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Low-carbon Mutual Funds

Finance Working Paper N° 659/2020
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Abstract

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Keywords: Behavioral finance, climate change, eco-labels, investor preferences, mutual funds, sustainable finance

JEL Classifications: D03, G02, G12, G23

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February 11, 2021

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1 Introduction

Climate change is one of the key economic challenges of our time. Economists and public policy scholars increasingly agree on the merits of carbon taxes and/or tradable permits to ensure adequate pricing of carbon emissions at the international level.[1] However, given the current practical and political challenges in implementing such policies, policy-makers are also exploring alternative strategies to accelerate the transition to a low-carbon economy. One central approach is to make "financial flows consistent with a pathway towards low greenhouse gas emissions" (Paris Agreement, Article 2) by improving the climate-related information available to investors about their portfolios.[2]

The success of this strategy, however, relies on the twin assumptions that investors will respond to more transparency by demanding more climate-conscious products and that financial intermediaries will in turn shift their assets towards more climate-friendly holdings. However, the triggering of this virtuous circle is far from obvious, because low-carbon funds are likely to have both benefits and costs. They can provide investors with a channel to reduce their exposure to climate risks (and to satisfy their green preferences), but at the expense of a lower sectoral diversification relative to the market portfolio, at least in the short-term. In this paper, based on a large sample of Europe- and US-domiciled funds, we document the existence of such trade-off and then study how investors and fund managers respond to it.

Mutual funds play a crucial role in the overall economy. As of year-end 2018, US and

[1] See Nordhaus (2019). On the internalization of external costs in general see the fundamental contributions of Pigou (1920), Coase (1960), and Weitzman (1974).

[2] For instance, as a follow-up to the "Action plan for sustainable finance" of March 2018 (European Commission, 2018), regulators are currently developing the criteria for an EU-wide eco-label for financial products that should help retail investors "express their investment preferences on sustainable activities."

European mutual funds, respectively, had some USD 17.7 trillion and USD 11 trillion in assets under management (Investment Company Institute, 2019). On April 30, 2018, Morningstar, the most important information provider in the mutual fund industry, introduced an eco-label for mutual funds, the Low Carbon Designation (LCD). This event altered the information available to investors on the climate performance of mutual funds.

After explaining the institutional setting in Section 2 and describing the data in Section 3, in Section 4 we show that low-carbon funds have a specific risk profile compared to conventional and also more generic sustainability funds. Specifically, low-carbon funds are likely to have lower exposure to future potential realizations of climate change risks. These funds outperform conventional funds in months with higher salience of climate change risks, as proxied by the negative climate news index used in Engle et al. (2020). However, low-carbon funds also display substantially higher idiosyncratic volatility relative to the current market portfolio, mostly due to their under-weighting of carbon-intensive sectors. Indeed, by construction, low-carbon funds exhibit lower "balance" (Pástor et al., 2020a) with respect to the current market portfolio. Hence, market participants face a fundamental trade-off between investing in a low-carbon way and diversifying a portfolio in a still not-low-carbon economy.

In contrast to low-carbon funds, funds with higher sustainability scores (used in the assignment of "Globes") do not offer enhanced protection against climate news risks. However, they have somewhat lower idiosyncratic risk.

Next, in Section 5 we exploit the quasi-experimental setting of the introduction of the LCD to test whether, despite the existence of the above trade-off, on average investors have a preference for "climate-friendly" funds. We find that funds that were labeled as low-carbon

at the end of April 2018 enjoyed a substantial increase in their monthly net flows relative to conventional funds, net of the effect of other fund characteristics. The economic impact is large. It corresponds to the effect of about 47% of a one-standard deviation stronger financial performance in the prior month. The effect is even stronger for European funds.

These findings hold controlling for many other factors, including the generic ratings for fund performance ("Stars") and sustainability ("Globes") of Morningstar for which prior work had shown an impact on fund flows (e.g., Del Guercio and Tkac, 2008, Ammann et al., 2018, Ben-David et al., 2019, Hartzmark and Sussman, 2019, and Evans and Sun, 2021). A battery of robustness checks alleviate concerns that the findings are driven by other unobserved factors.

The boost in flows received by low-carbon funds is not a one-off event: Receiving (losing) the LCD in quarterly updates that followed the initial publication through September 2019 translates into positive (negative) flow effects that are comparable to those at the initial introduction.

Finally, Section 6 studies how mutual funds actively changed their portfolios after the initial release of the LCD and the clear revelation of investors' preference for low-carbon investment products. We find that between April 2018 and September 2019, active funds rebalanced their portfolios towards more climate-conscious firms. For example, during the six quarters the LCD was in place through September 2019, mutual funds that were not considered low-carbon in April 2018 reduced their portfolio Carbon Risk (the portfolio's exposure to firms with un-managed climate-risks) by 17% of a standard deviation relative to LCD-recipients. We obtain similar results when accounting for changes in the underlying relative asset valuations of carbon-intensive sectors.

This "green shift" of mutual fund portfolios in recent years is likely influenced by several factors. We interpret the observed behavior of fund managers as a supply-side reaction to a general increase in demand for low-carbon investment products and higher awareness of climate-related risks, accelerated in the mutual fund industry by the release of Morningstar's LCD. Our setting is particularly suited to capture the effects of such competitive behavior because it allows us to study how funds' climate performance evolved after it became publicly available and proved an important driver of fund flows.

Our paper contributes, first, by empirically documenting the potential benefits and costs of low-carbon investment products. Existing research suggests that firms with better environmental performance have lower exposure to climate-related risks, and are hence priced accordingly by financial markets (e.g., Bolton and Kacperczyk, 2020a,b; Engle et al., 2020; Ilhan et al., 2020b; Huynh and Xia, 2020). Our analyses confirm that this type of insurance property extends to mutual funds under-weighting carbon-intensive firms. This benefit, however, comes at the expense of a lower sectoral diversification, which limits risk-sharing from a traditional portfolio-theory perspective (Markowitz, 1952). The trade-off that we highlight is consistent with the theoretical literature on green investing (Heinkel et al., 2001; Pástor et al., 2020b; Pedersen et al., 2020), but is still empirically under-explored. Given the growing expectations on finance to support the decarbonization of the economy, both policy-makers and investors should carefully weigh the benefits and costs of reducing investment flows to specific economic sectors.

Second, we complement the literature on investor behavior, in particular on whether and why investors prefer socially responsible investment products (e.g., Anderson and Robinson, 2019; Barber et al., 2020; Bassen et al., 2018; Bauer et al., 2018; Bialkowski and Starks, 2016;

Bollen, 2007; Bonnefon et al., 2019; Geczy et al., 2021; Renneboog et al., 2011; Riedl and Smeets, 2017).[3] The natural experiment that we analyze is appealing in this respect. Before the introduction of the LCD, investors already had the chance to self-select into different funds on the base of their generic sustainability preferences, given the availability since 2016 of easy-to-process information about the ESG performance of funds (Hartzmark and Sussman, 2019).[4] Hence, the effect that we identify can be attributed to investors' preferences for climate-related features, net of their preferences for sustainability more broadly defined. In addition, the empirical setting allows us to document that many investors prefer low-carbon funds despite having to give up diversification opportunities. In this perspective, our paper also relates to recent research studying the drivers of investor demand for high idiosyncratic volatility funds and the related tradeoffs (Goetzmann and Kumar, 2008; Clifford et al., 2020; Pástor et al., 2020a).

Third, we complement the literature that studies the behavior of professional money managers. Important prior studies in this area include Berk and Green (2004), Berk and Van Binsbergen (2015), Chevalier and Ellison (1997), Cooper et al. (2005), Donaldson and Piacentino (2018), Guercio and Reuter (2014), Harris et al. (2015), Hortaçsu and Syverson (2004), Kempf and Ruenzi (2008), and Wahal and Wang (2011). Most studies consider mutual fund manager behavior as a function of traditional performance metrics such as fees and returns. However, in recent years, ESG factors (in particular related to climate

[3]A broader stream of research studies the preferences of investors for socially and environmentally responsible firms, primarily through the lens of stock prices (e.g. Hong and Kacperczyk, 2009; Hong and Kostovetsky, 2012; Krüger, 2015; Lins et al., 2017; Flammer, 2021) or through the portfolio holdings of institutional investors (e.g, Dyck et al., 2019; Fernando et al., 2017; Gibson and Krüger, 2020; Gibson et al., 2019; Krüger et al., 2020) or both (Ramelli et al., 2019).

[4]More recently, Pástor and Vorsatz (2020) and Döttling and Kim (2020) study the effects of mutual funds' sustainability Globe ratings on fund flows during the COVID-19 crash.

change) have gained increasing importance in shaping the asset management industry. For instance, Krueger et al. (2020) and Ilhan et al. (2020a) provide survey evidence on the importance of climate risks for institutional investors. As deeds tend to speak louder than words, an investigation of how mutual funds actually adjust their holdings to newly released information on the climate risk of their portfolios is needed. This is one of the results that this paper delivers.[5]

2 Empirical setting

On April 30, 2018, Morningstar introduced the "Low Carbon Designation" (LCD) for mutual funds. This label is depicted as a green leaf icon which is visible on the fund's report, as shown in Figure 1. While not the first type of sustainability evaluation for funds, the LCD is particularly interesting because it specifically aims at helping clients to easily identify mutual funds with portfolios aligned with the transition to a low-carbon economy.

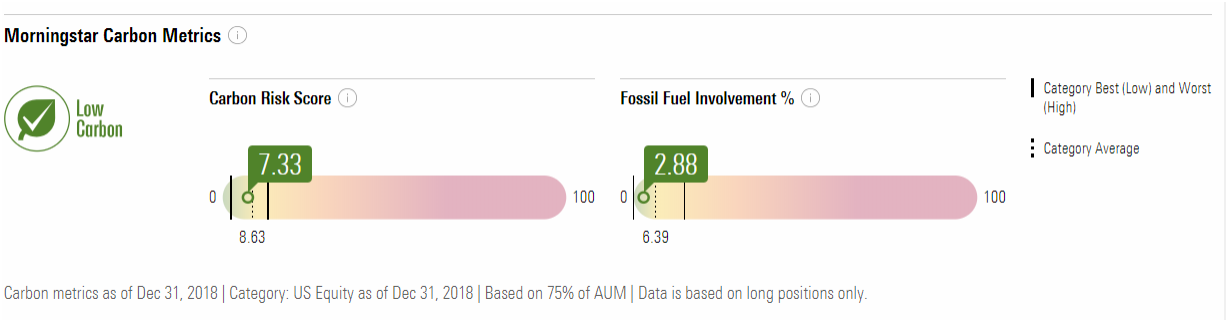
Details on the methodology underlying the assignment of the LCD are in Morningstar (2018a,b).[6] To receive the LCD, a mutual fund has to comply with two criteria: (1) a 12-month trailing average "Portfolio Carbon Risk Score" below 10 (out of 100); and (2) a 12-month trailing average "Fossil Fuel Involvement" below 7%. The Portfolio Carbon Risk Score is calculated if more than 67% of a fund's portfolio assets (based on the combined

[5] Alok et al. (2020) examine how fund managers change their holdings after they *experience* large climatic disasters, that is, after specific realizations of climate risk. More recently, Choi et al. (2021) document a decrease in institutional investors' exposure to domestic carbon-intensive firms after 2015, especially in countries with high climate awareness. Our analyses at the mutual fund level around a specific event indicate that, even in recent years, increased transparency on climate-related risks in the asset management industry is a significant driver of this global carbon divestment trend.

[6] For the purpose of our empirical analysis, we take Morningstar's approach to the assessment of funds' climate-related performance as given. Our objective is neither to praise nor criticise Morningstar's methodology, but rather to exploit it to study the behavior of both mutual fund clients and mutual fund managers.

market value of bond and equity holdings) have a carbon-risk rating from the ESG research provider Sustainalytics.

Figure 1: Morningstar Direct snapshot



The portfolio scores are based on *issuer-level* variables from Sustainalytics, which are updated on a yearly frequency. According to Sustainalytics, the "Carbon Risk Score" quantifies the portfolio companies' exposure and management of material carbon issues in their operations as well as their products and services (Morningstar, 2018b). The management of carbon issues focuses on portfolio companies' preparedness and track record in managing these issues. In Table A1 in the Appendix, we provide summary statistics of firm-level Carbon Risk scores by industries. As expected, firms in high-emitting sectors (e.g., Energy, Materials, and Utilities) are considered those having the highest carbon risks. However, within all sectors, there is substantial variability of this measure.

Morningstar computes the fund-level Carbon Risk scores by weighting the firm-level scores by the total investment (debt and equity) that a mutual fund holds at the end of the quarter in a given company.[7] As of April 2018, having a Carbon Risk score below 10 implies

[7]Chen et al. (2019) argue that many managers of fixed-income mutual funds misreport the credit quality of their assets to Morningstar to influence its assessments, in particular the Stars ratings. Contrary to the credit quality of fixed-income assets, the measures underlying the LCD (portfolio carbon risk and portfolio fossil fuel involvement) are not self-reported by fund managers, but are instead computed by Morningstar based on funds' portfolio holdings. Of course, we cannot definitively exclude that some funds decide to misre-

being amongst the 29% of funds with the best performance on this dimension.

"Fossil Fuel Involvement" measures the percentage of portfolio firms that derive a significant share of revenues from activities related to fossil fuels, including thermal coal, oil and gas, oil sands, shale energy, deep-water production, and Arctic offshore exploration. As of April 2018, having a 12-months trailing average Fossil Fuel Involvement below 7% represents a 33% under-weighting of fossil fuel-related companies relative to the global equity universe.

The LCDs were released for the first time at the end of April 2018 and assigned to funds based on their carbon scores as of the end of March 2018. Responding to our clarifying questions, Morningstar representatives noted that they did not communicate in advance the release of the label to either mutual fund managers or their clients. Indeed, the analysis of pre-publication trends further below is in line with the release of the LCD being unexpected. The LCDs for the period from January through the end of April 2018 (pre-publication period) were also released at the end of April 2018, based on the holdings in the previous quarters. Morningstar updates the portfolio aggregates of carbon risk metrics on a quarterly basis, and changes the LCD label assignment accordingly. This setting allows us to study not only the effects of the initial LCD release, but also the effects of later changes.

