%	66,664	4,931	34.49	66.22%
Count				291,358	11,811		

This table shows summary statistics for the yearly coverage of global market capitalization and ownership data for our study sample from 2004 to 2022. Global market capitalization is the worldwide market value of common equity according to World Bank (2024). Aggregated market capitalization is the aggregated market value at each year-end out of our sample of 11,811 firms. We report ownership data, including the number of owners observed, the number of firms held, the value held in $ trillion, and the covered ownership share, expressed as a proportion of aggregate market capitalization. The data are from the RDW database, ROP database, and World Bank (2024).

Table 2: Descriptive statistics

Panel A. Summary statistics

	N	Mean	Standard deviation	p1	Median	p99
Firm-level						
Shareholder preference-TE	350,911	3,155.71	3,415.72	25.27	2,601.72	15,259.64
Shareholder preference-CI	350,911	199.25	301.10	2.64	154.87	1,373.25
Firm-TE	350,911	1,948.29	7,586.67	0.05	71.84	45,200.00
Firm-CI	350,421	335.27	1,020.35	0.28	35.16	6,287.43
Revenues	350,911	6.89	14.48	0.00	1.92	83.18
Market capitalization	350,911	10.38	35.77	0.03	3.06	126.44
Total assets	347,662	26.00	83.68	0.05	4.24	464.69
Return on equity	345,338	6.27	44.69	-191.97	10.31	135.25
Leverage	350,911	37.88	26.27	0.00	36.35	99.90
Stock return	350,156	2.69	21.12	-48.63	1.82	67.99
Investor-level						
Investor preference-TE	4,811,001	1,927.75	6,413.83	0.07	96.38	34,839.90
Investor preference-CI	4,811,001	275.84	857.49	0.31	39.34	4,987.91

Panel B. Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Shareholder preference-TE	1.00									
(2) Shareholder preference-CI	0.51	1.00								
(3) Firm-TE	0.23	0.13	1.00							
(4) Firm-CI	0.07	0.16	0.47	1.00						
(5) Revenues	0.20	0.03	0.39	-0.03	1.00					
(6) Market capitalization	0.10	0.01	0.17	-0.03	0.50	1.00				
(7) Total assets	0.14	0.02	0.12	-0.04	0.47	0.37	1.00			
(8) Return on equity	0.07	0.00	0.02	-0.05	0.08	0.09	0.03	1.00		
(9) Leverage	0.06	0.02	0.07	0.02	0.11	0.03	0.22	-0.06	1.00	
(10) Stock return	-0.01	0.00	0.00	0.00	-0.01	0.02	-0.01	0.07	-0.03	1.00

Panel A of this table shows summary statistics for firm characteristics relating to 11,811 distinct firms over the sample period from 2004 to 2022. All displayed variables are winsorized at the 1% and the 99% level. Firm-TE, shareholder preference-TE, and investor preference-TE are displayed in kt CO_2e. Firm-CI, shareholder preference-CI, and investor preference-CI are displayed in t CO_2e per $ million revenues. Revenues, market capitalization, and total assets are displayed in $ billion. Return on equity is calculated as net income after preferred stock dividends divided by common equity (in percent). Leverage is the ratio of total debt to total financing (in percent). Stock return is the quarterly return (in percent). Panel B shows Pearson correlations for key variables and each pair of variables used in our main analysis.

