Mutual Fund Carbon Divestment:

Strategic Investment Reallocation toward Firms without Carbon Transparency

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Abstract

This study investigates the hidden strategies mutual funds use to conduct carbon divestment. Drawing on a large, representative panel dataset of 10,100 observations of U.S.-focused mutual funds with private equity investments, we employ a Difference-in-Differences (DiD) design to establish causal inference and address endogeneity concerns. We find that mutual funds reallocate investments toward firms without carbon disclosure in two primary ways: (1) shifting from brown (high-carbon) public firms to brown private firms, and (2) shifting toward brown public firms that lack available carbon risk scores. Our analysis further identifies two key mechanisms driving this behavior: (1) the incentive to attract capital from ESG-conscious investors, who tend to penalize visible brown public holdings while remaining largely unaware of disclosure gaps and brown private investments; and (2) information asymmetry in green labeling and weaker private-market disclosure requirements enable mutual funds to maintain diversification and pursue higher returns from carbon-intensive assets in private market without investors' awareness.

Keywords: Carbon divestment, greenwashing, carbon disclosure, private equity investment, low carbon designation, sustainability transition

Section I: Introduction

Climate change remains one of the most urgent global challenges of the 21st century, prompting widespread calls for decarbonization and long-term ecological responsibility. As countries pursue the United Nations' Sustainable Development Goals (SDGs), increasing attention has shifted to the private sector's role in driving climate action and environmental progress. Mutual funds face mounting pressure from stakeholders to consider sustainability investment, implement carbon divestment, and integrate environmental priorities into investment criteria. Hence, they started to integrate Environmental, Social, and Governance (ESG) criteria into capital allocation decisions (Jin, 2022; Kräussl et al., 2024; Zhang et al., 2024), and consumers reward firms that demonstrate environmental responsibility (Hosta & Zabkar, 2021; Vadakkepatt et al., 2021). One prominent example is carbon divestment, where funds strategically reduce holdings in brown (high carbon) industries, such as energy and transportation. Fidelity International, one of the largest and most well-known asset management firms in the world, is committed to phasing out its exposure to thermal coal investments by 2030 in OECD markets, as part of its exclusion framework in brown industries. Over time, this practice is becoming a defining characteristic of mutual fund strategies, as asset managers seek to balance financial returns with sustainability goals. However, such carbon divestment may prove illusory and may unintentionally lead to greenwashing, as it remains uncertain whether mutual funds are genuinely willing to prioritize the low-carbon transition.

Prior literature documents several forms of greenwashing within the investment industry, including green-label greenwashing, window dressing, and selective disclosure. For example, funds may adopt a green label while failing to reduce their carbon footprints (Abou Arab et al., 2024). At the country level, Gibson-Brandon, Glossner, Krueger, Matos, and Steffen (2022) show that U.S. institutional investors that become PRI signatories do not improve their ESG performance, partly due to uncertainty surrounding fiduciary duties and lower ESG market maturity. On the window-dressing side, as U.S. mutual funds report holdings only quarterly, managers have incentives to temporarily increase their positions in green assets at reporting dates and subsequently revert to higher-return, less-sustainable holdings (Parise and Rubin, 2024). Regarding the disclosure, Sahin et al., 2022 demonstrates that traditional ESG scores obscure

large amounts of missing or voluntarily undisclosed information. By introducing a "Missing (M)" pillar to capture undisclosed ESG data, they show that ESG assessments become more informative and better aligned with firm green commitment. Taken together, these studies reveal a consistent pattern: ESG claims often exceed actual ESG behavior, and greenwashing tends to flourish in environments with strong incentives to appear green, weak monitoring, and limited disclosure requirements.

Regulatory gaps also create opportunities for mutual funds to engage in greenwashing, particularly in less regulated settings such as private-market investments. In these environments, funds face fewer disclosure requirements and weaker scrutiny from regulators, investors, and analysts, increasing the likelihood of opportunistic ESG claims. There is still potential for funds to hold brown investments through less regulated private investments or bonds, as these are not as closely scrutinized and require less disclosure from regulators, investors, and analysts, thereby creating a possible channel for greenwashing. This possible channel for greenwashing is also supported by the fact that mutual funds have increasingly expanded their investment portfolios in private firms, demonstrating a growing presence in private equity markets. Over the past two decades, the number of mutual funds investing in private firms and the total capital allocated to these investments have risen dramatically. This trend has gained significant momentum, growing from fewer than 14 funds participating annually before 2000 to over 400 unique funds by 2018, based on an analysis of 14 mutual fund families investing in private firms (Kwon, Lowry, and Qian, 2019). The proportion of U.S. mutual funds investing in private firms has increased from less than 1% in 2001 to 7% in 2018, more than a seven-fold rise, underscoring the growing significance of this market. However, despite this notable shift, the allocation of these private investments between brown and green industries remains undocumented. Additionally, the motivations driving mutual funds to enter private markets, whether for financial returns, strategic positioning, or ESG considerations, are still open questions that are in the interest of further research. Thus, while carbon divestment is becoming a defining characteristic of mutual fund strategies, it is still uncertain whether these commitments will translate into meaningful and sustained action. Understanding how mutual funds adapt to these changing ESG expectations through carbon divestment is crucial for assessing their long-term viability and their role in fostering a greener economy.

In this study, we examine how mutual funds, which constitute a significant portion of global financial markets, engage in carbon divestment. Our analysis uses a quasi-natural experiment triggered by the key event occurred on April 30, 2018, when Morningstar, a leading data provider in the mutual fund industry, introduced an green-label for mutual funds, known as the Low Carbon Designation (LCD) which is given to mutual fund that have portfolios with low carbon-risk scores and low levels of exposure to fossil fuels (FFI). This LCD introduction created a sudden increase in both the availability and prominence of information on carbon risk, specifically climate transition risk which is the risk associated with the shift toward a lower-carbon economy. This new carbon risk score exhibited only a weak correlation with previously available environmental metrics from Refinitiv and MSCI KLD, underscoring its important shock to investors. Our study draws on data from 404 open-ended active mutual funds (i.e., not exchange traded or index funds) that primarily invest in U.S. equities and have exposure to private equity, to assess how fund managers and investors respond to the information shocks created by the release of Morningstar's LCD green-label.

We conduct the main investigation by using the holding weight in public and private investment of individual mutual fund at the monthly level and compare the 12 months before and after introducing the LCD. We use differences-in-differences and employ two approaches to identify the treated group: one based on LCD fund designation, and the other based on proximity to the LCD cutoff point. Our main finding is that mutual funds have increasingly shifted their investments from brown public firms to brown private firms after the introduction of LCD by Morningstar. The significant shift to private brown industry investments after the LCD shock of LCD funds is economically higher than non-LCD funds for all categories of brown sectors, where the differences represent up to a 70.4% relative to the initial average allocation for top 4 and 5 brown industries while surpasses 100% increase relative to the initial average allocation for top 3 brown industries. We also find similar results when we use proximity to the LCD cutoff point to classify the treated group. This shift suggests that mutual funds are strategically moving their investments to private firms in the brown sector, which still has a negative environmental impact. Regarding possible motivations, mutual funds can avoid the additional scrutiny that comes with holding public brown firms, particularly with respect to ESG concerns. The transition also appears to be motivated by the benefit of capital flows driven by investors' growing interest in ESG, while mutual funds still see potential future returns in holding brown private firms.

Investors are unaware and do not react to the brown private investment because private equity investments are not required to report environmental exposure like public firms. Similarly, we observe consistent evidence that capital is reallocated toward brown publicly listed firms lacking available carbon score disclosures and investors do not adjust their behavior as they are unaware of this shift.

Specific fund characteristics also can magnify this shift in investment strategy. First, mutual funds with lower return performance have stronger incentives to signal "greenness" to attract capital because the eco-label (LCD) provides a competitive advantage when differentiation opportunities are limited. Additionally, these funds often lack the resources to genuinely integrate ESG factors into their investment decisions. Second, mutual funds with higher expense ratios which tend to have lower adjusted return than low expense funds (Gil-Bazo and Ruiz-Verdú, 2009 and Fama and French, 2010) are more prone to shifting brown exposure into private firms, this result is consistent with the previous argument because high-expense funds face greater performance pressure so have more incentive to use brown private investments to appear greener without improving true environmental performance. Third, funds with lower risk tolerance are more likely to hiddenly shift toward brown private firms which are typically more risky, less liquid, and harder to value than public firms, maintaining diversification while attracting to ESG-conscious investors. In the context of LCD labeling, lower risk tolerance funds may similarly rely on private brown firms to conceal both carbon intensity and return volatility, as these firms are not marked-to-market and face minimal ESG disclosure requirements. This allows such funds to preserve exposure to carbon-intensive industries while presenting a smoother and more sustainable-looking risk profile to ESG-conscious investors.

Our paper makes several contributions to existing literature. Previous studies primarily focus on the immediate reactions of mutual funds to climate shocks and their subsequent effects on investor behavior and divested firms, with limited attention given to the possible greenwashing strategies employed by mutual funds after the climate shock. On the fund reaction side, mutual funds actively reduce their exposure to firms with high carbon risk scores (Stroebel and Wurgler, 2021) because mutual funds labeled as "low carbon" can gain the benefit of a significant increase in investor demand, as investors increasingly prioritize environmental sustainability and seek to align their portfolios with low-carbon, ESG-friendly investments (Ceccarelli et al., 2024). On the

perspective of divested firm, divested firms subsequently experience a stock price decline and reduce their carbon emissions at a higher level than non-divested firms (Rohleder et al., 2020). However, our research offers new insights into mutual fund carbon divestment strategies and links these strategies to greenwashing behavior. Our research has three main contributions as following.

Firstly, our paper makes a significant contribution to understanding the strategic behavior of mutual funds responding to global climate change concerns. Our study explores new evidence that takes a step further by examining the shift from brown public firms to brown private firms where ESG and carbon data transparency is lower, avoiding the scrutiny that public firms face. This strategy allows mutual funds to maintain the potential for higher returns in private brown firms while also attracting more capital from ESG-focused investors following divestment. To the best of our knowledge, this finding has not been documented in any existing literature.

Secondly, our research introduces a distinctive and comprehensive dataset that offers in-depth insights into the investment behaviors of mutual funds, specifically within the private market. A key focus of our analysis is on the brown sectors in private market, which have historically received less attention in terms of investment tracking compared to other industries, such as green or technology. By examining this dataset, we add value to the existing literature on private market investments and provide a detailed exploration of how mutual funds allocate capital to brown private industries.