3 Data

We obtain survivorship-bias-free data (in USD) for all open-end mutual funds domiciled in Europe and USA from Morningstar Direct. To work with a relatively homogeneous sample, we drop all funds classified by Morningstar in categories that are pure fixed income, sector-

port their holdings. However, significant legal and reputational risks are associated with such misreporting. Overall, therefore, misrepresentation does not seem to be a major concern in our setting.

specific, or investing exclusively outside US and Europe.[8] We remain with 20 categories composed of equity and diversified funds.[9]

Our sample period spans April 2017 (one year before the LCD introduction) through September 2019. Mutual funds issue several share classes to target specific investors groups or geographies. However, the underlying portfolio and, therefore, the LCD, is the same across share classes. Consequently, all our analyses are conducted at the fund level.[10]

In aggregating data from the share-class to the fund level, we compute funds' returns and volatility as value-weighted average values across different share classes. Fund assets (in USD) is the sum of the assets under management of a fund in its different share classes. Other fund-level information (including the assignment of the LCD) is retrieved from the largest share class of the funds. Funds with more than 50% of assets in institutional share classes are classified as institutional funds.[11]

Following Sirri and Tufano (1998), flows are computed as the monthly growth of assets under management net of reinvested returns. To ensure the robustness of our analysis, we trim flows at the 1st and 99th percentiles. Moreover, we compute a measure of normalized flows following Hartzmark and Sussman (2019): First, we split the sample into deciles ac-

[8] Our results hold also when using the full sample of funds domiciled in Europe and USA.

[9] Specifically, the categories in our sample are: Aggressive Allocation, Allocation Miscellaneous, Cautious Allocation, Equity Miscellaneous, Europe Emerging Markets Equity, Europe Equity Large Cap, Flexible Allocation, Global Equity Large Cap, Global Equity Mid/Small Cap, Long/Short Equity, Moderate Allocation, Target Date, UK Equity Large Cap, UK Equity Mid/Small Cap, US Equity Large Cap Blend, US Equity Large Cap Growth, US Equity Large Cap Value, US Equity Mid Cap, US Equity Small Cap, and Europe Equity Mid/Small Cap.

[10] Our fund-flows results continue to hold when using data at the share-class-level (which allows, for example, for different flows for different share classes), and clustering standard errors at the fund level. For the results on fund responses, no such robustness check can be conducted because all relevant variables only vary on the fund level.

[11] Morningstar classifies as institutional the share classes that meet one of the following criteria: have the word "institutional" in the name; have a minimum initial purchase of USD 100,000 or more; specifically address institutional investors or those purchasing on a fiduciary basis, as stated in the fund prospectus. We define a fund as institutional when more than 50% of assets in share classes are dedicated to institutional clients.

cording to fund size. Second, we rank funds according to their net flows within their size decile and compute percentiles of the net flow rankings. These percentiles correspond to the normalized flows variable.

Throughout the paper, returns are expressed in percentage points. Our main measure of returns is the total monthly return as reported by Morningstar. To obtain a relative measure of returns, we adjusted these for the assets-weighted averages by Morningstar categories (as done, for instance, by Pástor et al., 2017). We also compute CAPM-adjusted and Fama-French-adjusted returns using betas estimate through OLS regressions of monthly data from December 2016 through April 2018.

We compute the return volatility as the standard deviation of returns using a 12-month rolling window. We also collect information on the net expense ratio reported in the latest prospectus, age, global category (capturing the investment style), Morningstar's overall rating (the Morningstar "Stars", on a 1-5 scale, with 5 to indicate top financial performers), whether the fund is classified as "socially conscious",[12] and its overall sustainability ratings (the Morningstar "Globes", on a 1-5 scale, with 5 to indicate top sustainability performers).

To account for the impact that "Stars" have on fund flows (Del Guercio and Tkac, 2008), we define the variable ΔStars indicating funds that experienced an upgrade or a downgrade in the "Star" rating from the previous month, considering observations with continuing missing Stars ratings as no change. Similarly, to account for the impact of the generic sustainability rating (Ammann et al., 2018; Hartzmark and Sussman, 2019), we define the variables Δ1 Globe and Δ5 Globes as the monthly changes of dummy variables indicating funds in the

[12]Morningstar classifies as socially conscious any fund that identifies itself as investing according to some non-economic guidelines, for instance by excluding certain sectors or companies from the investable universe, or by aiming at selectively investing in good-performing companies based on environmental and social criteria.

two extreme sustainability categories (1 Globe and 5 Globes), considering the observations with continuing missing sustainability ratings as no change.

- Table 1 -

Panel A of Table 1 shows summary statistics for fund-month observations from April 2017 through September 2019 for which information of flows and LCD is available. Panel B provides a snapshot of the statistics as of the end of April 2018. The sample covers some 13,500 funds, of which around 18% obtained the Low Carbon Designation. The mean net flows in our sample period are negative, partially reflecting the overall shift of mutual fund clients towards index funds and ETFs. The average annual expense ratio is about 1.1 percentage points.[13] 10% of funds self-classify themselves as socially conscious. Interestingly, from the population of socially conscious funds, only a third received the LCD. Around a quarter of all funds are primarily sold to institutional clients. Appendix Table A2 shows the correlations between the variables in our main sample. On average, low-carbon-designated funds have higher assets under management, volatility, and expense ratios.

- Table 2 -

Table 2 shows the geographical distribution of the sample as of the end of April 2018. Around 9,300 funds are domiciled in Europe, and 4,200 in the USA. The share of funds that received the initial Low Carbon Designation is 18% in Europe and 17% in the USA.

[13]Information on this variable is missing for most of the sample as its annual reporting is compulsory only in the USA. In order not to significantly restrict our European sample, we do not include this variable in our main regressions, but our findings hold even when we do.

4 The risk profile of low-carbon funds

This section considers the potential risk benefits and costs of investing in low-carbon funds, compared to conventional funds and more generic sustainability funds.

To motivate why low-carbon funds may have specific financial characteristics, Table 3 shows the percentage of low-carbon funds for different values of Morningstars' sustainability ratings ("Globes") and overall performance ratings ("Stars"). Funds with high "Globes" and "Stars" ratings are more likely to receive the LCD. However, funds can be considered low-carbon despite having only one or two Globes, or one or two Stars. These relatively low correlations confirm that the climate-specific label we study is substantially different from other ratings already available on Morningstar.

- Table 3 -

4.1 Exposure to climate change risks

Given the emphasis of the existing literature on green investing's risk-management properties (e.g., Bolton and Kacperczyk, 2020a; Engle et al., 2020; Ilhan et al., 2020b; Pástor et al., 2020b), we start by analyzing the claimed ability of low-carbon funds to hedge future realizations of climate change risks.

The risks posed by climate change are unconventional and non-normal, with long-term and "fat tail" properties (Weitzman, 2009, 2011). These risks have still to materialize in their full potential, both in terms of natural disasters and regulatory measures. They are, therefore, difficult to quantify based on past realized returns.[14] However, one can get a

[14]The finance literature on rare disasters shows how some "puzzles" in finance (e.g., excess volatility

sense of the benefits of low-carbon funds in insuring against climate change by gauging the sensitivity of these funds' performance to variations in the perception of climate risk.

Therefore, we compute individual funds' factor loading on negative climate change news. Specifically, we regress each US fund's monthly returns on the three Fama-French global factors (obtained from Kenneth French's website) and the news-based climate change risk index from Engle et al. (2020), standardized to have zero mean and unit standard deviation.[15] We base our estimation on the 17-month period from December 2016 through April 2018, with a minimum of 12 monthly return observations, and we winsorize the estimated loadings at the 1st and 99th percentiles.[16] The estimated coefficient on the news-based climate change risk index represents the fund-specific sensitivity to negative climate-related information (akin to a "climate beta"), net of the sensitivity to the market, size, and value factors. Since the climate beta is computed from relatively small changes in negative climate change news, it arguably provides a lower-bound estimate of a fund's exposure to future climate risks, which are likely to follow non-normal distributions.

Figure 2 shows in binned scatter plots how the funds' loadings on negative climate news

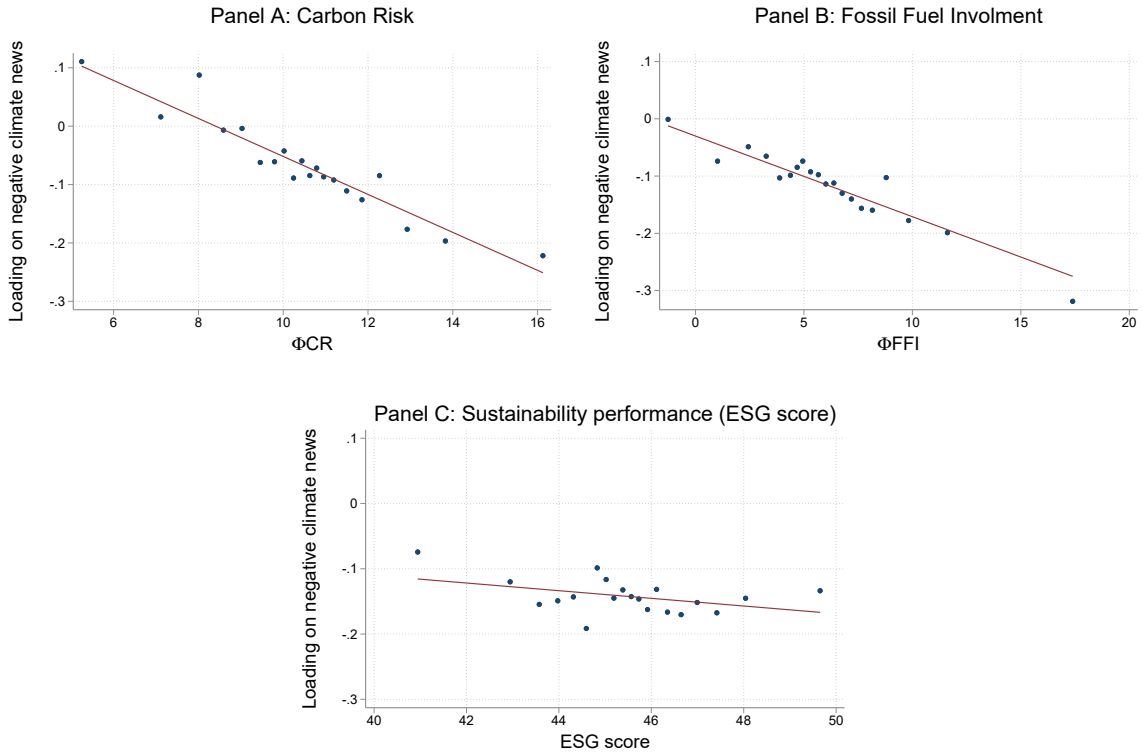
and high equity premiums) can be rationalized as the pricing-in of tail risks of future disaster events (e.g., Gabaix, 2012; Wachter, 2013; Tsai and Wachter, 2015). When dealing with fat-tail risks, the distribution of realized returns can be only partially informative of actual expected returns (Elton, 1999).

[15]Engle et al. (2020) find that environmentally-responsible firms – based on Sustainalytics' environmental scores – outperform non-environmentally-responsible firms in months with more climate-related news. For our analysis, we use the negative news-based risk index the authors obtained from the data analytics provider Crimson Hexagon (CH) ("CH Negative Climate Change News Index"), which focuses exclusively on negative climate news, and is available from January 2008 through May 2018. We thank Stefano Giglio and Johannes Stroebel for making these data available on their websites. We here restrict our attention to US funds for consistency with the Engle et al. (2020) index.

[16]There are three advantages of using a relative short estimation window in this application. First, this better captures the sensitivity of assets to the fast-evolving concerns of investors on climate change, as also discussed by Huynh and Xia (2020), who use a similar approach to study the effects of firms' past loading on climate news on corporate bond pricing. Second, it mitigates concerns over portfolio changes over time, as the LCD criteria disclosed in May 2018 (CR and FFI) reflect funds' average portfolio compositions only over the previous 12 months. Third, it allows us to focus on the period following the 2016 election of Donald Trump in November 2016, which caused high negative attention to climate change and, at least in the short run, an out-performance of carbon-intensive sectors (Ramelli et al., 2019).

relate to carbon risk (Panel A), fossil fuel involvement (Panel B), and generic sustainability scores (Panel C), controlling for category fixed effects and fund size.

Figure 2: LCD and loading on negative climate news
These figures show binned scatter plots of US funds' loading on negative climate news (climate beta) against funds' 12-month moving average Carbon Risk (Panel A), funds' 12-month moving average Fossil Fuel Involvement (Panel B), and generic sustainability performance (Panel C), controlling for category fixed effects and log assets. The sample is composed of US mutual funds as of April 2018. The loading on climate news is the coefficient on the standardized negative news-based climate risk index used in Engle et al. (2020) when regressing, for each fund, the monthly returns from December 2016 through April 2018 on that index and the Fama-French three global factors.



We observe that funds with lower CR and FFI have a significantly ($p < 0.001$) less negative loading on climate news, i.e., they tend to outperform when the "negative climate news" factor hits. Critically, as illustrated in Panel C, we do not identify any relation between the loading on climate news and the generic sustainability score ($p = 0.15$). The same relation holds when considering the Globes ratings, which are allocated on the basis of the relative ranking in sustainability score within each category (see Panel A in Figure A1 in the Supplementary Appendix). It may not be that surprising that LCD funds have lower climate change risk. But it is striking that investing in high-Globes funds provides little hedge against climate risks.

In sum, this evidence confirms that the release of the LCD provided investors with a valuable new proxy of a fund's exposure to future realizations of climate change risks.

4.2 Exposure to diversifiable risks

Are the benefits of low-carbon funds a "free lunch", or do they come at the cost of some sacrifices? We expect a major cost of low-carbon investing to be missed diversification opportunities, as long as the overall economy has not reached the low-carbon state, that is, as long as carbon-intensive companies are major constituents of the market portfolio.