Table 3: Panel regression of shareholder preference-CI on firm-CI

Dependent: Shareholder preference-CI	(1)	(2)	(3)
Firm-CI	0.008***	0.046***	0.007***
	(3.005)	(6.266)	(2.671)
Firm size (log. total assets)	-25.827***	2.424**	-4.785*
	(-10.290)	(1.966)	(-1.677)
Return on equity	0.111**	-0.088***	0.022
	(2.572)	(-2.732)	(0.519)
Leverage	0.014	-0.003	0.176*
	(0.153)	(-0.026)	(1.872)
Stock return	-0.059***	0.016	-0.023
	(-3.468)	(0.511)	(-1.114)
Ownership share Corporation	-2.801***	0.835**	-2.219***
	(-3.669)	(2.063)	(-2.835)
Ownership share Endowment Fund	-0.364	0.117	1.431
	(-0.069)	(0.104)	(0.300)
Ownership share Hedge Fund	-1.171	1.807***	-0.422
	(-1.501)	(4.639)	(-0.527)
Ownership share Holding Company	-1.682*	1.716***	-1.302
	(-1.767)	(3.228)	(-1.334)
Ownership share Individual Investor	-3.159***	-0.408	-2.672***
	(-3.608)	(-1.141)	(-2.977)
Ownership share Institutions	-4.455***	-1.881***	-4.365***
	(-4.373)	(-4.161)	(-3.938)
Ownership share Insurance Company	1.053	2.860***	0.679
	(0.870)	(3.234)	(0.540)
Ownership share Investment Advisor	-1.005	1.668***	-0.488
	(-1.316)	(4.384)	(-0.623)
Ownership share Investment Adv./Hedge F.	-1.850**	0.867**	-0.970
	(-2.413)	(2.406)	(-1.229)
Ownership share Other Insider Investor	-2.924***	-0.224	-2.413**
	(-2.692)	(-0.481)	(-2.235)
Ownership share Others	1.297	4.835***	1.748
	(1.128)	(7.641)	(1.511)
Ownership share Pension Fund	-1.150	3.130***	-0.561
	(-1.388)	(5.621)	(-0.666)
Ownership share Private Equity	0.024	1.488**	0.620
	(0.017)	(2.342)	(0.444)
Ownership share Research Firm	-1.764**	-0.067	-1.349*
	(-2.217)	(-0.144)	(-1.674)
Ownership share Sovereign Wealth Fund	-2.270***	1.882***	-1.201
	(-2.859)	(4.030)	(-1.479)
Ownership share Venture Capital	-0.221	1.674***	0.114
	(-0.232)	(3.388)	(0.118)
Firm fixed effects	Yes	No	Yes
Time fixed effects	No	Yes	Yes
N	343,380	344,194	343,380
Adjusted R^2	0.61	0.08	0.61

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, controlling for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 4: Panel regression of shareholder preference-CI on firm-CI (Temporal and regional separation)

Dependent: Shareholder preference-CI	Pre-Paris	Post-Paris	U.S.	EU	U.S. Pre-Paris	EU Pre-Paris	U.S. Post-Paris	EU Post-Paris
Firm-CI	0.002	0.012***	0.011***	0.006	0.001	0.021***	0.016***	0.009
	(1.004)	(4.327)	(4.294)	(1.058)	(0.201)	(2.827)	(4.642)	(1.450)
Firm size (log. total assets)	2.714	-12.880***	-4.196*	-10.567*	-3.121	6.631	-2.574	-18.994**
	(0.791)	(-2.976)	(-1.738)	(-1.846)	(-1.240)	(0.913)	(-0.620)	(-2.124)
Return on equity	0.125	0.018	0.010	0.088	0.179	0.366	-0.001	0.063
	(1.633)	(0.424)	(0.340)	(0.974)	(1.393)	(1.282)	(-0.018)	(0.771)
Leverage	0.189*	0.226*	-0.039	0.124	-0.179	0.601**	-0.036	0.149
	(1.914)	(1.784)	(-0.435)	(0.660)	(-0.995)	(2.015)	(-0.297)	(0.786)
Stock return	-0.050	-0.010	-0.016	0.006	-0.086	-0.013	-0.005	0.028
	(-1.305)	(-0.518)	(-0.684)	(0.131)	(-1.254)	(-0.172)	(-0.209)	(0.437)
Ownership share controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	136,574	206,287	108,599	47,841	35,953	21,464	72,287	26,347
Adjusted R^2	0.71	0.68	0.49	0.53	0.46	0.61	0.44	0.55

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, with separate analyses for the pre- and post-Paris Agreement periods, as well as the U.S. and EU. Additionally, regional subsamples are further divided into pre- and post-Paris Agreement periods. The regressions control for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return table (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 5: Panel regression of shareholder preference-CI on firm-CI (Climate Policy Score)

Dependent: Shareholder preference-CI	Low-CPS	High-CPS	Low-CPS Pre-Paris	High-CPS Pre-Paris	Low-CPS Post-Paris	High-CPS Post-Paris
Firm-CI	0.006**	0.015**	0.002	0.005	0.009***	0.018***
	(2.010)	(2.480)	(0.480)	(1.111)	(2.783)	(3.607)
Firm size (log. total assets)	-10.113**	2.790	1.681	1.055	-12.490**	1.021
	(-2.417)	(0.541)	(0.278)	(0.173)	(-2.085)	(0.129)
Return on equity	-0.008	0.215	0.096	0.069	0.013	0.151
	(-0.323)	(1.384)	(1.086)	(0.870)	(0.394)	(1.005)
Leverage	0.003	0.453*	0.169	0.511***	0.003	0.449
	(0.034)	(1.929)	(1.311)	(2.939)	(0.035)	(1.480)
Stock return	0.001	-0.069*	-0.055*	-0.043	0.044*	-0.071**
	(0.043)	(-1.952)	(-1.760)	(-0.652)	(1.744)	(-2.040)
Ownership share controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	129,443	104,992	51,746	33,496	77,612	71,419
Adjusted R^2	0.59	0.70	0.68	0.82	0.70	0.73
t-test (Firm-CI: Low = High)	[-1.30]		[-0.65]		[-1.44]	