Thirdly, our research explore a new channel of greenwashing by mutual funds by shifting investments to brown private firms, which are less transparent and not subject to the same level of public scrutiny as public firms. Private firms face fewer regulations, are not as exposed to the public eye, and may have greater flexibility to take risks or experiment with new business models. This creates situation where mutual funds could appear to be pursuing low-carbon strategies, while they are actually investing in firms with less stringent environmental oversight. This implication extends existing findings related to greenwashing.

However, we still cannot rule out another implication on risk-reward tradeoff in ESG investing of mutual funds which might strategically accept the risks associated with investing in brown private firms, seeing the long-term potential for transforming these firms into more sustainable entities in the future. This shift represents a dynamic approach to ESG investing, where mutual

funds balance short-term risks with the long-term opportunity to drive corporate transformation, leveraging greater influence over internal environmental practices in private markets. We will leave the investigation of this implication for future research to explore another dimensional possibility of the shift between public and private investments.

The rest of the paper is organized as follows. Section II discusses the theoretical perspectives and hypotheses. Section III explains the empirical setting and data. Section IV presents the main findings and section V illustrates the underlying mechanism and heterogeneity. Section VI concludes the paper. Variable definitions are in the Appendix.

Section II Theoretical Perspectives and Hypotheses

This study integrates Agency Theory, Regulatory Arbitrage Theory, and Greenwashing Theory to explain the hidden strategy that mutual funds use to conduct carbon divestment. Agency Theory highlights how information asymmetry enables managers to reallocate brown investments from highly transparent public markets to opaque private markets, masking carbon-intensive exposure while preserving financial returns. Regulatory Arbitrage Theory situates this behavior within uneven carbon-disclosure regimes, emphasizing how mutual funds exploit weaker reporting requirements in private markets to reduce the appearance of carbon risk without altering the underlying portfolio. Greenwashing Theory further explains how these shifts cater to legitimacy pressures, allowing funds to signal environmental commitment by divesting from visible public brown firms while quietly reinvesting in private high-carbon assets. Together, these perspectives provide a unified theoretical foundation for understanding the concealed reallocation of brown exposure in mutual fund investments.

Agency Theory

Agency Theory argues that managers operate under conditions of information asymmetry and may pursue actions that do not fully align with investors' best interests (Jensen & Meckling, 1976). In mutual fund settings, reduced transparency amplifies managerial discretion, enabling fund managers to undertake strategies that improve perceived performance or marketability rather than actual environmental impact. The disclosure gap between private and public equity markets provides fertile ground for such opportunistic behavior, as valuation uncertainty, limited disclosure, and infrequent monitoring allow managers to obscure the true nature of high carbon

holdings.(Fontenay and Broughman, 2025) Prior research shows that managers strategically exploit informational gaps when oversight is weak or when stakeholders lack visibility into underlying risk exposures (Mahoney, 2004; Dyakov, Harford and Qiu, 2021). Hence, reallocating brown investments from public firms, which face stringent reporting requirements and external scrutiny, to private firms represents a classic agency-driven response: managers retain the financial benefits of carbon-intensive investments while masking their environmental footprint from ESG-conscious investors. These dynamics show that agency problems are not only internal governance issues but extend to environmental transparency.

Regulatory Arbitrage Theory

Regulatory Arbitrage Theory is a practice where firms exploit the regulatory difference between different markets to circumvent unfavorable regulation (Riles, 2014). Financial intermediaries frequently respond to differential regulatory environments by shifting risk-bearing activities toward less regulated domains, where disclosure, supervision, and compliance burdens are lower (Honigsberg, Hu and Jackson, 2022). Evidence from banking and financial groups shows that fragmented or weak supervisory frameworks allow firms to migrate risk exposures to jurisdictions or entities with lighter regulatory touchpoints (Beck, Buston, and Wagner, 2025). This logic directly applies to carbon disclosure regimes: public firms face increasingly stringent emissions reporting from stakeholders together with third-party carbon scoring, creating a high-regulation and expectation environment around visible carbon emission. In contrast, private firms operate with minimal carbon disclosure obligations and mutual funds are not required to report the carbon data on private holding, making them attractive vehicles for retaining brown exposure while avoiding regulatory costs. Therefore, mutual funds' shift from brown public holdings to brown private holdings represents a form of ESG-related regulatory arbitrage, where managers exploit differences in disclosure regimes to reduce the appearance of carbon risk without materially altering the underlying portfolio carbon exposure.

Greenwashing Theory

Greenwashing Theory highlight how firms strategically disclose environmental actions to appear "green" without substantive changes (Lyon and Maxwell, 2011; Delmas and Burbano, 2011). Investors increasingly reward visible ESG improvements, especially reductions in exposure to publicly identifiable high carbon firms (Ceccarelli et al., 2024), creating strong incentives for

funds to cultivate a green image. However, when external investors lack access to full information with higher information asymmetry, such as the carbon characteristics of private-market holdings, firms may engage in symbolic actions that enhance perceived environmental performance while leaving actual sustainability outcomes unchanged. Existing literature shows that firms and financial institutions selectively disclose positive information and obscure negative ESG attributes when facing legitimacy pressures (Walker & Wan, 2012; Marquis, Toffel & Zhou, 2016). Hence, reallocating brown exposure into private firms constitutes a form of greenwashing: divestment from visible public brown firms is communicated as a sustainability initiative, yet the hidden reinvestment into private brown firms maintains the economic returns associated with high carbon sectors. Overall, the hypothesis that mutual funds shift their brown investments from public to private firms is supported by the three theoretical frameworks discussed, providing a strong foundation for our main research question.

Hypothesis Development

Hypothesis 1: Strategic Reallocation of Brown Exposure

From Agency Theory, when managers operate under substantial information asymmetry, they may adopt strategies that align with their own incentives while obscuring actions that investors might penalize (Jensen & Meckling, 1976). In the context of carbon exposure, public firms are highly visible, face third-party emissions scoring, and are more easily monitored by investors (Hartzmark and Sussman, 2019). In contrast, private firms operate in low-transparency environments with limited disclosure requirements, creating a setting where fund managers can retain exposure to profitable carbon-intensive industries while making their portfolios appear greener. Building on research showing that managers are motivated to divest high-carbon exposures to demonstrate ESG improvements in response to investor demand (Ceccarelli et al., 2024), we expect the possible hidden strategic reallocation that mutual funds may reduce visible brown exposure without necessarily reducing overall carbon risk after the ESG shock. Therefore, we expect managers to strategically reallocate carbon-intensive holdings from public to private firms, creating the illusion of decarbonization while maintaining underlying brown exposure.

Hypothesis 1A: After the introduction of the LCD label, mutual funds reduce holdings in brown public firms and increase holdings in brown private firms as a strategic reallocation rather than a genuine reduction in total portfolio carbon exposure.

Similarly, we also expect funds reallocate capital toward brown public firms that lack carbon data in Morningstar's coverage. Because Morningstar permits up to 33% of holdings to have no carbon risk information, funds can obscure their true carbon exposure.

Hypothesis 1B: After the introduction of the LCD label, mutual funds reallocate investments toward brown public firms that do not have carbon risk score data.

Hypothesis 2: Investor-Flow Mechanism (Rewards for Hidden Brown Exposure)

A growing literature documents that investors reward funds that appear greener, even when improvements are driven by cosmetic rather than substantive changes (Romos et al., 2025; Baker et al., 2022). Because investor attention is disproportionately focused on observable public holdings, particularly those associated with high carbon emissions, funds that reduce public brown exposure are likely to benefit from increased inflows (Ceccarelli et al., 2024). At the same time, private holdings are rarely explicitly shown, often disclosed in aggregate "other" categories, and lack emissions data, leaving ESG-conscious investors largely unaware of brown private investments. Building on evidence that fund flows reward visible ESG improvements even when underlying risks remain unchanged, we expect this mechanism to drive inflows toward mutual funds that mask brown exposure through private holdings.

Hypothesis 2A: Mutual funds that decrease their holdings of public brown firms but increase their holdings in private brown firms experience higher subsequent fund flows.

Hypothesis 2B: Fund flows from investors remain largely unchanged despite mutual funds shifting investments toward brown public companies without available carbon risk score information.

Hypothesis 3: Asymmetric Investor Penalties (public brown punished but private brown ignored)

Research in financial economics consistently shows that investors respond more strongly to attention-grabbing, easily observable information (Barber & Odean, 2008). Public brown holdings are highly attentive because their emissions data are widely available through ESG data vendors and are incorporated into rating agencies' sustainability metrics. Private brown holdings, in contrast, are largely invisible: carbon data are sparse, disclosure is voluntary, and mutual fund reporting rules allow private holdings to remain obscured. As a result, we expect investors to

penalize exposure to public brown firms, while failing to discipline funds that hold private brown assets. We conjecture that flows react strongly and negatively to public brown exposure but show no response to private brown holdings. This divergence reflects the limited capacity of investors to detect carbon risks hidden in obscure assets.

Hypothesis 3: Investor fund flows negatively respond to exposure to public brown firms but do not respond to exposure to private brown firms, enabling funds to maintain brown private assets without investor penalty.

Hypothesis 4 Future returns in holding brown private firms

Mutual funds expanded into private markets because public investment opportunities diminished and private investments offered higher potential returns. Funds also gained greater IPO share allocations, boosting their returns when the firms go public. (Kwon, Lowry, and Qian, 2019). Mutual funds invested in venture-backed private companies experienced 67%–161% higher returns from their private firm investments compared with broad market returns, particularly from firms that go public including unicorns (Kwon, Lowry, and Qian, 2019). As a result, we expect mutual funds that still hold private brown assets may experience higher return afterward.

Hypothesis 4: Mutual funds with greater exposure or shift to private brown firms earn higher subsequent returns than mutual funds without such exposure.

Hypothesis 5: Performance-Based Heterogeneity (low-alpha funds are more likely to greenwash)

Lower-performing funds face stronger competitive pressure to attract investor capital, creating incentives to rely on non-performance channels such as ESG positioning to increase inflows. Prior research shows that low-alpha or underperforming funds often find differentiation strategy to appeal to investors (Bonelli et al., 2023). In the context of carbon divestment, such funds may disproportionately benefit from appearing greener with sustainable responsibility without sacrificing the potential return from brown industry. Accordingly, we expect the reallocation following Morningstar's LCD introduction to be stronger among low-alpha funds, which have the most to gain from enhanced perceived ESG quality.

Hypothesis 5: The shift from public to private brown holdings following the LCD designation is concentrated among low-alpha funds.