To quantify this cost, we compute each fund's idiosyncratic volatility, a widely used measure of funds' realized diversifiable risk. Following the common practice in the literature, we define idiosyncratic volatility as the standard deviation of monthly residuals from a Fama-French three-factor model regression (e.g., Goyal and Santa-Clara, 2003; Bali et al., 2005; Ang et al., 2006, 2009; Huang et al., 2010). We again focus on the period from December

2016 through April 2018, before the publication of the LCD, with at least 12 observations of monthly returns.[17] From the same regressions, we also obtain individual funds' alpha relative to the Fama-French three-factor model.[18]

In Table 4, we run cross-sectional regressions of funds' idiosyncratic risk on decile indicators for the two performance scores underlying the LCD – carbon risk (CR) (column (1)) and fossil fuel involvement (FFI) (column (2)) – and the ESG score underlying the Globes rating (column 3)). The regressions use the fifth decile as the baseline and control for funds' log assets, alpha, and category. (Similar results are obtained when also controlling for fund age and activeness.)

- Table 4 -

The estimates in columns (1) and (2) show that funds in the first and second deciles of CR and FFI (i.e., funds with a strong tilt towards low-carbon firms) display a *higher* idiosyncratic risk than funds with climate metrics closer to the median values. Indeed, LCD funds – on average falling in the second decile of CR and the third decile of FFI – have a mean idiosyncratic risk of 1.70%, compared to a mean of 1.49% for not-LCD funds.

Naturally, *over-weighting* carbon-intensive sectors also increases idiosyncratic risk, as indicated by the coefficients on the highest deciles of CR and FFI. By definition, idiosyncratic

[17] To estimate the fund-specific Fama-French three-factor model, we obtain the market, size, and value factors for from Kenneth French's website. We use US-specific factors for US funds and Europe-specific factors for European funds. However, similar results are obtained when using the global factors for all funds. Evans and Sun (2021) provide evidence on the power of the Fama-French three-factor model in explaining funds' flow-return sensitivity.

[18] As shown in Table A3, low-carbon funds, on average, exhibit higher alphas than other funds, and it is therefore important to control for realized performance when comparing idiosyncratic risk. However, given our short sample period, one should not necessarily consider the observed out-performance of low-carbon funds as a compensation for higher idiosyncratic risk. Indeed, the evidence on the relation between idiosyncratic volatility and future expected returns is mixed (Ang et al., 2006, 2009; Huang et al., 2010). The model in Pástor et al. (2020b) suggests that while green assets have lower expected returns in equilibrium, they can experience higher realized returns after changes in investor 'green' preferences.

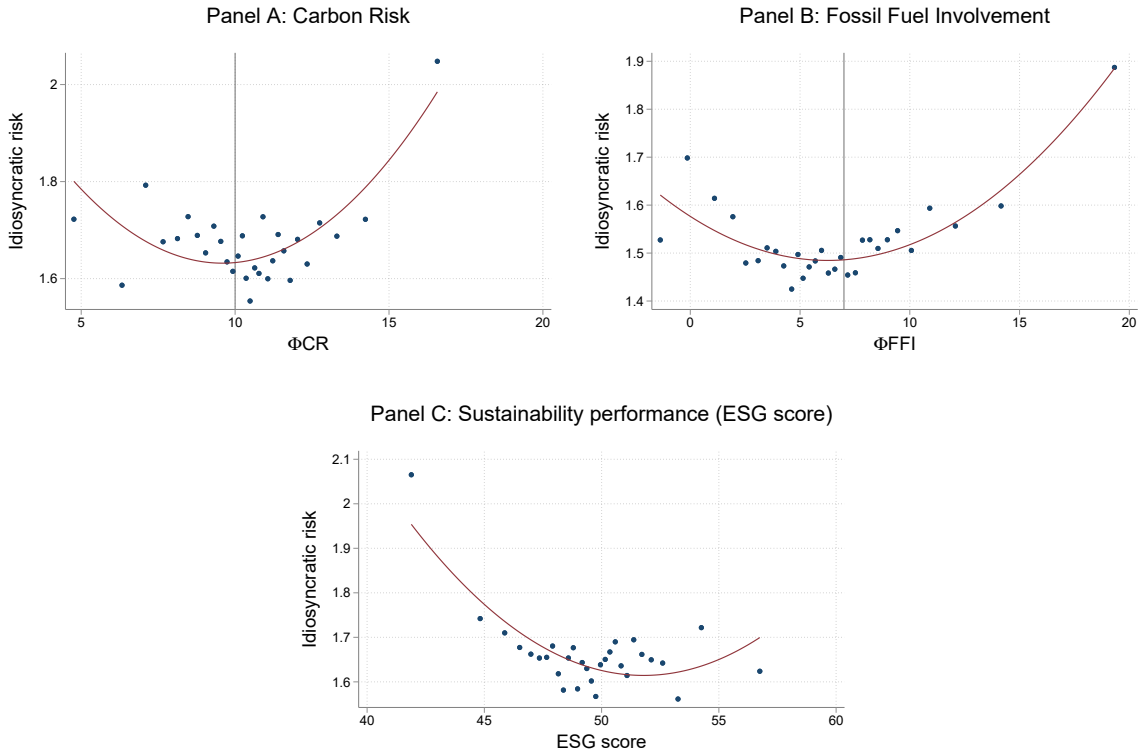
volatility is minimized by the market portfolio, which has values of CR and FFI above the LCD thresholds, as the two LCD criteria were set to reward funds with better-than-average climate performance. Either under- or over-weighting high-carbon firms relative to the market increases volatility.

Importantly, higher idiosyncratic risk is not necessarily a common feature of all sustainable investing strategies: In column (3) of Table 4, we observe that funds falling in the highest deciles of ESG scores do not display higher idiosyncratic risk. By contrast, low-sustainability funds (those in the bottom four deciles of ESG score) do have a significantly higher idiosyncratic risk than median-sustainability funds.[19] Naturally, the same result obtains when using the Globes ratings (as illustrated in Panel B of Figure A1 in the Appendix).

Figure 3 illustrates in binned scatter plots the relation between idiosyncratic risk and the three sustainability metrics under review: CR (Panel A), FFI (Panel B), and ESG score (Panel C). The decision to invest in a low-carbon rather than in a "average-carbon" fund implies accepting (intentionally or not) higher diversifiable volatility. The decision to invest in a high-ESG rather than an average-ESG fund appears more innocuous in this respect.

[19]This result is consistent with Renneboog et al. (2008) who document lower idiosyncratic risks for socially responsible investments funds and with Maxfield and Wang (2020), who show that funds with higher Morningstar sustainability scores have lower idiosyncratic risk. More generally, the finding is in line with the idea that sustainable investing can help investors avoid companies with higher firm-specific risks (Godfrey et al., 2009).

Figure 3: LCD criteria and idiosyncratic risk
These figures show binned scatter plots of funds' idiosyncratic risk against 12-month average Carbon Risk (Panel A), 12-month average Fossil Fuel Involvement (Panel B), and ESG score (Panel C), controlling for category fixed effects and log assets. *Idiosyncratic risk* is the standard deviation of monthly residuals relative to Fama-French three-factor model regressions run over the period from December 2016 through April 2018. For illustrative purposes, in the figure we winsorize CR and FFI at the 1st and 99th percentiles.



The contrasting effects of the Morningstar Globes and the LCD on idiosyncratic volatility are due to crucial differences in their scope and methodology: While Morningstar assigns the Globes based on "best-in-class" ESG sustainability scores, the LCD is granted to funds that under-weight carbon-intensive sectors and firms. In other words, the higher volatility of LCD funds emerges as a natural by-product of a smaller sectoral diversification, which limits risk-sharing from a mean-variance perspective (Markowitz, 1952).[20]

[20]To probe this interpretation, we employ data from Pástor et al. (2020a). These authors decompose portfolio diversification in terms of resemblance of portfolio weights relative to the market cap weights

Overall, the analyses presented in this section establish a special profile of low-carbon funds, different from both conventional and high-sustainability funds. Specifically, low-carbon funds can provide investors with a channel to potentially reduce their exposure to realizations of climate change risks, in addition to satisfying preferences for green investing. However, these benefits come at the expense of a lower (sectoral) diversification. In other words, with low-carbon funds easily identifiable, investors face a trade-off between minimizing idiosyncratic risk given the current state of the market portfolio and investing consistently with a low-carbon economy.[21] How investors and fund managers respond to this fundamental trade-off is ex-ante unclear. This open question motivates the analysis in the following section.

5 Investor responses

This section explores the initial reaction of mutual funds investors to the Low Carbon Designation (LCD). It is possible that investors by and large do not care for the climate performance of mutual funds or already had other means to express their potential carbon-related preferences. Thus, the null hypothesis is no effect on fund flows after the introduction of the

("balance") and number of stocks held ("coverage"). By matching our dataset with the data used in Pástor et al. (2020a), we remain with 915 US domestic equity mutual funds with available diversification data for 2014. Results available on request show that funds classified as low-carbon in April 2018 have a statistically significant lower "balance", even after controlling for category fixed effects. By contrast, the number of Globes is unrelated to "balance." Low-carbon funds also display a lower "coverage" than other funds, but the difference is not statistically significant when accounting for category fixed effects. We thank Lucian Taylor for making these data available on his website and for suggesting this analysis.

[21] The theoretical literature of responsible investing recognizes the existence of such trade-off. Pástor et al. (2020b), for instance, show that the propensity of climate-conscious investors to invest in green investment products is inversely related to their risk aversion, as moving away from the market portfolios comes at the cost of lower diversification. Of course, green investing can come in different degrees and shapes. For instance, Andersson et al. (2016) argue that a sector-by-sector ESG filtering approach can allow investors to significantly reduce carbon risk at the cost of a small tracking error with respect to the benchmark index.

LCD. Alternatively, if investors are eager to invest in climate-friendly mutual funds despite the lower diversification these funds entail relative to the market portfolio, we expect funds that Morningstar labeled as low-carbon to experience abnormally high flows after April 2018. Yet alternatively, if investors anticipate too large drawbacks from the lack of diversification, they might even (relatively) reduce flows to LCD finds.[22]

We start this section by graphically depicting flows for low-carbon and not-low-carbon funds. We then formally test whether investors reward low-carbon funds.

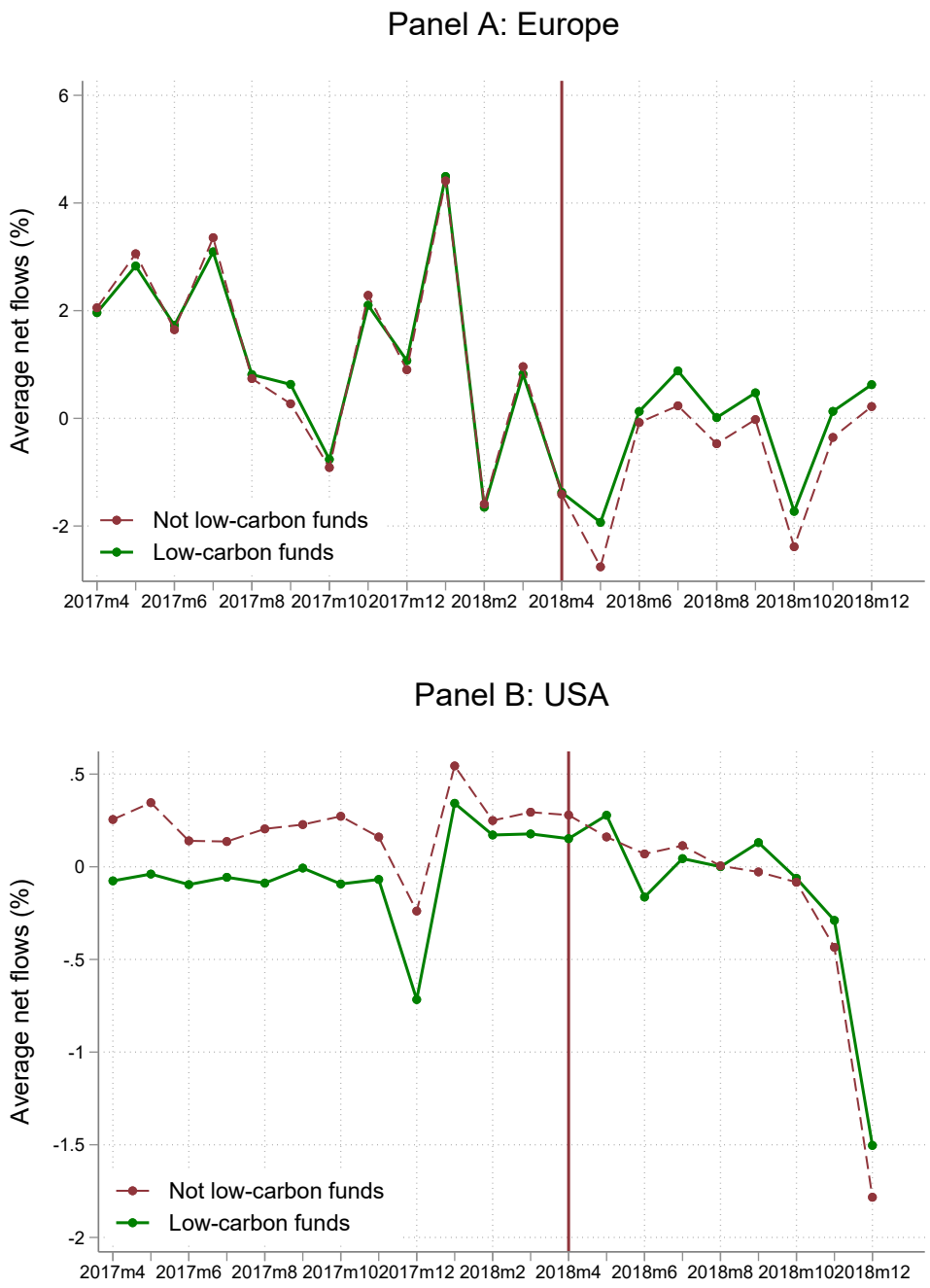
5.1 Graphical evidence

Figure 4 illustrates the average equally-weighted monthly net flows of funds that were categorized as low-carbon at the end of April 2018 and into or out of funds that did not (not-low-carbon), from April 2017 through December 2018. Importantly, information about the LCD became available to investors only from the beginning of May 2018. We call the period April 2017 through April 2018 the pre-publication period. For now, we focus on the post-publication period through December 2018 to document the initial reshuffling of flows caused by the release of the LCD. Section 5.3 investigates the fund-flow effects of LCD upgrades and downgrades over an extended sample period through September 2019.