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, with separate analyses for firms with headquarters in countries with a low-Climate Policy Score and high-Climate Policy Score. Additionally, these subsamples are further divided into pre- and post-Paris Agreement periods. The regressions control for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return table (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). [ ] denote t-statistics for tests of equality of the firm-CI coefficient between low- and high-CPS subsamples, reported for the full sample, pre-, and post-Paris Agreement periods. Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 6: Robustness—Panel regression of shareholder preference-CI on firm-CI (reported emissions only)

Dependent: Shareholder preference-CI	(1)	(2)	(3)
Firm-CI	0.009***	0.048***	0.006**
	(2.968)	(4.281)	(2.427)
Firm size (log. total assets)	-42.336***	-1.334	-13.414***
	(-9.606)	(-0.804)	(-3.003)
Return on equity	0.063	-0.001	-0.026
	(1.396)	(-0.024)	(-0.583)
Leverage	-0.249**	-0.376**	0.035
	(-2.023)	(-2.157)	(0.292)
Stock return	-0.029	0.133**	0.039
	(-1.289)	(2.418)	(1.556)
Ownership share controls	Yes	Yes	Yes
Firm fixed effects	Yes	No	Yes
Time fixed effects	No	Yes	Yes
N	163,624	163,839	163,624
Adjusted R^2	0.67	0.10	0.68

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, controlling for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 7: Robustness—Panel regression of shareholder preference-CI on firm-CI (selected investor types)

Dependent: Shareholder preference-CI	(1)	(2)	(3)
Firm-CI	0.004***	0.017***	0.003**
	(2.669)	(12.227)	(2.105)
Firm size (log. total assets)	-36.988***	-4.977***	-4.013**
	(-18.381)	(-6.992)	(-2.186)
Return on equity	0.134***	-0.047**	-0.003
	(5.207)	(-2.108)	(-0.120)
Leverage	-0.108	0.140***	0.141**
	(-1.547)	(3.290)	(2.288)
Stock return	-0.063***	0.119***	0.005
	(-5.081)	(4.656)	(0.332)
Ownership share controls	Yes	Yes	Yes
Firm fixed effects	Yes	No	Yes
Time fixed effects	No	Yes	Yes
N	342,401	343,204	342,401
Adjusted R^2	0.55	0.11	0.60

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, controlling for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 8: Robustness—Panel regression of shareholder preference-CI on firm-CI (selected industries)

Dependent: Shareholder preference-CI	(1)	(2)	(3)
Firm-CI	0.013**	0.046***	0.005**
	(2.560)	(4.503)	(2.113)
Firm size (log. total assets)	-63.688***	18.766***	-7.949
	(-5.217)	(2.884)	(-0.612)
Return on equity	0.314***	0.382***	0.160
	(2.702)	(3.204)	(1.499)
Leverage	0.527	0.475	0.539
	(1.215)	(0.871)	(1.251)
Stock return	-0.254***	0.002	-0.176**
	(-3.561)	(0.012)	(-2.050)
Ownership share controls	Yes	Yes	Yes
Firm fixed effects	Yes	No	Yes
Time fixed effects	No	Yes	Yes
N	72,010	72,208	72,010
Adjusted R^2	0.67	0.20	0.69

This table shows quarterly panel regression estimates of shareholder preference-CI as a function of firm-CI, controlling for key financial and ownership characteristics. Firm size is the natural logarithm of the book value of assets. Return on equity (ROE) is measured as net income after preferred stock dividends divided by common equity (in percent). Leverage is defined as the ratio of total debt to total financing (in percent). Stock return represents the firm's quarterly return (in percent). Ownership share by investor type reflects the mean proportion of a firm's equity held by a specific investor type (in percent). Standard errors are clustered at the firm level, and t-values are reported in parentheses. Significance levels are indicated by asterisks (*** p<0.01, ** p<0.05, * p<0.1).