Hypothesis 6: Expense-Based Heterogeneity (high-expense funds are more likely to engage in greenwashing)

High-expense funds face heightened pressure to justify their fee structures, as competition within the mutual fund industry has shifted investor flows toward low-cost products (Coates and Hubbard, 2007). Consequently, high-expense funds have stronger incentives to differentiate themselves through non-price mechanisms such as ESG positioning. Because fee revenue scales with assets under management, these funds stand to gain significantly from attracting ESG-oriented inflows. Consistent with this incentive structure, we expect expense ratios to moderate greenwashing behavior: higher-fee funds should exhibit a more pronounced shift toward hiding brown exposure in private markets after the LCD shock.

Hypothesis 6: High-expense funds exhibit stronger reallocation from public to private brown firms following the LCD designation.

Hypothesis 7: Risk-Based Heterogeneity (low - risk funds are more likely to engage in greenwashing)

Low-risk funds typically cater to more conservative investors who are also more sensitive to environmental and sustainability considerations (Aulia et al., 2024). These investors may demand portfolios that avoid highly visible brown exposures, intensifying pressure on managers to divest from public carbon-intensive firms. However, because private brown exposures remain largely hidden, reallocating these holdings into private markets allows low-risk funds to maintain diversification benefits and expected returns. In contrast, high-risk funds may face less investor scrutiny, reducing their incentive to adjust their carbon exposures after the LCD introduction. Your findings are consistent with this logic: low-volatility funds undertake substantial public-to-private brown reallocation, while high-volatility funds show minimal adjustments.

Hypothesis 7: Low-risk funds are more likely to reallocate from public to private brown firms following the LCD label.

Section III: Empirical Setting and Data

Empirical Setting

Our research uses the release of Morningstar's LCD label on April 30, 2018 as the exogenous shock for our empirical setting. The LCD label was introduced as a tool to help investors identify mutual funds that are aligned with the transition to a low-carbon economy by highlighting funds with both low carbon risk scores and minimal exposure to fossil fuels. The LCD label is assigned to funds that meet two specific criteria: a 12-month average portfolio carbon risk score below 10 (out of 100), and a 12-month average Portfolio Fossil Fuel Intensity (FFI) rating of under 7%. This LCD label provided a clear and tangible signal about which funds were more aligned with sustainability goals and the transition away from fossil fuels.

The portfolio carbon risk scores are derived from asset-weighted carbon-risk score of assets in a portfolio (long positions only), averaged over the trailing 12 months and at least 67% of portfolio assets must have a carbon-risk rating from Sustainalytics. This firm-level carbon-risk scores are provided by the ESG data of Sustainalytics, which publicly disclosed these scores for the first time at the end of April 2018. The release of both firm-level and fund-level carbon risk scores was made possible by Morningstar's control over Sustainalytics, which began with a 40% stake in 2017 and increased to full ownership by 2020. These firm-level carbon risk scores aim to assess a company's exposure to and management of material climate transition risks, reflecting the potential impact of the shift to a low-carbon economy on a company's economic value. The Portfolio FFI represents the proportion of the portfolio's exposure to fossil fuels, calculated as an average over the past 12 months. Firms considered to have fossil fuel involvement are those that generate at least 5% of their revenue from activities such as thermal coal extraction, thermal coal power generation, oil and gas production, and oil and gas power generation. Additionally, firms that earn 50% or more of their revenue from oil and gas products and services are also included.

This release of LCD label qualifies as a good exogenous shock for natural experiment because it introduced new, unexpected, and impactful information into the market that was not anticipated by either fund managers or investors. Morningstar did not communicate the release of the LCD label or the underlying metrics in advance, which means the shock was external to the market and not based on prior expectations. As a result, the shock to the market was significant because it provided new, high-quality data that had not been available before. This information at both the

firm level and fund level had the potential to influence investment decisions, fund manager strategies, and investor behavior, making the release of the LCD label a unique and important event for both practitioners and researchers.

Data

Our samples include 404 open-ended active mutual funds from 12 mutual fund families, following the approach of previous literature (Kwon, Lowry, and Qian, 2020), which focuses on fund families with the history of private holdings. Specifically, our sample consists of funds that invest in U.S. and held private investments at some point in time.

The holding weights of investments in brown private and brown public firms

We extract the weights of mutual fund investments from Morningstar Direct, using monthly data on firm-level equity holding weights, including industry classification and the returns of public investments. We combine all relevant data, including weights, industry classification, ISIN, and ticker. However, some public investments and all private investments lack ISINs and tickers, requiring us to identify them as public or private, equity or non-equity, and assign their industry classification.

We use Python to flag non-equity investments such as bonds and other non-equity assets (e.g., PIPEs – private investments in public equity, shares of newly public firms before the lock-up expiration, corporate bonds or notes with restricted conditions, and investments in foreign countries). We identify private firms in several steps. First, we apply fuzzy matching to link company names in Morningstar with those in the Initial Public Offering database (SDC Platinum) to flag private firms based on their IPO dates. Next, we repeat the fuzzy matching process for the remaining unidentified firms using private firm databases (Eikon and Bloomberg). Finally, we manually gather data for any unmatched samples, whether private or public, and for industry classification.

Once we have identified mutual fund investments in either private or public firms, along with their industry information, we calculate the holding weight of mutual fund investments in brown public and brown private firms. This is done by summing the holding weights in brown industries for the public and private categories, respectively. The brown industry classification is based on the carbon intensity rankings by sectors in the S&P 500, with a focus on the ratio of Scope 1

carbon emissions to market value (Ilhan, Sautner, and Vilkov, 2021). The top five sectors, ranked from highest to lowest in carbon intensity, are utilities, energy, materials, industrials, and consumer staples. We have three ratios for the holding weight of mutual fund investments in each category (brown public and brown private firms): one for the top 3, one for the top 4, and one for the top 5 industry, respectively. This approach results in 10,100 fund-year observations across 404 distinct mutual funds from 2017 to 2019.

Fund-level characteristics

We obtain fund characteristic data from the Morningstar Direct. We use the following fund characteristics as control variables. Fund size is measured as the natural logarithm of fund assets, denoted by Log Fund Size. Fund expense ratio is defined as the percentage of fund assets paid for operating expenses and management fees, including 12b-1 fees, administrative fees, and all other asset-based costs incurred by the fund, except brokerage costs. Fund turnover ratio is a ratio of how frequently an investment buys or sells its holdings. This ratio is expressed as a percentage of the investment's holdings have been traded over a given year as reported in the investment's periodic disclosure document. Fund age is the number of years the mutual fund has been operating since the inception year. Fund monthly return is the monthly return net of fees. Fund ESG Engagement is an indication whether the investment uses shareholder engagement, including raising resolutions, active proxy voting, and direct company engagement, to pursue ESG goals with invested companies. Detailed definitions of these variables are presented in the Appendix.

Variables to test underlying mechanism and fund heterogeneity

In addition to the aforementioned variables, we also use Morningstar Direct to incorporate fund performance and risk variables, including net-of-fee alpha, the Morningstar Medalist performance rating pillar, and the Morningstar overall risk rating, to investigate fund heterogeneity. For the underlying mechanism, we use the future fund flow variable. Following the fund flow literature, the future fund flow for fund p in month t is defined as the total net assets at time t+1 (TNA) divided by the total net assets at time t minus the fund return at time t+1.

$$\text{Future Flow}_{p,t} = \frac{\text{TNAp,t+1}}{\text{TNAp,t}} - (1+R_{p,t+1})$$

$TNA_{p,t+1}$ is fund p's total net assets at the end of month t+1, and $R_{p,t+1}$ is the fund return in month t+1.

Summary statistics

The summary statistics table presents key characteristics of 10,100 samples, with a primary focus on the percentage of investments in "brown" industries. The data highlights a sharp contrast in investment patterns between private and public markets. In private markets, funds have relatively low exposure with overall mean investments at 0.336% with averaging 0.019%, 0.095%, and 0.104%, respectively in the top 3, top 4, and top 5 brown industries while investments in public markets show much higher allocations with the mean investment over 99% with averaging 10.9%, 21.6%, and 26.5%, respectively in the top 3, top 4, and top 5 brown industries. However, when comparing the percentage invested in brown industries in private markets to the total percentage invested in private firms, the proportion of private investment allocated to brown industries in the top 4 and top 5 brown industries is notably significant, representing around 30% of the overall private market exposure. In contrast, the proportion of public investment allocated to brown industries is lower, at 22% and 26% in the top 4 and top 5 brown industries, respectively.

This suggests that while public market investments in brown industries have a significant but more limited presence. Other notable fund characteristics include an average fund size of 9.36 and an average fund age of 21 years, indicating a relatively mature set of funds. Additionally, the average monthly return across the funds is 1.16%, with a wide standard deviation of 4.12%, reflecting significant variability in performance. The funds have an average expense ratio of 0.777%, and an average turnover ratio of 49.36%, meaning nearly half of the portfolio is replaced annually, which suggests a relatively active investment strategy. ESG engagement is minimal across the sample, with an average value of only 0.001, showing that these funds may not heavily prioritize ESG factors in their investment strategies.