[22] A caveat for analyses like ours is that we can not observe investors' full holdings and how they changed after entering an LCD fund. An investor strongly exposed to high-carbon firms may even increase diversification by re-directing capital to a low-carbon fund. What we emphasize is the diversification opportunity an average investor misses when choosing a low-carbon funds instead of more balanced available options. Particularly for retail investors it is reasonable to expect this choice to also affect their overall portfolios, considering the low number of funds such investors use (e.g., Huberman and Jiang, 2006).

Figure 4: Effect of the LCD on fund flows

These figures show the equally-weighted average monthly flows of funds designated low-carbon at the end of April 2018 (solid green lines) and of conventional funds (dashed red line) domiciled in Europe (Panel A) and in the USA (Panel B), from April 2017 through December 2018. Flows are computed as of end of the month. The Low Carbon Designation was introduced at the end of April 2018.



Consider first Panel A, showing the European sample. During the pre-publication period, the net flows in funds that would be later designated low-carbon are very similar to the average flows in other funds. Crucially for the validity of our difference-in-differences approach, the two groups show common trends. With the release of the LCD at the end of April 2018, low-carbon-designated funds started enjoying a clear and persistent increase of flows compared to other funds.

In the USA (Panel B), funds with low-carbon features show lower flows than conventional funds in the pre-publication period but, more importantly, again following very similar fluctuations. Here, too, the release of the LCDs seems to have initiated a relative boost of flows for LCD funds in May 2018. In the following months there was some variation, though by the last four months of 2018, LCD funds had caught up to non-LCD funds in terms of monthly fund flows.

5.2 Regression evidence

5.2.1 Empirical strategy

Figure 4 provides suggestive evidence that in the post-publication period, mutual funds that receive the Low Carbon Designation experience higher flows than mutual funds that do not receive it. To formally test that hypothesis, we run the following OLS regression explaining fund i's flows in month t from April 2017 through December 2018:

$$Flows_{i,t} = \alpha + \beta_1\ LCD_i\ \times\ Post_t + \beta_2\ LCD_i + \gamma' \mathbf{X_{i,t-1}} + \delta_{\mathbf{i,t}} + \eta_i + \ \epsilon_{i,t}. \qquad (1)$$

The main explanatory variable is the difference-in-differences interaction term $LCD_i \times Post_t$. LCD_i identifies funds that received the LCD at its initial release. $Post_t$ is an indicator variable equal to 1 for months after April 2018, and 0 for all prior months. $\mathbf{X_{i,t-1}}$ is a vector of time-varying lagged fund-level controls that, based on previous literature, may influence fund flows of LCD recipients in a differential manner. These are monthly returns in the previous three months, the logarithm of assets under management, return volatility, the fund's age, the fund's entrance or exit in the two extreme sustainability rating (Globes) categories, and changes of Morningstar's overall assessment of the fund (Stars).[23] $\delta_{\mathbf{i,t}}$ represents month-by-style (Morningstar category) fixed effects. η_i is a set of country dummies (based on the fund's domicile). $\epsilon_{i,t}$ is the error term. Standard errors are clustered along both months and categories to account for cross-sectional dependence between observations.

5.2.2 Results

The regression results with our main specification are reported in columns (1), (3), and (6) of Table 5, using the full sample, European funds, and US funds, respectively. The coefficient on the DID interaction term is positive and highly statistically significant in each of the three samples. The coefficient in column (1) indicates that the assignment of the Low Carbon Designation is associated with an average 0.22 percentage points higher difference in net flows compared to the pre-publication period. This effect is economically important when compared to the effect of the main focus of the mutual funds literature so

[23] We use the change in sustainability and overall ratings rather than the absolute value because, as also noted in Hartzmark and Sussman (2019), if these rating systems are in equilibrium – e.g., existing investors have already sorted in low and high-sustainability funds according to their preferences, after an initial phase of reallocation – there is no reason to expect a continued flows-effect of ratings without further changes. That said, the results also hold just controlling for the number of Globes and the number of Stars.

far, returns. A one standard deviation stronger performance in terms of monthly returns yields $3.33 \times 0.14 = 0.47$ percentage points more flows. In other words, the LCD is worth almost half ($0.22/0.47 = 47\%$) of a standard deviation in returns. When compounded over the eight months from May through December 2018, the flow premium associated with the LCD can be quantified in an increase of around 2% in the assets under management.

It is worth noticing that the statistically and economically important flows boost caused by the LCD happens independently of the effects of the general sustainability ratings documented in Ammann et al. (2018) and Hartzmark and Sussman (2019). Indeed, as shown in Table A4, we find that the effect on flows of the LCD is stronger among low-sustainability than among high-sustainability funds, presumably because the former did not already have other means to target socially- and environmentally-conscious clients.[24]

The coefficients of the control variables are in line with previous literature. In particular, flows are negatively related to age and assets under management, and positively related to past financial performance (Patel et al., 1994).[25] Upgrades (downgrades) in terms of Morningstar's Stars are followed by a statistically significant increase (decrease) in flows.[26]

To limit the potential effects of size in determining monthly flows, we re-run the main DID analyses using normalized flows as dependent variable. The corresponding regression results are reported in models (2), (4) and (6) of Table 5. The effect of receiving the low-

[24]This result is consistent with research suggesting that less visible funds (e.g., funds that engage is less marketing and funds without a five-star rating) have a higher flow sensitivity to salient features (Sirri and Tufano, 1998; Del Guercio and Tkac, 2008).

[25]Virtually unchanged results are obtained when using the returns adjusted for the average performance by category, and using CAPM-adjusted or Fama-French-adjusted returns. The results are also unaffected by controlling also for annual returns, or squared lagged quarterly or monthly returns to account for potential non-linear effects on flows.

[26]Thus, we expand the findings of Del Guercio and Tkac (2008) in our sample period. Ben-David et al. (2019) also show that Stars ratings are a major determinant of fund flows across US mutual funds, followed only by recent past returns. Huang et al. (2020) develop a model where investors take Stars ratings as reputation signals of funds' informational advantage.

carbon label is again strongly statistically and economically significant: Net of the effects of control variables, on average, low-carbon funds move up 1.98 percentiles in net flows after April 2018, whereas a one standard deviation higher performance in the prior month results in a move up by 3.26 percentiles.

- Table 5 -

We conduct a series of robustness checks to ensure the reliability of our findings. First, in Table A5 we confirm that our results hold – and indeed are larger in magnitude – when adding fund fixed effects to the regressions. Second, we interact all control variables with Post to allow for potential changes over time of the effects on flows of fund characteristics other than the LCD. As shown in Table A6 in the Appendix, the results continue to hold.

Third, in Table A7 we re-run the DID analysis weighting the observations by assets, ruling out the possibility that the coefficients on the LCD are driven by small funds. The same inferences hold.

Fourth, we add to the regression the two scores used to allocate the LCD – the Portfolio Carbon Risk (CR) and Fossil Fuel involvement (FFI) – and their interaction with Post. This test also provides potential insights into whether investors also responded, conditional on a fund receiving or not receiving the label, to the level of the underlying climate performance. No robust pattern emerges in Table A8 in the Appendix in this respect. Importantly, the results for our main coefficient of interest, the interaction of LCD with Post, remain virtually unchanged, confirming the role of the label in driving investor responses.

Finally, we repeat our analysis using a shorter pre-publication period, starting from December 2017. This allows us to exploit the availability of the LCDs for the period from

December 2017 through April 2018, computed by applying the LCD methodology to the historical holdings. This setting allows to further rule out the possibility that the flow-effect of the LCD may be due to portfolio characteristics not explicitly related to climate performance. Results available on request show that our inferences hold when using the shorter pre-publication period (see Figure A2 in the Appendix for a graphical illustration).

Overall, our findings soundly reject the null hypothesis of no response to the introduction of the Low Carbon Designation. Investors in the mutual fund industry rewarded funds labeled as low-carbon with additional capital.

5.3 Effects of label upgrades and downgrades

We have shown that investors value climate responsibility, and rewarded funds labeled as low-carbon in April 2018. Was the release of the LCD a one-shot opportunity for funds to access the additional investment flows associated with being low-carbon?

Morningstar updates the LCD on a quarterly basis, with a one-month delay from the end of the quarter. Our sample period covers five quarterly updates in the post-publication period. As shown in Panel A of Table 6, while the large majority of funds had their LCD classification confirmed, in each of these updates a small fraction of funds did switch from LCD to not-LCD, or vice-versa. For each fund, we define the indicators *LCD Downgrade* and *LCD Upgrade*. These binary indicators are equal to 1 for months following an LCD downgrade or upgrade, respectively, and 0 otherwise.

The results in Panel B of Table 6 indicate that subsequent LCD upgrades and downgrades also have a significant impact on net flows. This is particularly the case for European funds.

In the USA, where there are fewer "switchers" compared to the European sample, only the coefficient on LCD upgrades is statistically significant.

- Table 6 -

Overall, these result indicate that managers of funds that are not considered low-carbon can potentially access an important source of flows as long as they successfully manage to rebalance their portfolios in a low-carbon direction.

6 Mutual fund responses

The prior section has shown that investors in mutual funds have preferences for climate-conscious investments despite facing a higher idiosyncratic risk exposure. In this section we ask how mutual fund managers react to these revealed preferences, and whether their allocation changes depend on their prior risk exposure. This is a novel contribution; while Ammann et al. (2018) and Hartzmark and Sussman (2019) document a flow effect due to Morningstar's Globes ratings, they do not study the supply-side reactions of fund managers.

6.1 Empirical strategy

To formally test how mutual funds changed their portfolios after the initial release of the LCD, we estimate difference-in-differences regressions. Our goal with this analysis is to shed light on the overall supply-side reaction of fund managers around an event that heightens awareness of climate-related risks and around which fund managers arguably noticed extra flows to low-carbon funds.[27] Here, it is intuitive to use as the treatment group those mutual

[27]Our ambition thus is not to explicitly identify a causal effect of the LCD as such on fund manager behavior. If one were interested in the causal effect of the label itself, one might be inclined to consider

funds that did *not* receive the LCD at its initial release. Specifically, we run the following regression explaining fund i's Carbon Risk in quarter q for quarters March 2017 through September 2019:

$$CR_{i,q} = \alpha + \beta_1\ NotLCD_i\ \times\ Post_q + \beta_2\ NotLCD_i + \gamma' \mathbf{X_{i,q-1}} + \delta_{\mathbf{i,q}} + \eta_i + \ \epsilon_{i,t}. \qquad (2)$$

The main explanatory variable is the difference-in-differences interaction term $NotLCD_i \times Post_q$. $NotLCD_i$ identifies funds that did not receive the LCD at its initial release. $Post_q$ is an indicator variable equal to 1 for the quarters the LCD was in place, i.e., 2018-Q2 through 2019-Q2, and 0 for all prior quarters. $\mathbf{X_{i,q-1}}$ includes quarterly time-varying lagged fund-level controls, analogue to specification (1) from the previous section. $\delta_{\mathbf{i,q}}$ includes quarter-by-style (Morningstar category) fixed effects. η_i is a set of country dummies (based on the fund's domicile). $\epsilon_{i,q}$ is the error term.

In this analysis, we exclude from our sample both explicit and closet indexers (around 12% of funds), which do not, by definition, follow active investment strategies.[28] We identify explicit indexers using the Morningstar definition, and closet indexers using the Active Share measures of Cremers and Petajisto (2009) and Cremers et al. (2016). In line with the previous studies, we use an active share below 60% as a cutoff for identifying a closet indexer. However, the portfolios of explicit and closet indexers still provide useful information, since we can use

a regression discontinuity (RD) design, because the LCD is awarded based on two thresholds. However, this method faces several challenges in our empirical setting: Importantly, treatment occurs every quarter, instead of being a one-shot event like entering a schooling program. In our setting, not only would we expect funds that barely did not receive the LCD to improve their climate performance, but also funds that barely got the LCD have an incentive to improve their climate performance since they risk losing the label in the next quarter. This can happen if low-carbon-risk firms underperform relative to high-carbon-risk firms, driving the portfolio CR score up. Additionally, the running variable (the fund's climate performance) is also our outcome variable, meaning that fund managers can "manipulate" their treatment status. This violates the validity requirements of the RD design (Lee and Lemieux, 2010).

[28] As shown by Cremers and Petajisto (2009) and Cremers et al. (2016), a large number of so-called active funds are actually "closet indexers". Such funds are marketed as being actively managed, but their portfolios are mostly allocated passively according to an index.

them as a benchmark for the changes we observe in the portfolio holdings of active funds.

Besides rebalancing activities, there are two additional ways through which the climate performance of mutual funds may change. First, these can originate from changes in the underlying carbon risk of firms. Second, they can originate from changes in market values of portfolio assets. We can exclude the first channel for most of our sample period since Sustainalytics updates the firms' climate scores on a yearly frequency, and all portfolio scores up to Q1-2019 are based on the firm-level carbon performance of 2017. Moreover, our results remain virtually unchanged if we drop the observations for Q2-2019 and Q3-2019, the only ones based on 2018 firm-level data. To account for the second channel, similarly to Leippold and Rueegg (2020), we benchmark the climate performance of active funds with that of funds that by definition, do *not* actively rebalance their portfolios, i.e., outright and closet indexers (together called passive funds). Our results remain unchanged if we use only the outright indexers as benchmark.