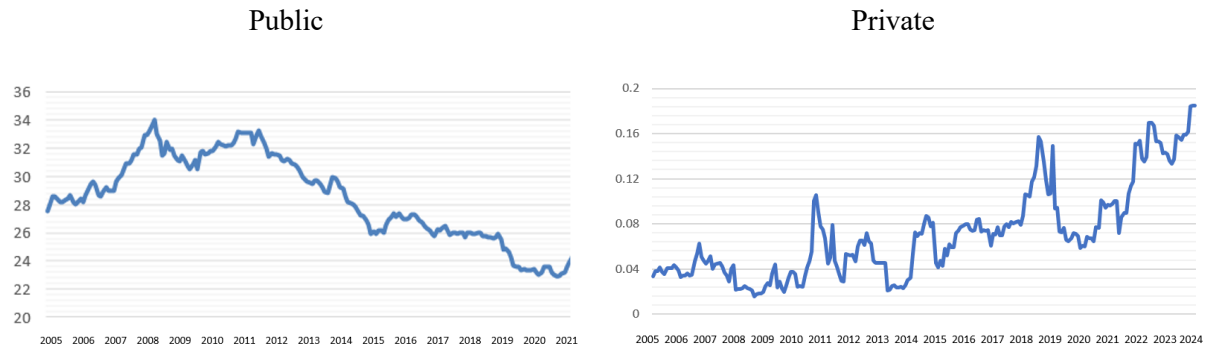
Table 1

Summary Statistics

Variable	# of Sample	Mean	Std. Dev.	Min	Max	P10	P90
%Brown Private (Top 3 Brown Industry)	10,100	0.019	0.218	0	12.755	0	0.10198
%Brown Private (Top 4 Brown Industry)	10,100	0.095	0.477	0	12.755	0	0.17155
%Brown Private (Top 5 Brown Industry)	10,100	0.104	0.488	0	12.755	0	0.22235
%Private	10,100	0.336	0.935	0	12.755	0	1.05171
%Brown Public (Top 3 Brown Industry)	10,100	10.934	16.677	0	99.562	0	18.68538
%Brown Public (Top 4 Brown Industry)	10,100	21.63	19.682	0	100	0.36331	32.24416
%Brown Public (Top 5 Brown Industry)	10,100	26.511	20.529	0	100	0.80837	41.78103
%Public	10,100	99.277	3.919	0	100	96.49582	99.99922
Log Fund Size	10,100	9.359	0.78	5.465	11.953	8.419536	10.33961
Fund Turnover Ratio %	10,100	49.36	40.063	0.03	244.25	8	105
Fund Age	10,100	21.016	12.053	0	89	8	34
Fund Expense Ratio %	10,100	0.777	0.355	0	1.75	0.17	1.23
Fund Monthly Return %	10,100	1.156	4.118	-17.68	15.104	-4.09337	5.60462
Fund ESG Engagement	10,100	0.001	0.036	0	1	0	1

In addition, regarding the trend in brown investments, there is a growing shift toward increased allocation to brown private firms. Figure 1 reveals a contrasting trend in mutual fund investments in brown industries between public and private firms from 2008 to 2024. Investment in brown public firms has declined over this period, with the percentage allocated to brown public firms decreasing from 34% in 2008 to 24% in 2024. This trend indicates a divestment from higher-carbon, less sustainable sectors in public markets. In contrast, investments in brown private firms have seen a substantial increase, rising from a mere 0.02% in 2008 to just below 0.2% in 2024, a tenfold increase. This sharp growth highlights a significant shift in investment patterns toward private brown firms, even as public market exposure to these industries declines.

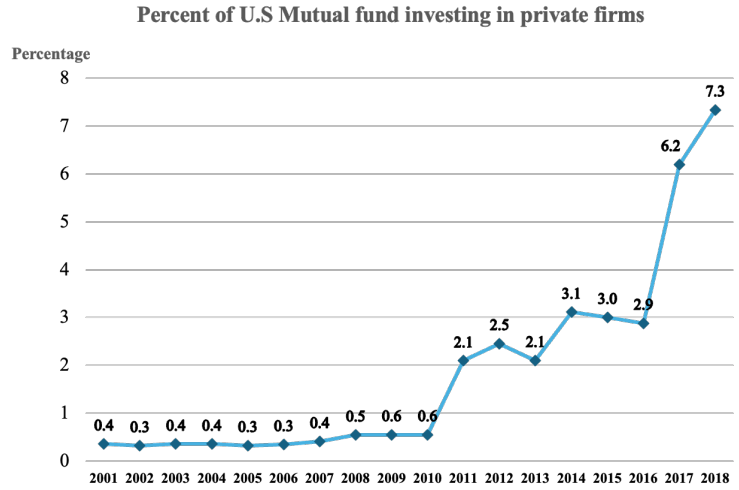
Figure 1 Trend of Mutual Fund Investment in Brown Firms (Top 5 Brown Industry)



Another important fact is about the proportion of U.S. mutual fund starting to invest in private market, figure 2 illustrates a significant increase in the percentage of U.S. mutual funds investing

in private firms over time. While the share remained low and stable for many years, there has been a sharp rise in recent periods, reflecting a growing interest among mutual funds in private market opportunities. This shift suggests that private market has become more attractive to mutual funds who are seeking higher returns and diversification beyond traditional public equities. However, increased exposure to private firms also brings challenges, including higher risk and less transparency, which could impact investor outcomes and market dynamics.

Figure 2 Trend of Mutual Fund Investment in Private Market



Section IV: Main Findings

Baseline Result

Following several studies, including the latest by Ceccarelli, Ramelli, and Wagner (2024), we use the LCD label by Morningstar as an exogenous shock. We employ the following differences-in-differences approach to examine the divestment of mutual funds from brown public firms to brown private firms after this LCD label, covering the period from 2017 to 2019.

$$(1) \qquad Y_{i,t} = \alpha + \sum_{k \neq -1} \beta_k \cdot 1\{t - T_i = k\} + X_{i,t}\gamma + FE + \varepsilon_{i,t}$$

where $Y_{i,t}$ represents a percentage variable for the holding weights of investments in brown public firms, and the holding weights of investments in brown private firms. $Treat_i$ is equal to one for the mutual fund that received LCD label by Morningstar after April 2018 and zero for non-treated group or the mutual fund that did not receive LCD label. $Post_{i,t}$ is equal to one for 12-

month period following April 2018 and zero otherwise. The coefficients of the interaction terms (β_1) capture changes in the differences between the treated and control groups for the holding weights of investments in brown public firms, and the holding weights of investments in brown private firms around the event time.

We use a 12-month window period and use Equation 1 to analyze the changes in the differences between the treated and control groups for brown public firms and brown private firms separately. The first analysis focuses on the monthly holding weights of mutual fund investments in brown public firms around the event time, while the second examines the monthly holding weights of mutual fund investments in brown private firms. Control is a vector of time-varying fund-level control variables that, based on previous literature, may influence holding weight of brown investments. These controls are monthly returns, the logarithm of fund size, the fund's age, the fund expense ratio, the fund turnover ratio and ESG engagement. To mitigate potential truncation bias, both time and fund fixed effects are included. Robust standard errors at the fund level are employed in both regressions.

Table 2 presents the baseline regression results, organized into two sets of columns. Columns 1 to 3 show the dependent variable as the holding weights of investments in brown public firms in the top 3, top 4, and top 5 brown industries. Columns 4 to 6 display the dependent variable as the holding weights of investments in brown private firms in the same top 3, top 4, and top 5 brown industries. All columns include control variables, fund fixed effects, and time fixed effects. Across all the first three columns, the estimated coefficient of the interaction term Treat*Post consistently appears significantly negative. In terms of statistical significance, the coefficient is negative and statistically significant at the 1% level for the top 3 and top 5 brown industries and at the 5% level for the top 4 brown industry in the public brown firm columns. This indicates that the LCD label led to a reduction in mutual fund investments in public brown firms in the top brown industries, particularly the top 3 and top 5 industries. In terms of economic significance, the decrease in public brown industry investments 12 months after the LCD shock of LCD funds is economically meaningful comparing to non-LCD funds for all categories of brown sectors, where the differences represent about -2.4%, -1.7% and -5.1% relative to the initial average holding weight for top 5, top 4 and top 3 brown industries, respectively. For column 4 to column 6, the estimated coefficient of the interaction term Treat*Post consistently appears significantly positive. In terms of statistical

significance, the coefficient is positive and statistically significant at the 5% level across the top 3, top 4 and top 5 brown industries. In terms of economic significance, the increase in private brown industry investments 12 months of LCD funds after the LCD shock is economically significant comparing to non-LCD funds for all categories of brown sectors, where the differences represent up to a 70.4% for top 4 and 5 brown industries while surpasses 100% increase relative to the initial average holding weight for top 3 brown industries, highlighting a strong response of mutual fund to the LCD shock. This indicates that the LCD label led to an increase in mutual fund investments in private brown firms in the top brown industries. This suggests that these LCD mutual funds are making substantial adjustments to their portfolios, shifting more capital into private brown industries in reaction to new ESG shock, despite the small initial allocations.

Table 2

Baseline Regression

Table 2 reports the results of the baseline regression in equation (1) using difference-in-differences model. This table uses exogeneous shock of low carbon designation (LCD) by MorningStar in April 2018. Window period is 12 months and treated group is LCD fund while non-treated group is non-LCD fund. Post is 12 months after the event shock. The dependent variables are the holding weights of investments in brown private firms and the holding weights of investments in brown public firms, respectively. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

Variables	%Weight of Public Brown Firm			%Weight of Private Brown Firm		
	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown	Top 4	Top 3
	(1)	(2)	(3)	Industry (4)	(5)	(6)
Treat*Post	**-0.636*** **	**-0.377** **	**-0.558*** **	**0.0732** **	**0.0792** **	**0.0211** **
	(-2.643)	**(-2.051)**	**(-3.515)**	**(2.084)**	**(2.274)**	**(2.560)**
Log Fund Size	-1.678	-0.596	-1.328*	-0.0679	-0.0521	-0.0111
	(-1.500)	(-0.603)	(-1.930)	(-0.556)	(-0.498)	(-0.179)
Fund Expense Ratio	-1.167	0.529	-0.386	0.530	0.472	-0.0360
	(-0.363)	(0.221)	(-0.292)	(1.605)	(1.462)	(-0.953)
Fund Turnover Ratio	0.000793	-0.00380	-0.00780*	0.000373	0.000414	0.000222
	(0.0868)	(-0.435)	(-1.663)	(0.564)	(0.636)	(1.098)
Fund Monthly Return	-0.00574	-0.00599	-0.0128*	0.00411***	0.00396***	0.00276**
	(-0.466)	(-0.626)	(-1.694)	(2.660)	(2.602)	(2.393)
Fund Age	-0.781***	-0.713***	-0.567***	0.0178	0.0168	-0.00177
	(-3.436)	(-3.627)	(-4.317)	(0.968)	(0.977)	(-0.594)
ESG Engagement	-3.111***	-1.984***	-0.345***	-0.0185	-0.0171	0.0198*
	(-12.56)	(-8.993)	(-2.815)	(-0.575)	(-0.576)	(1.799)
Constant	59.70***	42.06***	35.95***	-0.0995	-0.198	0.157
	(5.747)	(4.723)	(6.490)	(-0.0740)	(-0.160)	(0.288)
Observations	10,100	10,100	10,100	10,100	10,100	10,100
R-squared	0.026	0.028	0.060	0.017	0.017	0.026
Number of funds	404	404	404	404	404	404
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Figure 3 Panel A presents a parallel trend analysis of public firms in the top four brown industries, illustrating how mutual funds have adjusted their investment patterns over time. The x-axis represents different time periods, ranging from six months prior to twelve months post the introduction of LCD by MorningStar, while the y-axis measures the holding weight of investments in brown public firms. During the pre-designation period (April 2017–18), the holding weights of investments in brown public firms that would be designated low carbon were very similar to the holding weights in other funds. After April 2018, LCD funds start showing a persistent decrease in brown public firm investment, compared with other funds. At the same time, in Figure 3 Panel B, LCD funds show a significant increase in brown private firm investment more than other funds in the post-designation period. Overall, both observed trends support the baseline regression, the LCD label triggered a shift in mutual fund investments, with funds reducing their investments in public brown firms, while increasing investments in private brown firms. This behavior may reflect efforts to appear more sustainable where funds adjust their portfolios to meet environmental expectations without making substantial changes in their overall impact and indicate a strategic move to avoid public scrutiny, as private firms may face less regulatory pressure or public visibility compared to their public counterparts.

Figure 3, Panel A: Parallel Trend Analysis - Public (Top 4 Brown Industry)

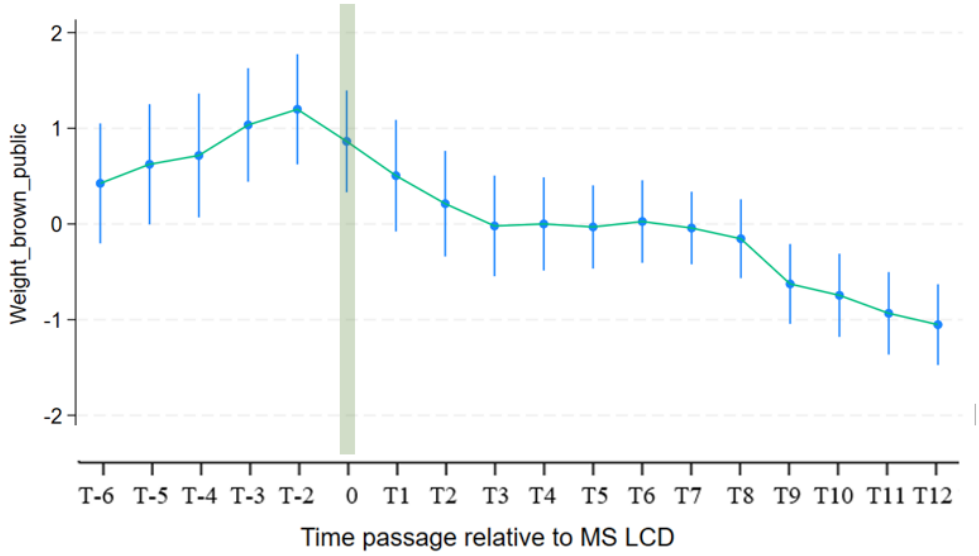
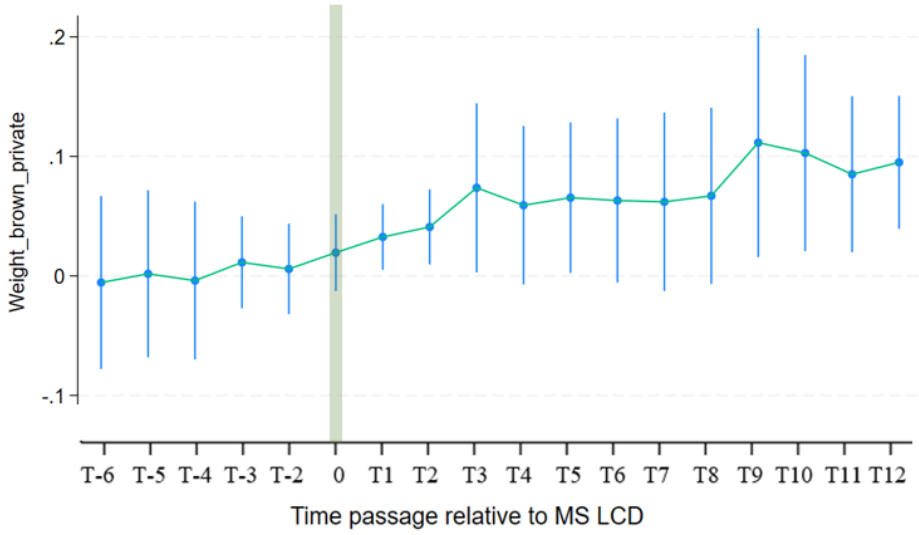


Figure 3, Panel B: Parallel Trend Analysis - Private (Top 4 Brown Industry)



Alternatively, to strengthen our identification strategy, we employ an alternative staggered difference-in-differences specification using the distance from Morningstar's carbon risk score cutoff for LCD designation. This approach strengthens the classification of the treatment group by distinguishing mutual funds that care about obtaining the LCD label from those that do not, as funds near the threshold have stronger incentives to achieve the LCD label and therefore adjust their portfolios through reallocation toward private investments. We classify funds with carbon risk scores between 10 and 13 as treated (close to LCD eligibility), and funds with scores from 13 to 100 as control (further from LCD eligibility). This approach allows us to capture funds likely to be influenced by the prospect of receiving the label, even if they were not officially designated as LCD, thereby extending the analysis to a broader but conceptually similar group.

The results in Table 3 closely mirror those from the baseline model. The coefficient on *Treat* × *Post* remains negative and significant for public brown holdings, and positive and significant for private brown holdings, particularly for broader brown industry definitions (Top 5 and Top 4). For instance, in Column (1), funds closer to the LCD cutoff reduce their exposure to public brown firms post-shock (t = -2.73), while increasing their exposure to brown private firms (Column 4, t = 1.89). These findings suggest that even funds not officially receiving the LCD label but close to the eligibility threshold respond similarly by adjusting their portfolio composition, reinforcing the idea that the LCD designation operates as a credible signal and shapes fund behavior through both direct and anticipatory channels. By combining these two identification strategies, the direct LCD

designation and the distance-from-cutoff design, we establish consistent evidence of portfolio reallocation behavior. Mutual funds reduce brown public firm exposures, likely due to their visibility and potential reputational risk, while increasing holdings in brown private firms, which may face lower public scrutiny, as investments in private firms are typically classified under the 'other' category in mutual fund portfolios, making them less visible to investors and the public. These results align with theories of strategic greenwashing or label-seeking behavior, where funds optimize perceived ESG alignment without necessarily reducing total brown investments. This dual strategy strengthens the internal validity of our results and highlights important policy implications: ESG labels, while influential, may create perverse incentives unless accompanied by broader transparency across both public and private firm exposures.

Table 3
Alternative baseline regression using Morningstar's carbon risk score cutoff

Table 3 reports the results of the baseline regression in equation (1) using staggered difference-in-differences model. This table uses the distance from Morningstar's carbon risk score cutoff for LCD designation. Window period is 12 months, and the treated group is funds that have their carbon risk score's distance close to the cutoff point which is set at score 10 (Score between 10-13) while control group is non-LCD fund that have their carbon risk score's distance relatively far from the cut off (Score from 13 to 100). Post is 12 months after the event shock. The dependent variables are the holding weights of investments in brown private firms and the holding weights of investments in brown public firms, respectively. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	%Weight of Public Brown Firm			**%Weight of Private Brown Firm**		
Variables	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
	(1)	(2)	(3)	(4)	(5)	(6)
Treat x Post	**-1.368*** **	**-0.791***	**-0.453**	**0.128***	**0.128***	**0.0684** **
	(-2.732)	**(-1.963)**	**(-1.360)**	**(1.886)**	**(1.893)**	**(2.041)**
Log Fund Size	-1.616	-1.168	-1.302	0.0334	0.0341	-0.00308
	(-1.148)	(-1.017)	(-1.443)	(0.345)	(0.352)	(-0.0417)
Fund Expense Ratio	-1.455	-1.400	-1.865	0.124	0.115	-0.182**
	(-0.378)	(-0.561)	(-1.545)	(0.727)	(0.683)	(-2.055)
Fund Turnover ratio	-0.00490	-0.00519	-0.00940	-0.000551	-0.000525	0.000544
	(-0.436)	(-0.498)	(-1.272)	(-0.557)	(-0.531)	(1.304)
Fund Monthly Return	-0.00991	0.000214	0.000955	0.00668**	0.00667**	0.00687**
	(-0.548)	(0.0164)	(0.0928)	(2.197)	(2.190)	(2.360)
Fund Age	0.472**	0.257	0.191	0.0114	0.0106	-0.0169*
	(1.977)	(1.177)	(1.048)	(0.714)	(0.667)	(-1.809)
Constant	41.92***	37.31***	26.98***	-0.598	-0.589	0.464
	(3.283)	(3.642)	(3.318)	(-0.529)	(-0.521)	(0.560)
Observations	3,525	3,525	3,525	3,525	3,525	3,525
R-squared	0.059	0.046	0.095	0.024	0.024	0.035
Number of funds	148	148	148	148	148	148
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Section IV: The Underlying Mechanism and Heterogeneity

The Underlying Mechanism

1) Investor Future Fund Flow

Table 4 examines the strategic behavior of funds that decrease holdings in public brown firms but differ in their response to private brown firms. Specifically, the analysis compares funds that both decrease their holdings in public brown firms and increase their holdings in private brown firms (denoted by Treat = 1) with funds that decrease holdings in public brown firms but do not increase holdings in private brown firms (denoted by Treat = 0). The dependent variable is the future fund flow, measured over a 12-month window following the low-carbon label in April 2018. The results show that funds that increase their holdings in private brown firms (Treat = 1) experience a statistically significant positive effect on future fund flows in the top 5 and top 4 brown industries, with coefficients of 0.013 and 0.015 with t-statistic of 3.42 and 3.72, respectively. For the economic significance, funds that increased their investments in private brown industries experienced a 1.5% higher fund flow compared to those that did not increase their holdings in private brown industries, 12 months after the LCD shock. This difference can generate a larger amount of revenue for well-established funds and suggests that mutual funds that strategically reallocated their portfolios toward private brown industries in response to the LCD were able to attract significantly higher investor capital, reflecting the market's positive reception of these strategic shifts. These funds are perceived to be adapting their portfolios to align with sustainability trends, even though they remain exposed to brown industries in private market. In contrast, the effect for the top 3 brown industry is not statistically significant (coefficient of 0.0046), indicating that this relationship may not be as pronounced for more carbon-intensive industries. Overall, this behavior could be interpreted as a form of strategic adjustment to investor sentiment by increasing their allocations to private brown firms, signaling their commitment to addressing environmental concerns without fully divesting from brown sectors, and engaging in a form of greenwashing, where they appear to be more sustainable by investing in private firms, even though their core exposure to brown industries remains largely unchanged.

For investors, the results highlight the importance of critically assessing the sustainability claims of funds. Funds that signal a shift to private brown firms may still be involved in carbon-intensive

industries, and their commitment to sustainability may be more superficial than genuine. The ability of these funds to attract capital based on their perceived efforts to improve sustainability underscores the need for more stringent regulations and disclosures that can help investors distinguish between genuine sustainability efforts and marketing tactics designed to attract ESG-conscious capital.