Thus, for each quarter, *abnormal* CR is computed as the difference between the active fund's climate performance and the average climate performance of the passive funds in the same category. This way, we account for systematic differences between categories and across time. Additionally, to capture differences in levels, we perform the adjustment by the degree to which a fund fulfills the criteria for obtaining the LCD, i.e., ∅CR≤10, ∅FFI≤7%, both, or neither. We summarize this computation in equation 3 below.

$$AbnCR^{\tau}_{i,q,k} = CR^{\tau}_{i,q,k} - \varnothing CR^{Passive,\tau}_{q,k}, \forall \text{ fund } i, \text{ quarter } q, \text{ category } k, \text{ and } \tau \in \{\varnothing\text{CR} \leq 10,\ \varnothing\text{FFI} \leq 7\%, \text{ both, neither.}\} \tag{3}$$

Analogously to equations (2) and (3), we also run regressions explaining (abnormal) FFI.

6.2 Results

Table 7 shows our main results. Columns (1) and (3) use gross climate performance as the dependent variable and columns (2) and (4) use the abnormal climate performance, i.e., after controlling for the average CR and FFI of passive funds. All regressions include the full set of lagged fund-level controls, as well as quarter times style and country fixed effects. Standard errors are double clustered at the quarter and style level.

- Table 7 -

the coefficient on the DID interaction term is negative and highly statistically significant across specifications. For example, the interaction coefficient $NotLCD \times Post$ in column (1) indicates that funds that did not receive the LCD at its initial release on average decreased CR by 0.57 (17% of a standard deviation) more than funds that received the LCD in April 2018. When we account for differential changes in market capitalization of the underlying assets in column (2) we find that the size of the coefficient is similar, but the economic significance is somewhat stronger (26% of a standard deviation).

Columns (3) and (4) reveal a similar picture for Fossil Fuel Involvement (FFI). Overall, when compared to funds that received the LCD, Not-LCD funds under-weighted their FFI by 0.49% (8% of a standard deviation) per quarter, or 3 percentage points when aggregated over the six quarters the LCD was in place. When we account for differential changes in market capitalization in column (4), we find that the actual improvement amounts to a 0.95% decrease in Abnormal FFI (22% of a standard deviation). The reason why adjusting for market trends is particularly important for FFI is that, in contrast to Carbon Risk, this

variable is sector-specific and particularly prone to market swings.[29] We remove this bias when we control for the climate-performance of passive funds. We obtain similar results when we only control for the climate performance of outright indexers.

We conduct a series of checks to ensure the reliability of our findings. Panel A of Appendix Table A9 shows weighted regressions by a fund's assets under management. We do this to account for the possibility that the rebalancing we observe is simply a shift of high Carbon Risk firms from small funds to large funds. Our main findings are robust to this specification.

Panel B of Appendix Table A9 includes fund fixed effects. We do this to account for potential omitted variables that remain constant for a given fund. Despite the brief time series, the coefficients remain significant. These robustness tests mitigate omitted variables and selection bias concerns.

Overall, the evidence provided in this section is consistent with fund managers responding to the revealed preferences of their clients and the increased awareness of climate risks by improving the climate-performance of their portfolios.

One final question that remains is if fund managers take the idiosyncratic volatility of their portfolio into account when choosing how to adjust their climate performance after the introduction of the LCD. In Section 4, we documented how having either very low or very high climate risk (either CR or FFI) was correlated with having a portfolio with higher idiosyncratic volatility compared to funds whose climate risk is around the LCD threshold. If funds were to dislike being under-diversified, we should observe both extreme categories converge towards the threshold. Hence, the coefficient of $NotLCD \times Post$ should be *larger*

[29] Consider an energy sector fund with a FFI of 70% and USD 100m in assets under management. Suppose that the fossil-fuel dependent stocks in its portfolio were to halve in value, whereas the value of the other stocks remains unchanged. If the fund were passive, its FFI would now be 0.5×70m /(0.5×70m + 30m), around 54%.

in absolute magnitude (that is, more negative) for funds with initially high idiosyncratic volatility compared to those that started out better diversified.

In Table 8, we test whether this is indeed the case. We split the sample into funds that had above-median or below-median idiosyncratic volatility in April 2018, the month when the LCD was introduced. (Similar results are obtained when using the 75th percentile as the cutoff.) It seems that, if anything, the funds that were less diversified when the LCD was introduced react slightly less to the label compared to those funds that were better diversified. This finding suggests that, from the point of view of mutual fund managers, the benefits of having a lower climate risk exposure outweighs the costs in terms of lower diversification.

- Table 8 -

7 Conclusion

Around the introduction of Morningstar's Low Carbon Designation (LCD) label in April 2018, mutual funds directly experienced the intensity of investors' preferences for climate-responsible investments: Funds labeled as low-carbon enjoyed a significant increase of assets under management from May through the end of December 2018 relative to funds that were not labeled as low-carbon. The quantities involved are substantial: Effectively, investors valued climate performance (receiving the LCD) as being equivalent to one half of a standard deviation of financial performance.

This result is noteworthy because the risk properties of LCD funds are quite different from those of funds with a high number of Morningstar ESG "Globes" (which investors are

also fond of, as prior work by Hartzmark and Sussman (2019) has shown). In particular, funds with more globes have somewhat lower idiosyncratic risk but are likely to offer limited hedge against climate risk. By contrast, LCD funds offer such a hedge, but entail higher idiosyncratic risk relative to the market portfolio.

Changes in culinary habits and trends inspire chefs worldwide to adapt their menus to the new preferences of their clients. Similarly, with the chefs of the financial industry, investors' call for a low-carbon diet in their portfolios did not fall on deaf ears: Mutual funds that initially did not receive the LCD subsequently reduced (increased) their holdings in high (low) carbon-intensity companies. In other words, the release of climate-related information is likely to have accelerated the adoption of climate-related investment strategies in the mutual fund industry.

The high-carbon assets shunned by mutual funds seeking to be considered low-carbon do not disappear, but are picked up by other investors. However, this type of divestment is likely to increase the cost of capital for high-carbon firms, much like the divestment from "sin stocks" by certain norm-constrained investors increases the cost of capital (and the expected returns) of companies involved in alcohol, tobacco, or gambling-related activities (Hong and Kacperczyk, 2009). Whether and how this will induce high-carbon firms to attempt to convert their business models toward cleaner business activities remains unclear.[30]

A full analysis, including welfare considerations, is outside the scope of this paper. Even with this caveat, we believe that the results have important implications for fund managers, policy-makers, and investors. First, they alert active fund managers to the importance of

[30]For instance, in Oehmke and Opp (2020) socially responsible investors can indeed lead firms to adopt clean production technologies, but only under certain conditions. In particular, in their model, socially responsible investors need to have a broad mandate – i.e., the ability to also invest in "dirty" firms – in order to generate impact.

sustainability as a key competitive edge, especially in light of the return and fee pressure coming from index funds and ETFs. Second, our analyses can inform policy-makers and investors of the potential effectiveness of eco-labeling schemes in re-orienting capital flows. On the one hand, they "work" in the sense of inducing desired behavioral responses by market participants. On the other hand, certain designs of eco-labels may incentivize funds to reduce diversification, to the potential detriment of investors. Policy-makers trying to partially outsource the decarbonisation of the economy to financial markets should be aware of such potential undesired effects.

References

Alok, Shashwat, Nitin Kumar, and Russ Wermers, 2020, Do fund managers misestimate climatic disaster risk?, *Review of Financial Studies* 33, 1146–1183.

Ammann, Manuel, Christopher Bauer, Sebastian Fischer, and Philipp Muller, 2018, The impact of the Morningstar sustainability rating on mutual fund flows, *European Financial Management* 1, 1–34.

Anderson, Anders, and David T. Robinson, 2019, Knowledge, fear and beliefs: Understanding household demand for green investments, Working Paper.

Andersson, Mats, Patrick Bolton, and Frédéric Samama, 2016, Hedging climate risk, *Financial Analysts Journal* 72, 13–32.

Ang, Andrew, Robert J. Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2006, The cross-section of volatility and expected returns, *The Journal of Finance* 61, 259–299.

Ang, Andrew, Robert J. Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2009, High idiosyncratic volatility and low returns: International and further US evidence, *Journal of Financial Economics* 91, 1–23.

Bali, Turan G., Nusret Cakici, Xuemin Yan, and Zhe Zhang, 2005, Does idiosyncratic risk really matter?, *The Journal of Finance* 60, 905–929.

Barber, Brad M., Adair Morse, and Ayako Yasuda, 2020, Impact investing, *Journal of Financial Economics* Forthcoming.

Bassen, Alexander, Katrin Gödker, Florian Lüdeke-Freund, and Josua Oll, 2018, Climate information in retail investors' decision-making: Evidence from a choice experiment, *Organization & Environment* 1–21.

Bauer, Rob, Tobias Ruof, and Paul Smeets, 2018, Get real! Individuals prefer more sustainable investments, Working Paper.

Ben-David, Itzhak, Jiacui Li, Andrea Rossi, and Yang Song, 2019, What do mutual fund investors really care about?, Working Paper.

Berk, Jonathan B., and Richard C. Green, 2004, Mutual fund flows and performance in rational markets, *Journal of Political Economy* 112, 1269–1295.

Berk, Jonathan B., and Jules H. Van Binsbergen, 2015, Measuring skill in the mutual fund industry, *Journal of Financial Economics* 118, 1–20.

Bialkowski, Jedrzej, and Laura T. Starks, 2016, SRI funds: Investor demand, exogenous shocks and ESG profiles, Working Paper.

Bollen, Nicolas P.B., 2007, Mutual fund attributes and investor behavior, *Journal of Financial and Quantitative Analysis* 42, 683–708.

Bolton, Patrick, and Marcin T. Kacperczyk, 2020a, Do investors care about carbon risk?, *Journal of Financial Economics* Forthcoming.

Bolton, Patrick, and Marcin T. Kacperczyk, 2020b, Global pricing of carbon-transition risk, Working paper.

Bonnefon, Jean-Francois, Augustin Landier, Parinitha Sastry, and David Thesmar, 2019, Do investors care about corporate externalities? Experimental evidence, Working Paper.

Chen, Huaizhi, Lauren Cohen, and Umit Gurun, 2019, Don't take their word for it: The misclassification of bond mutual funds, Working Paper.

Chevalier, Judith, and Glenn Ellison, 1997, Risk taking by mutual funds as a response to incentives, *Journal of Political Economy* 105, 1167–1200.

Choi, Darwin, Zhenyu Gao, and Wenxi Jiang, 2021, Global carbon divestment and firms' actions, Working Paper.

Clifford, Christopher P., Jon A. Fulkerson, Russell Jame, and Bradford D Jordan, 2020, Salience and mutual fund investor demand for idiosyncratic volatility, *Management Science* Forthcoming.

Coase, Ronald, 1960, The problem of social cost, *Journal of Law, Economics, and Organization* 3, 1–44.

Cooper, Michael J., Huseyin Gulen, and P. Raghavendra Rau, 2005, Changing names with style: Mutual fund name changes and their effects on fund flows, *The Journal of Finance* 60, 2825–2858.

Cremers, K. J. Martijn, and Antti Petajisto, 2009, How active is your fund manager? A new measure that predicts performance, *Review of Financial Studies* 22, 3329–3365.

Cremers, Martijn, Miguel A. Ferreira, Pedro Matos, and Laura Starks, 2016, Indexing and active fund management: International evidence, *Journal of Financial Economics* 120, 539–560.

Del Guercio, Diane, and Paula A. Tkac, 2008, Star power: The effect of Morningstar ratings on mutual fund flow, *Journal of Financial and Quantitative Analysis* 43, 907–936.

Donaldson, Jason Roderick, and Giorgia Piacentino, 2018, Contracting to compete for flows, *Journal of Economic Theory* 173, 289–319.

Döttling, Robin, and Sehoon Kim, 2020, Sustainability preferences under stress: Evidence from mutual fund flows during COVID-19, Working Paper.

Dyck, Alexander, Karl V. Lins, Lukas Roth, and Hannes F. Wagner, 2019, Do institutional investors drive corporate social responsibility? International evidence, *Journal of Financial Economics* 131, 693–714.

Elton, Edwin J., 1999, Presidential address: Expected return, realized return, and asset pricing tests, *The Journal of Finance* 54, 1199–1220.

Engle, Robert F, Stefano Giglio, Bryan Kelly, Heebum Lee, and Johannes Stroebel, 2020, Hedging climate change news, *Review of Financial Studies* 33, 1184–1216.

European Commission, 2018, Action plan for sustainable finance, Available at `https://ec.europa.eu/info/publications/180308-action-plan-sustainable-growth_en`.

Evans, Richard B, and Yang Sun, 2021, Models or stars: The role of asset pricing models and heuristics in investor risk adjustment, *Review of Financial Studies* 34, 67–107.

Fernando, Chitru S., Mark P. Sharfman, and Vahap B. Uysal, 2017, Corporate environmental policy and shareholder value: Following the smart money, *Journal of Financial and Quantitative Analysis* 52, 2023–2051.

Flammer, Caroline, 2021, Corporate green bonds, *Journal of Financial Economics* Forthcoming.

Gabaix, Xavier, 2012, Variable rare disasters: An exactly solved framework for ten puzzles in macro-finance, *The Quarterly Journal of Economics* 127, 645–700.

Geczy, Christopher, Robert F. Stambaugh, and David Levin, 2021, Investing in socially responsible mutual funds, *Review of Asset Pricing Studies* Forthcoming.

Gibson, Rajna, Simon Glossner, Philipp Krüger, Pedro Matos, and Tom Steffen, 2019, Responsible institutional investing around the world, Working Paper.

Gibson, Rajna, and Philipp Krüger, 2020, The sustainability footprint of institutional investors, Working Paper.

Godfrey, Paul C., Craig B. Merrill, and Jared M. Hansen, 2009, The relationship between corporate social responsibility and shareholder value: An empirical test of the risk management hypothesis, *Strategic Management Journal* 30, 425–445.

Goetzmann, William N., and Alok Kumar, 2008, Equity portfolio diversification, *Review of Finance* 12, 433–463.

Goyal, Amit, and Pedro Santa-Clara, 2003, Idiosyncratic risk matters!, *The Journal of Finance* 58, 975–1007.

Guercio, Diane Del, and Jonathan Reuter, 2014, Mutual fund performance and the incentive to generate alpha, *The Journal of Finance* 69, 1673–1704.

Harris, Lawrence E., Samuel M. Hartzmark, and David H. Solomon, 2015, Juicing the dividend yield: Mutual funds and the demand for dividends, *Journal of Financial Economics* 116, 433–451.

Hartzmark, Samuel M., and Abigail B. Sussman, 2019, Do investors value sustainability? A natural experiment examining ranking and fund flows, *The Journal of Finance,* 74, 2789–2837.

Heinkel, Robert, Alan Kraus, and Josef Zechner, 2001, The effect of green investment on corporate behavior, *Journal of Financial and Quantitative Analysis* 36, 431–449.

Hong, Harrison, and Marcin Kacperczyk, 2009, The price of sin: The effects of social norms on markets, *Journal of Financial Economics* 93, 15–36.

Hong, Harrison, and Leonard Kostovetsky, 2012, Red and blue investing: Values and finance, *Journal of Financial Economics* 103, 1–19.

Hortaçsu, Ali, and Chad Syverson, 2004, Product differentiation, search costs, and competition in the mutual fund industry: A case study of S&P 500 index funds, *The Quarterly Journal of Economics* 119, 403–456.

Huang, Chong, Fei Li, and Xi Weng, 2020, Star ratings and the incentives of mutual funds, *The Journal of Finance,* 75, 1715–1765.

Huang, Wei, Qianqiu Liu, S. Ghon Rhee, and Liang Zhang, 2010, Return reversals, idiosyncratic risk, and expected returns, *Review of Financial Studies* 23, 147–168.

Huberman, Gur, and Wei Jiang, 2006, Offering versus choice in 401 (k) plans: Equity exposure and number of funds, *The Journal of Finance* 61, 763–801.

Huynh, Thanh, and Ying Xia, 2020, Climate change news risk and corporate bond returns, *Journal of Financial and Quantitative Analysis* Forthcoming.

Ilhan, Emirhan, Philipp Krueger, Zacharias Sautner, and Laura T. Starks, 2020a, Climate risk disclosure and institutional investors.

Ilhan, Emirhan, Zacharias Sautner, and Grigory Vilkov, 2020b, Carbon tail risk, *Review of Financial Studies* Forthcoming.

Investment Company Institute, ICI, 2019, Investment company fact book, Available at `www.ici.org`.

Kempf, Alexander, and Stefan Ruenzi, 2008, Tournaments in mutual-fund families, *The Review of Financial Studies* 21, 1013–1036.

Krueger, Philipp, Zacharias Sautner, and Laura T. Starks, 2020, The importance of climate risks for institutional investors, *Review of Financial Studies* 33, 1067–1111.

Krüger, Philipp, 2015, Corporate goodness and shareholder wealth, *Journal of Financial Economics* 115, 304–329.

Krüger, Philipp, Zacharias Sautner, and Laura T Starks, 2020, The importance of climate risks for institutional investors, *The Review of Financial Studies* 33, 1067–1111.

Lee, David S., and Thomas Lemieux, 2010, Regression discontinuity designs in economics, *Journal of Economic Literature* 48, 281–355.

Leippold, Markus, and Roger Rueegg, 2020, How rational and competitive is the market for mutual funds?, *Review of Finance* 24, 579–613.

Lins, Karl V., Henri Servaes, and Ane Tamayo, 2017, Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis, *The Journal of Finance* 72, 1785–1824.

Markowitz, Harry, 1952, Portfolio selection, *The Journal of Finance* 7, 77–91.

Maxfield, Sylvia, and Liu Wang, 2020, Does sustainable investing reduce portfolio risk? A multilevel analysis, *European Financial Management* .

Morningstar, 2018a, Measuring transition risk in fund portfolios, available at: `https://www.morningstar.com/lp/measuring-transition-risk`.

Morningstar, 2018b, Morningstar Low Carbon Designation, available at: https://s21.q4cdn.com/198919461/files/doc_news/2018/Morningstar-Low-Carbon-Designation-Methodology-Final.pdf.

Nordhaus, William, 2019, Climate change: The ultimate challenge for economics, *American Economic Review* 109, 1991–2014.

Oehmke, Martin, and Marcus M. Opp, 2020, A theory of socially responsible investment, Working Paper.

Pástor, Ľuboš, Robert F. Stambaugh, and Lucian A. Taylor, 2020a, Fund tradeoffs, *Journal of Financial Economics* 138, 614–634.

Pástor, Ľuboš, and M. Blair Vorsatz, 2020, Mutual fund performance and flows during the COVID-19 crisis, *The Review of Asset Pricing Studies* 10, 791–833.

Pástor, Ľuboš, Robert F. Stambaugh, and Lucian A. Taylor, 2017, Do funds make more when they trade more?, *The Journal of Finance* 72, 1483–1528.

Pástor, Ľuboš, Robert F. Stambaugh, and Lucian A. Taylor, 2020b, Sustainable investing in equilibrium, *Journal of Financial Economics* Forthcoming.

Patel, Jayendu, Richard J. Zeckhauser, and Darryll Hendricks, 1994, Investment flows and performance: Evidence from mutual funds, cross-border investments, and new issues, in Ryuzo Sato, Richard Levich, and Rama Ramachandran, eds., *Japan, Europe and the International Financial Markets: Analytical and Empirical Perspectives*, 51–72 (New York, NY: Cambridge University Press).

Pedersen, Lasse Heje, Shaun Fitzgibbons, and Lukasz Pomorski, 2020, Responsible investing: The ESG-efficient frontier, *Journal of Financial Economics* Forthcoming.

Pigou, Arthur C., 1920, *The Economics of Welfare* (MacMillan, London).

Ramelli, Stefano, Alexander F. Wagner, Richard J. Zeckhauser, and Alexandre Ziegler, 2019, Investor rewards to climate responsibility: Evidence from the 2016 climate policy shock, Working Paper.

Renneboog, Luc, Jenke Ter Horst, and Chendi Zhang, 2008, The price of ethics and stakeholder governance: The performance of socially responsible mutual funds, *Journal of Corporate Finance* 14, 302–322.

Renneboog, Luc, Jenke Ter Horst, and Chendi Zhang, 2011, Is ethical money financially smart? Nonfinancial attributes and money flows of socially responsible investment funds, *Journal of Financial Intermediation* 20, 562–588.

Riedl, Arno, and Paul Smeets, 2017, Why do investors hold socially responsible mutual funds?, *The Journal of Finance* 72, 2505–2550.

Sirri, Erik R., and Peter Tufano, 1998, Costly search and mutual fund flows, *The Journal of Finance* 53, 1589–1622.

Tsai, Jerry, and Jessica A Wachter, 2015, Disaster risk and its implications for asset pricing, *Annual Review of Financial Economics* 7, 219–252.

Wachter, Jessica A., 2013, Can time-varying risk of rare disasters explain aggregate stock market volatility?, *The Journal of Finance* 68, 987–1035.

Wahal, Sunil, and Albert Yan Wang, 2011, Competition among mutual funds, *Journal of Financial Economics* 99, 40–59.

Weitzman, Martin, 1974, Prices versus quantities, *Review of Economic Studies* XLI, 477–491.

Weitzman, Martin L., 2009, On modeling and interpreting the economics of catastrophic climate change, *The Review of Economics and Statistics* 91, 1–19.

Weitzman, Martin L, 2011, Fat-tailed uncertainty in the economics of catastrophic climate change, *Review of Environmental Economics and Policy* 5, 275–292.

Tables

Table 1: Descriptive statistics
Descriptive statistics of active mutual funds domiciled in Europe and USA for which information on the Low Carbon Designation (LCD) and flows is available. Panel A covers all fund-month observations from April 2017 through September 2019, while Panel B provides a snapshot as of the end of April 2018. LCD is a dummy variable indicating funds that obtained the Low Carbon Designation at the end of April 2018. CR and FFI are the funds' carbon risk and fossil fuel involvement. Abn CR and Abn FFI are the funds' climate performance after controlling for differential market performance. Flows (in percentage points) is the monthly growth of assets net of reinvested returns. Normalized flows are computed following Hartzmark and Sussman (2019). Return is the monthly net return. Log assets is the log of AUM in USD. Volatility is the standard deviation of returns in the previous 12 months. Expense ratio is the annual percentage of assets deducted for fund expenses. Age is the number of years since the inception of the oldest share class. Globes is the Morningstar sustainability rating on a 1-5 scale. Stars is the overall Morningstar rating system on a 1-5 scale. Δ1 Globe and Δ5 Globes indicate funds entering (1) or exiting (-1) the 1 Globe and 5 Globes category in a given month. ΔStars indicates if a fund received a downgrade or an upgrade in the Morningstar rating system (Stars). Socially conscious is a dummy variable for funds that label themselves as socially conscious in either their name or prospectus. Institutional is a dummy variable for funds with more than 90% of assets in institutional share classes. Idiosyncratic risk is the standard deviation of residuals from a Fama-French three-factor model run over the period from December 2016 through April 2018, funds with at least 12 observations of monthly returns.

Panel A: From April 2017 through September 2019

	N	min	p25	mean	p50	p75	max	sd
LCD	392,417	0.00	0.00	0.18	0.00	0.00	1.00	0.38
CR	244,879	0.23	8.37	10.13	10.05	11.44	45.60	3.42
FFI	346486	0.00	3.03	6.98	6.17	9.50	92.73	5.83
Flows	392,417	-19.54	-1.53	0.07	-0.23	1.29	30.66	3.99
Normalized flows	392,417	1.00	27.00	50.27	50.00	73.00	100.00	27.20
Return	392,417	-99.71	-1.08	0.41	0.61	2.23	26.21	3.33
Log assets	392,417	4.69	16.76	18.34	18.30	19.82	26.02	2.10
Volatility	392,417	0.01	1.73	2.78	2.51	3.57	28.72	1.48
Expense ratio	189,481	-0.25	0.73	1.13	1.07	1.46	15.15	0.69
Age	392,417	0.16	5.49	13.47	12.08	18.66	119.32	10.26
Globes	284,513	1.00	2.00	3.05	3.00	4.00	5.00	1.13
Stars	235,777	1.00	2.00	3.15	3.00	4.00	5.00	1.06
Δ1 Globe	392,417	-1.00	0.00	-0.00	0.00	0.00	1.00	0.13
Δ5 Globes	392,417	-1.00	0.00	0.00	0.00	0.00	1.00	0.13
ΔStars	392,417	-1.00	0.00	-0.00	0.00	0.00	1.00	0.30
Socially conscious	392,417	0.00	0.00	0.10	0.00	0.00	1.00	0.30
Institutional	392,417	0.00	0.00	0.19	0.00	0.00	1.00	0.40
Idiosyncratic risk	299,075	0.00	0.87	1.51	1.48	2.00	17.06	0.82

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Panel B: End of April 2018

	N	min	p25	mean	p50	p75	max	sd
LCD	13,465	0.00	0.00	0.18	0.00	0.00	1.00	0.38
CR	9,251	0.23	9.02	10.68	10.61	11.92	45.58	3.44
FFI	13,419	0.00	2.92	6.66	5.89	9.05	70.99	5.50
Flows	13,465	-19.27	-2.20	-0.89	-1.55	-0.00	30.48	3.87
Normalized flows	13,465	1.00	27.00	49.68	49.00	73.00	100.00	27.33
Return	13,465	-9.79	0.47	2.04	1.81	3.45	13.91	2.10
Log assets	13,465	7.14	16.79	18.36	18.32	19.85	25.93	2.09
Volatility	13,465	0.07	1.73	2.25	2.30	2.73	9.20	0.81
Expense ratio	6,338	-0.21	0.72	1.14	1.07	1.45	14.53	0.72
Age	13,465	0.16	5.07	13.11	11.71	18.33	118.24	10.28
Globes	9,595	1.00	2.00	3.02	3.00	4.00	5.00	1.14
Stars	9,842	1.00	2.00	3.16	3.00	4.00	5.00	1.05
Δ1 Globe	13,465	-1.00	0.00	-0.00	0.00	0.00	1.00	0.15
Δ5 Globes	13,465	-1.00	0.00	0.00	0.00	0.00	1.00	0.14
ΔStars	13,465	-1.00	0.00	0.01	0.00	0.00	1.00	0.32
Socially conscious	13,465	0.00	0.00	0.10	0.00	0.00	1.00	0.30
Institutional	13,465	0.00	0.00	0.20	0.00	0.00	1.00	0.40
Idiosyncratic risk	13,028	0.09	0.94	1.57	1.46	2.11	10.92	0.85

Table 2: Geographical distribution of funds
This table shows the geographical distribution of funds included in the sample, with the share of funds that obtained the Morningstar Low Carbon Designation. Standard deviations and 25th, 50th, and 75th percentiles of flows for each area are reported to facilitate the interpretation of regression results that follow. The table covers all funds included in the sample as of April 2018. Portfolio Carbon Risk Scores are assigned by Morningstar only to funds with more than 67% of portfolio assets in companies covered by Sustainalytics in terms of carbon-risk rating (Morningstar, 2018b).

			Flows			
Area of domicile	N	Fraction of LCD funds	p25	p50	p75	sd
Europe	9,266	0.18	-2.58	-1.80	-0.87	3.90
USA	4,199	0.17	-1.00	-0.23	0.75	3.51
Total	13,465	0.18	-2.20	-1.55	-0.00	3.87

Table 3: Morningstar LCD, sustainability, and overall ratings
This table shows the absolute frequencies of funds without and with the Low Carbon Designation (LCD) along the Morningstar sustainability "Globes" ratings (Panel A) and the Morningstar overall "Stars" ratings (Panel B) as of April 2018.