These findings are consistent with research on greenwashing in finance, where firms or funds make strategic decisions to appear more sustainable in order to appeal to investors, without making substantial changes to their core business practices (Kim, and Yoon, 2023). The increase in future fund flow of mutual fund after the shifting to brown private firm investment aligns with Ceccarelli, Ramelli, and Wagner (2024), who suggest that mutual funds labeled as "low carbon" experienced a significant increase in investor demand, especially those with high risk-adjusted returns.

Table 4

The Effect of Strategic Behavior of Mutual Fund to Future Fund Flow

Table 4 reports the strategic behavior of fund increasing holdings in private brown firms to future fund flows in next 12-month window period. This tables compare funds that both decrease holdings in public brown firms, but one group increase holdings of private brown firms and another group does not increase holdings of private brown firms. Treat equals 1 if funds decrease holdings in public brown firms but increase holdings of private brown firms after low carbon designation in April 2018. Treat equals 0 if funds decrease holdings in public brown firms, but do not increase holdings of private brown firms after low carbon designation in April 2018. The dependent variable is the future fund flow in the next 12 months, with the results broken down further in specific sectors, such as the top 5 brown industry, top 4 brown industry, and top 3 brown industry. The regression model includes control variables, the same as the baseline regression. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	Future Fund Flow		
	Top 5 Brown Industry	Top 4	Top 3
Treat*Post	**0.013*** **	**0.015*** **	0.0046
	(3.42)	**(3.72)**	(0.59)
Log fund size	-0.0028	-0.0031	-0.0027
	(-1.34)	(-1.46)	(-1.18)
Expense ratio	-0.0091**	-0.0095**	-0.0099**
	(-2.28)	(-2.35)	(-2.26)
Turnover Ratio	-0.00001	-0.00002	-0.00002
	(-0.47)	(-0.58)	(-0.55)
Return	-0.00016	-0.0001	-0.0003
	(-0.79)	(-0.51)	(-1.33)
Fund Age	0.0021	0.0031	0.0043
	(0.32)	(0.53)	(0.84)
Observations	7,843	7,843	7,843
R-squared	0.0656	0.0787	0.0525
Number of funds	222	222	222
Controls	YES	YES	YES

Table 5 further investigates how investors respond to public versus private brown holdings in terms of future fund flows. Specifically, this analysis distinguishes between holdings in brown public firms and brown private firms to see whether investors recognize funds' private brown holdings and punish such behaviors. Across all three industry groups (Top 5, Top 4, and Top 3 brown industries), the results consistently indicate that exposure to brown public firms has a statistically significant negative association with future fund flows, while exposure to brown private firms shows no such penalty. For example, in the top 5 brown industry specification, the coefficient on the weight of brown public firms is -0.0005 (t = -2.076), suggesting that higher exposure to public brown firms deters investor capital. In contrast, the coefficient of private brown firms is small and statistically insignificant, indicating no meaningful investor reaction. From this result, investors appear to penalize funds for visible exposure to public brown firms but are less responsive or even unaware of brown investments hidden within private holdings.

Table 5

The Response of Investors from the Mutual Fund's Holding in Brown Investment

Table 5 examines the relationship between mutual fund exposure to brown firms, separated into private and public investment, and future fund flows. The dependent variables are future fund flows, and the independent variable is the holding weights of investments in brown private firms and the holding weights of investments in brown public firms, respectively. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	Future Fund Flow		
VARIABLES	Top 5 Brown Industry (1)	Top 4 (2)	Top 3 (3)
%Weight of Private Brown Firm	**-0.000325**		
	(-0.201)		
%Weight of Public Brown Firm	-0.000500**		
	(-2.076)		
%Weight of Private Brown Firm		**0.000474**	
		(0.355)	
%Weight of Public Brown Firm		-0.000457*	
		(-1.724)	
%Weight of Private Brown Firm			**-0.00129**
			(-0.773)
%Weight of Public Brown Firm			-0.000523
			(-1.621)
Constant	-0.148	-0.159	-0.162
	(-1.214)	(-1.303)	(-1.336)
Observations	10,100	10,100	10,100
R-squared	0.013	0.013	0.013
Number of funds	404	404	404
Controls	YES	YES	YES
Time FE	YES	YES	YES
Firm FE	YES	YES	YES

2) Future Fund Return

Another important motivation for reallocating toward private firms is that mutual funds can continue to earn high potential returns from brown private investments even after receiving the LCD designation. As shown in the table 6, the coefficient of *Treat* × *Post* is positive and highly significant in both treatment group classifications, with coefficients of 0.380 for LCD funds and 0.19 for funds near the LCD cut-off point. This indicates that, following LCD introduction, treated funds significantly increase their exposure to private brown investments relative to control funds. The results suggest that private markets provide an attractive channel through which funds can maintain or enhance returns from carbon-intensive assets while complying with, or appearing to comply with, low-carbon labeling requirements. Combined with the weaker disclosure and monitoring in private markets, this return-seeking incentive helps explain why mutual funds strategically shift toward brown private firms.

Table 6

The Future Fund Return from the Mutual Fund's Shifting to Brown Private Investment

Table 6 examines the consequence of fund increasing holdings in private brown firms to future fund return in next month window period. This tables compare LCD funds (treated group) versus non-LCD fund (control group) and funds that have their carbon risk score's distance close to the cutoff point (treated group), score between 10 and 13 versus non-LCD fund that have their carbon risk score's distance relatively far from the cut off (control group), score from 13 to 100. The dependent variable is the fund return in the next month (t+1). The regression model includes control variables, the same as the baseline regression. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	Future Fund Return	
Treatment Group	LCD designation	LCD cut-off point
Treat*Post	**0.380*** **	**0.19*** **
	(5.53)	**(2.92)**
Log fund size	-0.026	0.017
	(-0.91)	(0.51)
Expense ratio	-0.025	-0.0429
	(-0.30)	(-1.03)
Turnover Ratio	-0.0005	-0.0008
	(-0.79)	(-1.49)
Return	-0.019	-0.06*
	(-1.10)	(-1.91)
Fund Age	0.001	-0.0009
	(0.95)	(-0.65)
Observations	10,100	3,525
R-squared	0.0879	0.0787
Number of funds	404	148
Controls	YES	YES

Strategic Reallocation to Firms Lacking Carbon Disclosure

To support our earlier finding regarding the reallocation to private firms with unavailable carbon data, we also investigate whether funds are shifting investments toward brown public companies lacking carbon data according to Morningstar's data sources. Fund holdings should clearly move toward these brown public companies with missing carbon data. Morningstar allows up to 33% of total holdings to be without carbon risk data, creating a gap in accurately assessing true portfolio carbon exposure. Table 7 shows that mutual funds tend to shift investments toward these brown public firms without available carbon data, effectively evading carbon risk measurement in brown public firms. The results consistently show a significant shift toward non–carbon-rated firms among mutual funds with carbon scores close to the cut-off point, across different classifications of treatment groups.

Table 7
The reallocation of mutual fund holdings toward public brown firms without available carbon risk score

Table 7 reports the results of the dynamic staggered difference-in-differences regressions examining the reallocation of mutual fund holdings toward public brown firms without available carbon risk score. The treated group consists of funds with carbon risk scores close to the LCD designation cutoff (Score 10–13 or 10–20), while the control group includes funds with scores further from the cutoff. The window period is 12 months, and the dependent variable is the percentage weight of public brown firms with no carbon rating. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	%Weight of public brown firm with no carbon rating (Treatment group = close to LCD cut-off point fund, dynamic change in each period)					
	Treatment Group: carbon risk score 10-13			**Treatment Group: carbon risk score 10-20**		
VARIABLES	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
Treat x Post	**0.255*** **	**0.266***	0.0569	**1.007** **	**0.460***	0.0202
	(4.030)	**(1.923)**	(0.261)	**(2.366)**	**(1.782)**	(0.249)
Log Fund Size	-0.00107	0.00523**	0.0238***	0.00190	-0.00905***	-0.00567***
	(-0.875)	(2.063)	(6.074)	(0.510)	(-3.534)	(-4.214)
Fund Return	-0.0572***	-0.172***	-0.0897*	-0.138**	-0.129***	-0.0241***
	(-5.167)	(-6.013)	(-1.802)	(-2.528)	(-5.092)	(-2.577)
Fund Expense Ratio	0.0160***	0.0340***	0.0543***	0.0616***	0.00294	0.00879
	(3.565)	(3.004)	(3.564)	(3.310)	(0.211)	(1.478)
Fund Turnover Ratio	0.125	1.188*	-0.484	-0.840	1.754***	0.466**
	(0.562)	(1.649)	(-0.716)	(-1.303)	(3.258)	(2.283)
Fund Age	0.0101**	-0.0239**	0.0507**	0.0663***	-0.0238**	0.00387
	(2.406)	(-2.486)	(2.476)	(3.348)	(-2.436)	(0.782)
Constant	1.397	2.378	31.76***	40.43***	1.619	0.468
	(0.680)	(0.358)	(5.088)	(6.788)	(0.327)	(0.249)
Observations	3,228	3,228	3,228	3,228	3,228	3,228
R-squared	0.838	0.898	0.935	0.980	0.988	0.994
Controls	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES

Importantly, the investor response to this strategic shift appears muted. The analysis of future fund flows in Table 8 reveals no significant decrease in fund inflows despite the increased weighting in brown public firms lacking carbon rating data. This suggests that investors either do not perceive the missing carbon data as a risk signal or lack the necessary information to respond. These results highlight an important blind spot in current carbon footprint assessments and underscore the need for improved data coverage by providers such as Sustainalytics.

Table 8

The Response of Investors from the Mutual Fund's Holding in Public Brown Investment with no carbon risk score

Table 8 examines the response of investors when mutual fund exposes to public brown firms that have no carbon risk score available to future fund flows. The dependent variables are future fund flows, and the independent variable is the interaction of post and holding weights of investments in public brown firms with no carbon risk score, respectively. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

	Future Fund Flow		
	Top 5 Brown Industry	Top 4	Top 3
VARIABLES	(1)	(2)	(3)
Post*%Weight of public brown firm with no carbon risk score	**0.00000453** **(0.110)**	**-0.000163** **(-1.455)**	**-0.0000523** **(-0.885)**
Fund Turnover Ratio	0.0000683	0.0000688	0.0000689
	(1.609)	(1.616)	(1.622)
Fund Expense Ratio	-0.00742*	-0.00756*	-0.00755*
	(-3.930)	(-4.057)	(-4.053)
Fund Return	-0.00118**	-0.00118**	-0.00117**
	(-4.429)	(-4.463)	(-4.379)
Log Fund Size	-0.0154	-0.0158	-0.0157
	(-2.305)	(-2.371)	(-2.372)
Fund Age	0.00105	0.00106	0.00106
	(1.363)	(1.371)	(1.369)
Observations	8,441	8,441	8,441
R-squared	0.083	0.083	0.083
Number of funds	321	321	321
Controls	YES	YES	YES
Time FE	YES	YES	YES
Fund FE	YES	YES	YES

Heterogeneity across Fund Characteristics

Table 9 explores how the treatment effect, LCD label, differ depending on the performance of the funds, as measured by net of fee alpha. Specifically, the funds are categorized into two groups: Low Alpha and High Alpha, with alpha determined by the median of lagged alpha from the MS Medalist Rating.

For funds with low alpha, the treatment effect is significantly negative for all categories in the holding weight of public brown firms. In the top 5 brown industry, the coefficient is -1.204 with a t-statistic of -3.560, indicating a highly significant negative effect of the treatment. Similarly, significantly negative treatment effects are observed in other industries (top 4 and top 3 brown industries) with coefficients of -0.585 (t-statistic = -2.257) and -0.830 (t-statistic = -3.495), respectively. This suggests that for funds with prior low alpha, the treatment leads to a significant decrease in their allocation to public brown firms, particularly in the top 5 and top 3 brown industry. Meanwhile, funds with high alpha show no significant differences in treatment effects for all categories, with coefficients close to zero and t-statistics indicating no statistically significant changes. For the holding weight of private brown firms, the treatment effect is significantly positive for all categories, with coefficients of 0.124, 0.129, and 0.0234, and t-statistics of 2.394, 2.287, and 2.154, respectively. For funds with high alpha, the treatment effect is statistically insignificant, as evidenced by the coefficients: 0.00362 with a t-statistic of 0.189 for the top 5 brown industry, 0.00874 with a t-statistic of 0.487 for the top 4 brown industry, and 0.0196 with a t-statistic of 1.517 for the top 3 brown industry

The implication for this result is that low-alpha funds, which may be more in need of improvement or innovation to enhance performance, could be more responsive to changes, possibly in an attempt to improve their relative standing, especially on the sustainability perspective, to attract more investors while funds with higher past performance tend to exhibit greater stability in their strategies and are less likely to react to short-term shocks. This aligns with findings from Carhart (1997), who argued that past performance, particularly positive performance, reduces the likelihood of major strategy changes or a reallocation of assets.

Table 9

The Heterogeneity of Fund Performance to Investment in Brown Firms

Table 9 reports the heterogeneity in the baseline result based on fund performance measured by net of fee alpha and MS medalist performance rating pillar. Panel A, the funds are categorized into two groups based on the median of lagged alpha from the MS Medalist Rating. Panel B, the funds are categorized into two groups based on the median lagged performance rating. The dependent variable is the holding weight of investment in public brown firm and private brown firm, with the results broken down further in specific sectors, such as the top 5 brown industry, top 4 brown industry, and top 3 brown industry. The regression model includes control variables, the same as the baseline regression, as well as fixed effects for both fund and time. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

Panel A: Net of fee alpha -- (use MS Medalist Rating and classify into high/low alpha based on the median lagged alpha)

	%Weight of Public Brown Firm			**%Weight of Private Brown Firm**		
Treat*Post	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
Low Alpha	**-1.204*** **	**-0.585** **	**-0.830*** **	**0.124** **	**0.129** **	**0.0234** **
	(-3.560)	**(-2.257)**	**(-3.495)**	**(2.287)**	**(2.394)**	**(2.154)**
High Alpha	-0.0625	-0.333	-0.312	0.00362	0.00874	0.0196
	(-0.198)	(-1.370)	(-1.656)	(0.189)	(0.487)	(1.517)
Observations	10,100	10,100	10,100	10,100	10,100	10,100
R-squared	0.057	0.080	0.068	0.050	0.041	0.032
Number of funds	404	404	404	404	404	404
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Panel B: MS medalist performance rating pillar -- (classify into high/low performance rating based on the median lagged performance rating)

	%Weight of Public Brown Firm			**%Weight of Private Brown Firm**		
Treat*Post	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
Low Perf Rating	**-1.434*** **	**-0.808*** **	**-0.918*** **	**0.0953***	**0.100***	0.0145
	(-3.756)	**(-2.863)**	**(-3.753)**	**(1.665)**	**(1.756)**	(1.637)
High Perf Rating	0.150	0.0338	-0.219	0.0596	0.0643	0.0307**
	(0.556)	(0.149)	(-1.086)	(1.449)	(1.576)	(2.257)
Observations	10,100	10,100	10,100	10,100	10,100	10,100
R-squared	0.046	0.045	0.052	0.019	0.017	0.031
Number of funds	404	404	404	404	404	404
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Table 10 examines how the treatment effects, represented by the interaction term of *Treat*Post*, vary based on monthly fund expenses. The funds are classified into two categories: low expense and high expense, with classification based on the median lagged fund expense. For funds with high expenses, the treatment effect on public brown firms is more pronounced than funds with low expenses, with significant negative effects in the top 5 and top 3 brown industries. In the top 5 brown industry, the coefficient is -0.687 with a t-statistic of -1.924, and in the top 3 brown industry, the coefficient is -0.503 with a t-statistic of -1.968. These results suggest that higher-expense funds experience a larger and more statistically significant reduction in their allocations to public brown firms compared to lower-expense funds after the LCD label. On the other hand, for the holding weight of investment in private brown firms, high-expense funds show significantly positive treatment effects across the top sectors, with coefficients of 0.110 (t-statistic = 1.997), 0.120 (t-statistic = 2.208), and 0.0274 (t-statistic = 2.655) for the top 5, top 4, and top 3 brown industries, respectively. This indicates that high-expense funds tend to increase their allocation to private brown firms in response to the LCD label, with stronger effects observed in the top 5 and top 4 brown industries.

Table 10

The Heterogeneity of Fund Expense to Investment in Brown Firms

Table 10 reports the heterogeneity in the baseline result based on fund expense measured by the median lagged fund expense. The dependent variable is the holding weight of investment in public brown firm and private brown firm, with the results broken down further in specific sectors, such as the top 5 brown industry, top 4 brown industry, and top 3 brown industry. The regression model includes control variables, the same as the baseline regression, as well as fixed effects for both fund and time. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

Fund Expense -- (classify into high/low expense based on the median lagged fund expense)

	%Weight of Public Brown Firm			**%Weight of Private Brown Firm**		
Treat*Post	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
Low Expense	-0.454	-0.280	-0.509***	0.0239	0.0234	0.0145
	(-1.607)	(-1.382)	(-3.028)	(1.123)	(1.091)	(1.176)
High Expense	**-0.687***	-0.379	**-0.503***	**0.110****	**0.120****	**0.0274*****
	(-1.924)	(-1.268)	**(-1.968)**	**(1.997)**	**(2.208)**	**(2.655)**
Observations	10,100	10,100	10,100	10,100	10,100	10,100
R-squared	0.086	0.089	0.116	0.030	0.030	0.035
Number of funds	404	404	404	404	404	404
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

For funds with low expenses, the treatment effect on the holding weight of public brown firms is negative across all industry categories, though the magnitude of the effect varies. In the top 5 brown and the top 4 brown industry show insignificant difference after the LCD label. The coefficients are -0.454 and -0.280 with a t-statistic of -1.607 and -1.382, respectively. This suggests that for funds with low expenses, the treatment does not lead to a substantial decrease in the allocation to public brown firms. Similarly, for the weight of private brown firms, funds with low expenses exhibit positive but statistically insignificant treatment effects across all industry categories, with coefficients ranging from 0.0145 to 0.0239 and t-statistics indicating no significant changes. These results suggest that high-expense funds might have more incentive to greenwash as a strategy to attract investors seeking sustainable investment options (Cao et al., 2024) and to leverage their higher fees to fund such marketing tactics because funds with higher expense ratios can increase their revenue from assets under management by attracting more investors.

Table 11 explores the heterogeneity in the baseline result based on the risk profile of the funds, as determined by the lagged MS overall risk rating. Specifically, the funds are classified into two groups: low risk and high risk, with the average lagged risk rating from Morningstar serving as the cutoff point between high and low risk.

For low-risk funds, the treatment effect is significantly negative for the top 3 and top 5 brown industries in the public brown firm category, with a coefficient of -0.929 (t-statistic = -3.910) in the top 3 brown industry and -0.654 (t-statistic = -1.703) in the top 5 brown industry. This suggests that low-risk funds tend to decrease their allocation to public brown firms in most relevant sectors (top 3 and top 5 industries) following the treatment. In contrast, the effect is not significant for the top 4 brown industry, with a coefficient of -0.426 (t-statistic = -1.582), indicating a weaker response in this specific category. Meanwhile, for the private brown firm category, low-risk funds show a significantly positive treatment effect across all sectors, with coefficients of 0.0609 (t-statistic = 2.810), 0.0632 (t-statistic = 2.913), and 0.0372 (t-statistic = 2.477) for the top 5, top 4, and top 3 brown industries, respectively. These results indicate that low-risk funds tend to increase their allocation to private brown firms, consistently in all top brown industries following the LCD label.

For high-risk funds, the treatment effects for public brown firms are similar in sign but not significant. This suggests that high-risk funds show less significant decrease in their allocation to

public brown firms compared to low-risk funds. For private brown firms, the results are positively insignificant for high-risk funds. The coefficients for the top 5, top 4 and top 3 brown industries are 0.0659 (t-statistic = 1.223), 0.0742 (t-statistic = 1.391), and 0.00467 (t-statistic = 1.365), respectively. These findings suggest that low-risk funds are more responsive to the LCD label, particularly with respect to their allocation to private brown firms, while high-risk funds exhibit more stability in their strategies and are less likely to make significant adjustments to their allocation, either to public or private brown firms.

The implication of this result is that low-risk funds may be more inclined to engage in greenwashing due to pressures from their investors. Low-risk funds typically aim to attract risk-averse investors, such as institutions seeking stable returns with minimal volatility. As investors increasingly use ESG data for their investment decision and demand sustainable investment options, which are perceived as less risky and likely to provide stable returns over the long term (Amel-Zadeh and Serafeim, 2018), low-risk funds may resort to greenwashing to signal their commitment to sustainability. This allows them to attract capital from investors who prioritize ESG factors (Ceccarelli et al., 2024).