Panel A: Morningstar sustainability ratings ("Globes")

LCD	1	2	3	4	5	Total
0	858	1,671	2,595	1,619	703	7,446
1	183	366	677	581	342	2,149
Total	1,041	2,037	3,272	2,200	1,045	9,595
% of LCD funds	17.58%	17.97%	26.09%	26.41%	32.72.41%	22.40%

Panel B: Morningstar overall ratings ("Stars")

LCD	1	2	3	4	5	Total
0	497	1,618	2,898	2,062	736	7,811
1	86	368	682	604	291	2,031
Total	583	1,986	3,580	2,666	1,027	9,842
% of LCD funds	14.75%	18.53%	19.05%	22.66%	28.33%	20.64%

Table 4: Low-carbon funds have higher idiosyncratic volatility
This table shows regressions of funds' idiosyncratic risk on decile indicators along funds' carbon risk (CR) (column (1)), fossil fuel involvement (FFI) (column (2)), and ESG sustainability score (column 3). *Idiosyncratic volatility* is computed as the standard deviation of residuals from Fama-French three-factor model regressions over the period from December 2017 through April 2018, when at least 12 observations of monthly returns are available. *FF3 alpha* is the estimated intercept from these regressions. t-statistics based on robust standard errors are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
Dependent variable:	Idiosyncratic volatility		
Sorting variable:	CR	FFI	ESG score
Decile = 1	0.06***	0.21***	0.52***
	(2.61)	(8.48)	(9.90)
Decile = 2	0.05**	0.05**	0.24***
	(2.23)	(2.33)	(7.41)
Decile = 3	0.04*	0.01	0.08***
	(1.78)	(0.65)	(2.83)
Decile = 4	0.01	0.00	0.07***
	(0.53)	(0.11)	(2.58)
Decile = 6	0.00	0.02	-0.04*
	(0.19)	(1.08)	(-1.79)
Decile = 7	0.02	0.06***	-0.05*
	(0.83)	(3.41)	(-1.86)
Decile = 8	0.04**	0.07***	-0.11***
	(2.06)	(3.72)	(-3.87)
Decile = 9	0.10***	0.13***	-0.17***
	(4.82)	(6.90)	(-5.80)
Decile = 10	0.31***	0.25***	-0.14***
	(10.81)	(9.91)	(-4.97)
Log assets	-0.02***	-0.03***	-0.03***
	(-5.67)	(-9.41)	(-8.36)
FF3 alpha	0.13***	0.14***	0.11***
	(5.33)	(5.60)	(4.05)
Constant	1.88***	1.91***	2.17***
	(34.58)	(35.50)	(29.52)
Observations	8,968	12,981	9,447
R-squared	0.58	0.56	0.52
Category FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes

Table 5: Investors prefer low-carbon funds

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period). The sample includes active equity and diversified mutual funds domiciled in Europe or USA, excluding funds that experienced an LCD upgrade or downgrade in August or November 2018. Models (1), (3) and (5) use monthly net flows as the dependent variable, while models (2), (4), and (6) use monthly normalized flows. All regressions control for lagged fund characteristics, and month-by-style and country fixed effects. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at the style and month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.22***	1.98**	0.26***	2.34**	0.23**	1.91***
	(3.16)	(2.53)	(3.60)	(2.49)	(2.53)	(3.49)
LCD	0.11	0.78	0.08	0.66	0.09	0.28
	(0.99)	(0.95)	(0.64)	(0.74)	(0.80)	(0.30)
Return	0.14***	0.98**	0.15***	1.00***	0.21***	1.57***
	(3.85)	(2.64)	(5.08)	(3.50)	(11.32)	(8.14)
Return t-2	0.12***	0.95***	0.11***	0.85***	0.21***	1.77***
	(4.36)	(3.30)	(5.01)	(3.56)	(7.24)	(6.08)
Return t-3	0.15***	1.25***	0.12***	0.95***	0.25***	2.07***
	(3.66)	(3.14)	(3.22)	(2.89)	(6.82)	(7.27)
Log assets	-0.04*	0.60*	-0.01	0.94**	-0.07***	0.29
	(-1.92)	(1.80)	(-0.62)	(2.59)	(-3.52)	(0.79)
Volatility	0.05	0.50	0.02	0.02	0.01	0.69
	(0.69)	(0.82)	(0.39)	(0.06)	(0.08)	(0.46)
Age	-0.04***	-0.40*	-0.05***	-0.38***	-0.04***	-0.42***
	(-6.19)	(-1.79)	(-6.76)	(-7.08)	(-3.84)	(-4.73)
Δ1 Globe	-0.04	0.36	0.01	0.62	-0.08	0.38
	(-0.65)	(1.48)	(0.16)	(1.49)	(-1.01)	(1.23)
Δ5 Globes	0.10	0.28	0.09	0.17	0.09	-0.03
	(1.21)	(0.43)	(1.01)	(0.28)	(1.10)	(-0.10)
ΔStars	0.06*	0.23	0.09*	0.39	0.01	-0.13
	(2.07)	(0.90)	(2.03)	(1.04)	(0.37)	(-0.67)
Observations	261,361	261,361	178,267	178,267	83,087	83,087
R-squared	0.17	0.13	0.22	0.13	0.09	0.24
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Effects of LCD downgrades and upgrades through September 2019
Panel A of this table summarizes the results of the quarterly LCD updates that took place between May 2018 and September 2019 at a quarterly frequency, based on the portfolio holdings as at the end of each quarter. Panel B shows results of OLS regressions of monthly flows from May 2018 through September 2019 on *LCD Downgrade* and *LCD Upgrade*, and control variables (monthly, returns in the previous three months, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars). *LCD Downgrade* and *LCD Upgrade* are dummy variables equal to 1 for months following an LCD downgrade or upgrade, and 0 otherwise. All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered at the style and month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: LCD changes after April 2018

LCD updates	Aug 2018 (Q2-2018)	Nov 2018 (Q3-2018)	Feb 2019 (Q4-2018)	May 2019 (Q1-2019)	Aug 2019 (Q2-2019)
Downgrades	206	324	412	555	593
Confirmations	13,045	12,625	12,280	12,388	12,215
Upgrades	140	302	474	582	733

Panel B: Effect of LCD changes after April 2018

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD Downgrade	-0.18**	-0.80	-0.20**	-0.88*	-0.04	0.04
	(-2.57)	(-1.46)	(-2.63)	(-1.92)	(-0.27)	(0.02)
LCD Upgrade	0.21**	1.41**	0.21**	1.30***	0.19	1.56
	(2.62)	(2.21)	(2.91)	(2.95)	(0.70)	(0.69)
Observations	228,446	228,446	158,703	158,703	69,736	69,736
R-squared	0.10	0.12	0.13	0.12	0.07	0.19
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: Funds tilt portfolios towards low-carbon firms

This table shows results of OLS regressions of quarterly gross and Abnormal Carbon Risk (CR and Abn CR) and Fossil Fuel Involvement (FFI and Abn FFI) from March 2017 through September 2019 on a dummy, Post, indicating the period after April 2018. Abnormal climate performance metrics (indicated by Abn) are constructed to account for price changes by subtracting for each category-month pair the mean CR and FFI of explicit indexers and passive investors (Active Share $\leq$60%). The sample includes active funds domiciled in Europe or the US. We compute the means separately by the degree to which the treatment criteria are fulfilled, i.e., $\varnothing$CR$\leq$10, $\varnothing$FFI$\leq$7, both, and none. All regressions control for quarter-by-style fixed effects and lagged fund-level controls. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at the quarter and category are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dep. variable:	CR	Abn CR	FFI	Abn FFI
NotLCD × Post	-0.61***	-0.34***	-0.49***	-0.95***
	(-5.83)	(-3.53)	(-4.02)	(-4.19)
NotLCD	3.56***	0.40*	6.12***	0.37
	(27.37)	(2.24)	(16.78)	(0.86)
Observations	59,252	59,252	59,252	59,252
R-squared	0.62	0.12	0.44	0.09
Controls	Yes	Yes	Yes	Yes
Quarter-style FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Quarter-style clustered FE	Yes	Yes	Yes	Yes

Table 8: Funds tilt portfolios towards low-carbon firms - High and low idiosyncratic risk funds

This table shows results of OLS regressions of quarterly Carbon Risk (CR) and Fossil Fuel Involvement (FFI) from March 2017 through September 2019 on a dummy, Post, indicating the period after April 2018. The sample of Models (1) and (2) includes funds that have an idiosyncratic volatility measured in April 2018 above the sample median. Models (3) and (4) show only funds that have an idiosyncratic volatility below the median. All Models include all active mutual funds domiciled in Europe or USA. All regressions control for month-by-style fixed effects and lagged fund-level controls. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at the quarter and category are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	High idiosyncratic volatility		Low idiosyncratic volatility	
	(1)	(2)	(3)	(4)
Dep. variable:	CR	FFI	CR	FFI
NotLCD × Post	-0.57***	-0.36**	-0.62***	-0.60***
	(-5.71)	(-3.10)	(-6.04)	(-4.01)
NotLCD	3.54***	6.31***	3.48***	5.73***
	(28.53)	(19.64)	(20.50)	(14.23)
Observations	28,331	28,331	30,828	30,828
R-squared	0.66	0.46	0.58	0.44
Controls	Yes	Yes	Yes	Yes
Quarter-style FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Quarter-style clustered FE	Yes	Yes	Yes	Yes

Supplementary Appendix

Figure A1: Sustainability Globes, loading on negative climate new, and idiosyncratic risk

These figures show binned scatter plots of funds' climate news beta (Panel A) and idiosyncratic risk (Panel B) against funds' Morningstar Globes ratings, controlling for category fixed effects and log assets.

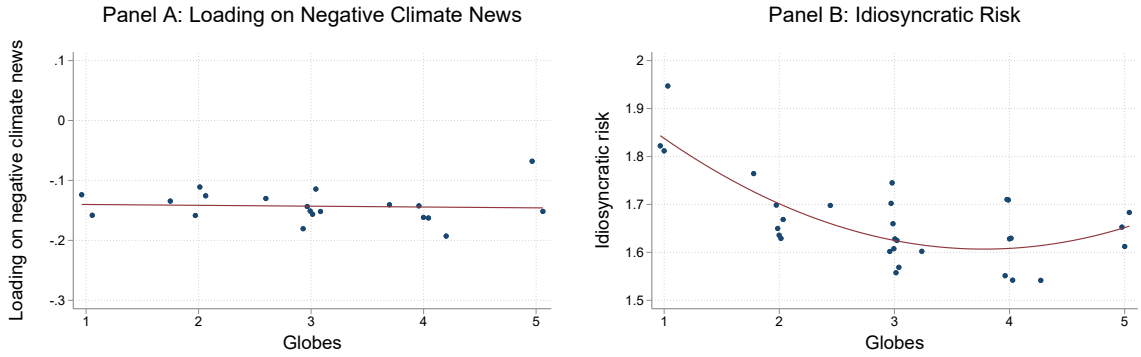
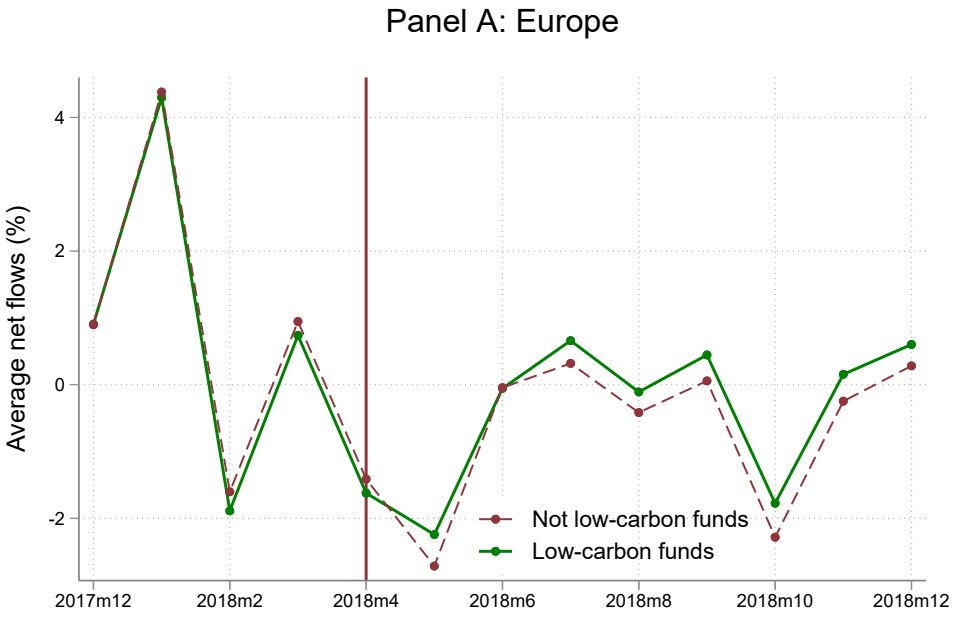


Figure A2: Investors prefer low-carbon funds - Robustness check: Shorter pre-publication period with pre-publication labels

These figures show the equally-weighted average monthly flows from December 2017 through December 2018 of European (top) and US (bottom) funds that had portfolios with low-carbon features (solid green lines) and of those that did not (dashed red line). These graphs leverage on the availability of LCD data from December 2017 to April 2018 (pre-publication period). Flows are computed as of end of the month.