Table 11

The Heterogeneity of Fund Risk to Investment in Brown Firms

Table 11 reports the heterogeneity in the baseline result based on fund risk measured by the average lagged MS overall risk rating. The dependent variable is the holding weight of investment in public brown firm and private brown firm, with the results broken down further in specific sectors, such as the top 5 brown industry, top 4 brown industry, and top 3 brown industry. The regression model includes control variables, the same as the baseline regression, as well as fixed effects for both fund and time. The t-statistics (in parentheses) are based on fund-level robust standard errors. The table also presents the number of observations and R^2 values for each regression. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Details of each variable are defined in the Appendix.

Fund Risk-- (classify into low/high fund risk based on the average MS overall risk rating)

	%Weight of Public Brown Firm			**%Weight of Private Brown Firm**		
Treat*Post	Top 5 Brown Industry	Top 4	Top 3	Top 5 Brown Industry	Top 4	Top 3
Low risk	**-0.654***	-0.426	**-0.929*****	**0.0609*****	**0.0632*****	**0.0372****
	(-1.703)	(-1.582)	**(-3.910)**	**(2.810)**	**(2.913)**	**(2.477)**
High risk	-0.618*	-0.286	-0.254	0.0659	0.0742	0.00467
	(-1.906)	(-1.052)	(-1.042)	(1.223)	(1.391)	(1.365)
Observations	10,100	10,100	10,100	10,100	10,100	10,100
R-squared	0.046	0.045	0.063	0.025	0.027	0.047
Number of funds	404	404	404	404	404	404
Controls	YES	YES	YES	YES	YES	YES
Fund FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Section V: Conclusion

Our study provides new evidence that mutual funds, despite publicly committing to carbon divestment and ESG principles, strategically shift investments from brown public firms to brown private firms following the introduction of Morningstar's LCD. This behavior enables funds to maintain exposure to carbon-intensive industries under less regulatory scrutiny, raising significant concerns about greenwashing within the mutual fund industry. Our findings reveal that the increased investor fund flows, future fund return and the lack of awareness in the high carbon exposure in private investment by investors are the main potential motivations of this shift. While investors tend to penalize visible brown public holdings, they remain largely unaware of brown private investments and public brown firms with no carbon risk data, creating incentives for funds to obscure their true carbon exposure. Furthermore, we show heterogeneity in fund characteristics, those with lower performance, bearing higher expenses, and lower risk tolerance are more likely to drive this shift. These results underscore the need for enhanced transparency and regulatory oversight across private markets to ensure ESG commitments translate into meaningful environmental impact. Ultimately, this research advances the discourse on sustainable investing by illuminating the complex trade-offs mutual funds navigate and the potential unintended consequences of ESG labeling initiatives.

Reference

Atta-Darkua, V., Glossner, S., Krueger, P., & Matos, P. (2023). Decarbonizing institutional investor portfolios: Helping to green the planet or just greening your portfolio? [Working paper].

Beck, T., Silva-Buston, C., & Wagner, W. (2025). Supervisory cooperation and regulatory arbitrage. *Review of Finance*, 29(2), 381–413.

Coates, J. C., IV, & Hubbard, R. G. (2007). Competition in the mutual fund industry: Evidence and implications for policy (*Harvard Law and Economics Discussion Paper* No. 592). Harvard Law School.

Berg, F., Koelbel, J. F., & Rigobon, R. (2025). Spotting portfolio greenwashing in environmental funds. *Journal of Business Ethics*, 197, 811–839.

Berk, J. B., & Green, R. C. (2004). Mutual fund flows and performance in rational markets. *Journal of Political Economy, 112*(6), 1269–1295.

Brandon, R. G., Glossner, S., Krueger, P., Matos, P., & Steffen, T. (2022). Do responsible investors invest responsibly? *Review of Finance*, 1389–1432.

Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, 142(2), 517–549.

Cao, S., & Smith, A. (2022). The economics of greenwashing funds [Working paper].

Ceccarelli, M., Ramelli, S., & Wagner, A. F. (2024). Low carbon mutual funds. *Review of Finance*, 45–74.

Fama, E. F., & French, K. R. (2010). Luck versus skill in the cross-section of mutual fund returns. *Journal of Finance*, 65(5), 1915–1947.

Gil-Bazo, J., & Ruiz-Verdú, P. (2009). The relation between price and performance in the mutual fund industry. *Journal of Finance*, 64(5), 2153–2183.

Hartzmark, S. M., & Sussman, A. B. (2019). Do investors value sustainability? A natural experiment examining ranking and fund flows. *Journal of Finance*, 74(6), 2789–2837.

Honigsberg, C., Hu, E., & Jackson, R. J., Jr. (2022). Regulatory arbitrage and the persistence of financial misconduct. *Stanford Law Review*, 74, 737–789.

Ilhan, E., Sautner, Z., & Vilkov, G. (2021). Carbon tail risk. *The Review of Financial Studies, 34*(3), 1540–1571.

Kim, S., & Yoon, A. S. (2022). United Nations Principles for Responsible Investment signatories: Evangelists or hypocrites? *The Journal of Impact and ESG Investing, 3*(1), 134–139.

Kim, S., & Yoon, A. (2023). Analyzing active fund managers' commitment to ESG: Evidence from the United Nations Principles for Responsible Investment. *Management Science*.

Kwon, S., Lowry, M., & Qian, Y. (2019). Mutual fund investments in private firms. *Journal of Financial Economics, 136*(2), 407–443.

Parise, G., & Rubin, M. (n.d.). Green window dressing. EDHEC Business School [Working paper].

Raghunandan, A., & Rajgopal, S. (2022). Does ESG funds make stakeholder-friendly investments? *Review of Accounting Studies, 27*, 822–863.

Ramos, S. B., Cortez, M. C., Covachev, S., & Silva, F. (2024). In labels we trust? The influence of sustainability labels in mutual fund flows. ESSEC Business School [Working paper].

Rohleder, M., Wilkens, M., & Zink, J. (2022). The effects of mutual fund decarbonization on stock prices and carbon emissions. *Journal of Banking & Finance, 134*, 106352.

Appendix A: Variable definitions

Variable	Definition
Top 3 Brown Industry	Top 3 brown industry includes utilities, energy and materials. This is based on carbon intensity rankings for the top 3 sectors of the S&P 500, with a focus on the ratio of Scope 1 carbon emissions to market value. (Ilhan, Sautner, and Vilkov, 2021)
Top 4 Brown Industry	Top 4 brown industry includes utilities, energy, materials and industrials. This is based on carbon intensity rankings for the top 4 sectors of the S&P 500, with a focus on the ratio of Scope 1 carbon emissions to market value. (Ilhan, Sautner, and Vilkov, 2021)
Top 5 Brown Industry	Top 5 brown industry includes utilities, energy, materials, industrials and consumer staples. This is based on carbon intensity rankings for the top 5 sectors of the S&P 500, with a focus on the ratio of Scope 1 carbon emissions to market value. (Ilhan, Sautner, and Vilkov, 2021)
%Brown Private (Top 3 Brown Industry)	Percentage of the mutual fund's portfolio is invested in private brown firms (Top 3 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Private\ Brown\ Firms\ (\text{Top 3 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Brown Private (Top 4 Brown Industry)	Percentage of the mutual fund's portfolio is invested in private brown firms (Top 4 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Private\ Brown\ Firms\ (\text{Top 4 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Brown Private (Top 5 Brown Industry)	Percentage of the mutual fund's portfolio is invested in private brown firms (Top 5 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Private\ Brown\ Firms\ (\text{Top 5 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Private	Percentage of the mutual fund's portfolio is invested in private brown firms to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Private\ Firms}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Brown Public (Top 3 Industry)	Percentage of the mutual fund's portfolio is invested in public brown firms (Top 3 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Public\ Brown\ Firms\ (\text{Top 3 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Brown Public (Top 4 Industry)	Percentage of the mutual fund's portfolio is invested in public brown firms (Top 4 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Public\ Brown\ Firms\ (\text{Top 4 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$

Variable	Definition
%Brown Public (Top 5 Industry)	Percentage of the mutual fund's portfolio is invested in public brown firms (Top 5 Brown Industry) to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Public\ Brown\ Firms\ (\text{Top 5 Brown Industry})}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
%Public	Percentage of the mutual fund's portfolio is invested in public firms to the total size of the fund's portfolio. $\frac{Market\ Value\ of\ Mutual\ Fund's\ Holdings\ in\ Public\ Firms}{Total\ Market\ Value\ of\ Mutual\ Fund's\ Portfolio} \times 100$
Log Fund Size	The natural logarithm of mutual fund's size. Fund Size is the total amount of money managed as a standalone portfolio across share classes that existed as of the end of each month.
Fund Turnover Ratio %	A ratio of how frequently an investment buys or sells its holdings. This ratio is expressed as a percentage of the investment's holdings have been traded over a given year as reported in the investment's periodic disclosure document.
Fund Age	The fund age is calculated as the number of years the mutual fund has been operating since the inception year. Fund Age = Current year − Inception year.
Fund Expense Ratio %	The percentage of fund assets paid for operating expenses and management fees, including 12b-1 fees, administrative fees, and all other asset-based costs incurred by the fund, except brokerage costs.
Fund Monthly Return %	Return is the monthly return net of fees.
Fund ESG Engagement	An indication whether the investment uses shareholder engagement, including raising resolutions, active proxy voting, and direct company engagement, to pursue ESG goals with invested companies.
Net of fee alpha	Use MorningStar Medalist Rating (five-tier scale running from Gold to Negative) which compares this fund net alpha against the net alpha of other funds within the same Morningstar Category. Net alpha is calculated by deducting expense ratio from gross alpha.
MS medalist performance rating pillar	Morningstar calculates the Performance Pillar using an algorithm designed to predict the Performance Pillar score our fund analysts would assign to the fund. The quantitative rating is expressed as Positive, Neutral, or Negative.
Fund Risk	Morningstar Risk Rating is an annualized measure of a fund's downside volatility. There are five categories including High, Above Average, Average, Below Average, and Low.
Future Fund Flow	Following the fund flow literature, the future investment flow for fund p in month t is defined as the future net flow into the fund divided by the total net assets at time t (TNA). Future $Flow_{p,t} = \frac{TNAp,t+1}{TNAp,t} - (1+R_{p,t+1})$ $TNA_{p,t+1}$ is fund p's total net assets at the end of month t+1, and $R_{p,t+1}$ is the fund return in month t+1.