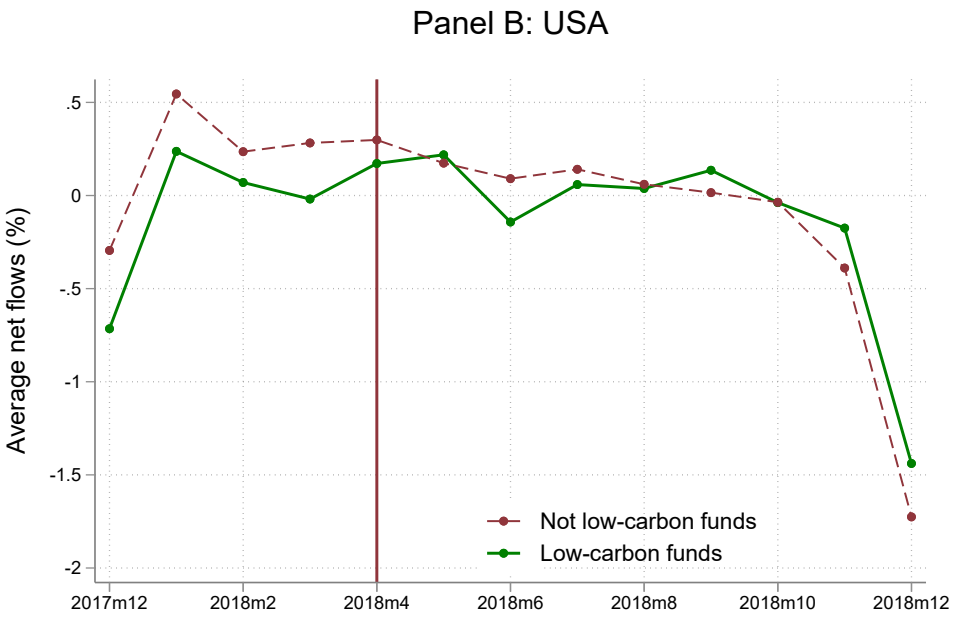


Table A1: : Firm-level Carbon Risk scores by GICS sectors

This table shows the descriptive statistics of 2017 firm-level Carbon Risk scores from the ESG research provider Sustainalytics, by GICS sector. Panel A looks at firms head-quartered in Europe, while Panel B looks at firms head-quartered in the USA. According to Sustainalytics, the Carbon Risk score capture the remaining unmanaged carbon risk after taking into account a firm's carbon risk management activities (for details, see Morningstar, 2018b). Morningstar uses the firm-level Carbon Risk scores from Sustainalytics to compute the value-weighted fund-level Carbon Risk scores.

Panel A: Europe

	N	min	p25	mean	p50	p75	max	sd
Energy	34	8.89	16.90	28.31	26.46	35.97	62.89	14.14
Materials	74	1.59	11.63	18.33	17.33	24.54	48.40	8.02
Industrials	170	0.00	6.51	13.92	13.70	21.90	36.05	9.26
Consumer discretionary	108	0.00	0.00	8.51	7.23	12.13	41.25	7.93
Consumer staples	51	0.00	3.89	8.42	6.97	12.01	20.69	5.62
Health Care	65	0.00	0.00	2.72	0.00	5.93	14.72	4.49
Financials	144	0.00	7.95	11.70	11.86	15.27	25.20	5.27
IT	62	0.00	0.00	3.21	0.00	5.92	23.91	5.14
Communication	62	0.00	0.00	5.39	3.49	9.40	19.36	6.22
Utilities	41	0.00	8.50	15.80	14.00	23.54	38.70	9.64
Real Estate	67	4.28	8.44	12.68	12.54	17.13	20.70	4.92
Total	878	0.00	4.61	11.30	10.32	15.96	62.89	9.34

Panel B: USA

	N	min	p25	mean	p50	p75	max	sd
Energy	106	0.00	12.27	33.61	24.07	58.15	75.28	24.24
Materials	104	0.00	9.93	16.40	15.35	21.64	63.51	11.59
Industrials	149	0.00	8.27	14.84	14.21	21.16	46.22	9.56
Consumer discretionary	131	0.00	0.00	11.58	10.10	17.63	67.65	11.22
Consumer staples	60	0.00	4.74	12.03	10.64	17.50	58.06	10.08
Health care	95	0.00	0.00	8.97	7.28	14.37	81.09	11.08
Financials	161	0.00	7.24	13.03	12.98	16.25	76.20	10.19
IT	125	0.00	0.00	9.95	7.81	14.41	67.32	12.06
Communication	58	0.00	0.00	8.95	7.62	14.78	35.07	8.69
Utilities	52	0.00	9.67	16.27	16.48	23.14	37.79	10.26
Real Estate	104	0.00	8.73	13.92	13.80	18.72	54.08	8.76
Total	1,145	0.00	5.78	14.61	12.55	19.50	81.09	13.98

Table A2: Correlations between variables

This table shows the correlations between variables for the period from April 2017 through September 2019. * indicates that the parameter estimate is significantly different from zero at the 1% level.

Variables	1	2	3	4	5	6	7	8	9	10
1. LCD										
2. Flows	0.01*									
3. Normalized flows	0.02*	0.75*								
4. Return	0.04*	0.06*	-0.03*							
5. Log assets	0.08*	-0.01*	-0.01*	0.03*						
6. Volatility	0.19*	-0.05*	-0.02*	0.04*	-0.00					
7. Age	0.07*	-0.11*	-0.14*	0.01*	0.29*	0.05*				
8. Globes	0.09*	-0.00	0.00	0.01*	-0.02*	-0.08*	0.03*			
9. Stars	0.06*	0.14*	0.17*	0.04*	0.31*	-0.06*	0.00	-0.02*		
10. Socially conscious	0.11*	0.03*	0.04*	0.01*	0.05*	0.03*	-0.03*	0.17*	0.04*	
11. Institutional	-0.03*	0.03*	0.06*	0.00	0.15*	-0.02*	-0.12*	-0.04*	0.12*	0.05*

Table A3: Financial and climate performance

This table shows results of cross-sectional OLS regressions of funds' average performance (alpha) relative to the Fama-French three factor model over the period from December 2016 through April 2018 on the Low Carbon Designation (LCD) and underlying criteria, controlling for fund size and category. The sample includes funds included in our sample as of May 2018.The fund-specific Fama-French three factor models are estimated based on EU and US factors retrieved from Kenneth French's website. t-statistics based on robust standard errors are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Fama-French 3-factor model alpha					
LCD	0.09***	0.15***	0.01	0.12***	0.26***	0.07**
	(7.94)	(9.14)	(1.04)	(6.76)	(12.59)	(2.33)
CR		-0.00		0.01***		-0.04***
		(-0.19)		(3.02)		(-6.67)
FFI		0.01***		0.01***		-0.00*
		(5.56)		(6.88)		(-1.69)
Log assets	0.02***	0.02***	0.03***	0.03***	0.01***	0.01***
	(9.70)	(7.26)	(9.37)	(6.74)	(3.54)	(3.17)
Constant	-0.33***	-0.33***	-0.31***	-0.40***	-0.53***	-0.03
	(-7.14)	(-5.37)	(-4.70)	(-5.12)	(-7.86)	(-0.36)
Observations	13,024	8,968	8,940	6,272	4,082	2,694
R-squared	0.36	0.40	0.27	0.32	0.05	0.17
Category FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A4: Cross-sectional heterogeneity of LCD flow premium: Low vs. high sustainability funds

This table shows results of OLS regressions of monthly flows from April 2017 through December 2018 exploring the differential effect of the LCD in the subsamples of low (1 or 2 Morningstar sustainability globes) and high (4 or 5 Globes). The regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered at the month and category level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows		Flows		Flows	
	Low sust.	High sust.	Low sust.	High sust.	Low sust.	High sust.
LCD × Post	0.34**	0.09	0.30*	0.11	0.33	0.21
	(2.49)	(0.68)	(2.00)	(0.71)	(1.46)	(1.19)
LCD	0.11	0.26***	0.07	0.30***	0.20	0.02
	(0.65)	(3.43)	(0.35)	(3.97)	(1.14)	(0.20)
Observations	59,246	62,274	39,977	42,512	19,265	19,744
R-squared	0.16	0.16	0.20	0.21	0.10	0.08
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A5: Investors prefer low-carbon funds - Robustness check: Adding fund fixed effects

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period), and control variables. Models (1), (3) and (5) use monthly net flows as the dependent variable, while models (2), (4), and (6) use monthly normalized flows. All regressions control for month-by-style and fund fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at the style and month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
Dep. variable:	(1) Flows	(2) Normalized flows	(3) Flows	(4) Normalized flows	(5) Flows	(6) Normalized flows
LCD × Post	0.41***	2.77***	0.45***	3.11***	0.35***	2.28**
	(5.59)	(3.40)	(3.47)	(3.13)	(3.47)	(2.21)
Observations	261,361	261,361	178,267	178,267	83,087	83,087
R-squared	0.37	0.39	0.39	0.35	0.38	0.56
Constant & controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A6: Investors prefer low-carbon funds - Robustness check: Fully interacted model

This table shows results of difference-in-differences regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), control variables (monthly return, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars), and the interaction of all variables with a dummy Post equal to 1 for months after April 2018. t-statistics, based on robust standard errors clustered at month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.20**	1.98**	0.25***	2.43**	0.16*	1.66***
	(2.37)	(2.21)	(2.93)	(2.19)	(2.02)	(3.53)
LCD	0.12	0.79	0.08	0.62	0.12	0.43
	(1.03)	(0.92)	(0.62)	(0.67)	(0.96)	(0.46)
Return × Post	-0.07	-0.30	-0.04	0.20	0.02	0.08
	(-1.09)	(-0.43)	(-0.75)	(0.34)	(0.23)	(0.19)
Log assets × Post	0.06*	-0.37	-0.02	-1.01*	0.06**	-0.66
	(1.93)	(-0.94)	(-0.68)	(-1.77)	(2.38)	(-1.11)
Volatility × Post	0.22	1.91*	0.23	2.14**	0.31**	2.66*
	(1.67)	(1.92)	(1.56)	(2.15)	(2.67)	(1.76)
Age × Post	0.02***	0.05	0.02**	0.02	0.01	0.06
	(3.46)	(1.21)	(2.39)	(0.33)	(1.43)	(0.88)
Δ1 Globe × Post	-0.12	-0.59	-0.05	-0.22	-0.17	-0.32
	(-0.81)	(-0.71)	(-0.35)	(-0.24)	(-1.14)	(-0.27)
Δ5 Globes × Post	0.12	1.12	0.03	0.86	0.17	0.33
	(0.97)	(1.04)	(0.30)	(0.87)	(0.85)	(0.20)
ΔStars × Post	0.02	0.05	0.04	0.03	0.01	0.05
	(0.46)	(0.12)	(0.76)	(0.06)	(0.11)	(0.09)
Observations	261,361	261,361	178,267	178,267	83,087	83,087
R-squared	0.17	0.14	0.22	0.13	0.09	0.25
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A7: Investors prefer low-carbon funds - Robustness check: Asset-weighted regressions

This table shows results of OLS asset-weighted difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period), and control variables. All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered at month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.23***	2.08***	0.28***	2.46***	0.22**	1.96***
	(3.18)	(3.42)	(3.47)	(3.33)	(2.40)	(3.42)
LCD	0.11***	0.77**	0.08*	0.73*	0.07	0.03
	(3.03)	(2.32)	(1.92)	(1.98)	(1.08)	(0.05)
Observations	261,361	261,361	178,267	178,267	83,094	83,094
R-squared	0.17	0.14	0.22	0.13	0.08	0.24
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A8: Investors prefer low-carbon funds - Robustness check: Controlling for CR and FFI

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), Portfolio Carbon Risk (CR) and Fossil fuel involvement (FFI), their interaction with Post, and control variables (monthly return, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars). All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered at the month and categorymonth level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
Dep. variable:	(1) Flows	(2) Normalized flows	(3) Flows	(4) Normalized flows	(5) Flows	(6) Normalized flows
LCD × Post	0.23**	1.91**	0.22	1.92*	0.19*	1.06
	(2.72)	(2.84)	(1.67)	(1.86)	(1.93)	(1.68)
LCD	-0.06	-0.77	-0.06	-0.51	-0.04	-1.00*
	(-0.80)	(-1.32)	(-0.59)	(-0.70)	(-0.45)	(-1.91)
CR	-0.02	-0.20	0.00	-0.06	-0.04	-0.19
	(-0.98)	(-1.27)	(0.03)	(-0.36)	(-1.21)	(-0.71)
CR × Post	0.01	0.11	-0.00	0.00	-0.01	-0.14
	(0.29)	(0.50)	(-0.12)	(0.02)	(-0.43)	(-0.52)
FFI	-0.03***	-0.20***	-0.03***	-0.23***	-0.01	-0.11
	(-3.21)	(-3.25)	(-4.94)	(-3.63)	(-0.30)	(-0.62)
FFI × Post	0.01	0.00	0.01	0.01	0.01	0.01
	(1.55)	(0.11)	(1.13)	(0.11)	(0.84)	(0.12)
Observations	168,821	168,821	115,575	115,575	53,227	53,227
R-squared	0.16	0.14	0.20	0.13	0.10	0.27
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-style clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A9: Funds tilt portfolios towards low-carbon firms - Robustness checks
This table shows robustness tests to the mutual fund responses regressions. Panel A shows results of asset-weighted OLS difference-in-differences (DID) regressions of quarterly Abnormal Carbon Risk (Abn CR) and Fossil Fuel Involvement (Abn FFI) from March 2017 through September 2019 on Not Low Carbon Designation (NotLCD),the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period), and control variables. Panel B shows results of OLS difference-in-differences (DID) regressions using the same dependent and independent variables but adding fund fixed effects. Abnormal climate performance metrics (indicated by Abn) are constructed to account for price changes by subtracting for each category-month pair the mean CR and FFI of explicit indexers and passive investors (Active Share $\leq$60%). We compute the means separately by the degree to which the treatment criteria are fulfilled, i.e., $\varnothing$CR$\leq$10, $\varnothing$FFI$\leq$7, both, and none. All regressions control for lagged fund-level controls. Regressions in Panel A also control for quarter-by-style and country fixed effects. Those in Panel B include fund and quarter fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at the quarter and style are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Asset-weighted regressions

	(1)	(2)
Dep. variable:	Abn CR	Abn FFI
NotLCD × Post	-0.34*	-0.92**
	(-1.97)	(-2.31)
NotLCD	0.41***	0.38
	(2.97)	(1.28)
Observations	59,253	59,253
R-squared	0.12	0.09
Controls	Yes	Yes
Quarter-style FE	Yes	Yes
Country FE	Yes	Yes
Quarter-style clustered FE	Yes	Yes

Panel B: Fund fixed effects

	(1)	(2)
Dep. variable:	Abn CR	Abn FFI
NotLCD × Post	-0.20**	-0.48**
	(-3.16)	(-2.33)
Observations	59,149	59,149
R-squared	0.85	0.78
Controls	Yes	Yes
Quarter FE	Yes	Yes
Fund FE	Yes	Yes
Quarter-style clustered FE	Yes	Yes

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