The Economic Impact of ESG Ratings*

Florian Berg,[2] Florian Heeb,[1] Julian F. Kölbel[1,2]

July 22, 2022

Abstract

This study examines the impact of ESG ratings on mutual fund holdings, stock returns, corporate investment, and corporate ESG practices, using panel event studies. Looking specifically at changes in the MSCI ESG rating, we document that rating downgrades reduce ownership by mutual funds with a dedicated ESG strategy, while upgrades increase it. We find a negative long-term response of stock returns to downgrades and a slower and weaker positive response to upgrades. Regarding firm responses, we find no significant effect of up- or downgrades on capital expenditure. We find that firms adjust their ESG practices following rating changes, but only in the governance dimension. These results suggest that ESG rating changes matter in financial markets, but so far have only a limited impact on the real economy.

Keywords: Responsible investing, social impact, ESG ratings, asset prices, corporate investment, corporate governance

JEL classification: G11, G12, G32, G34

*We thank Marc Chesney, Thorsten Hens, Philipp Krüger, Stefano Ramelli, and the participants at the Geneva Finance Research Institute Seminar.

[1] Department of Banking and Finance, University of Zurich, Plattenstr. 14, 8032 Zurich, Switzerland.
[2] MIT Sloan School of Management, 100 Main Street, Cambridge, MA 02142, USA.

1 Introduction

Investors are increasingly integrating information on environmental, social, and governance (ESG) issues into their investment decisions. Over 4,000 asset managers and asset owners, representing over USD 100 trillion in assets, have signed the Principles for Responsible Investment (PRI), the first of these requiring investors to incorporate ESG issues into investment analysis and decision-making processes. According to the Global Sustainable Investment Alliance GSIA (2021), the volume of investment products explicitly integrating ESG information exceeded USD 25 trillion in 2020 and is destined to grow further. ESG ratings, which provide an aggregated assessment of firms' sustainability performance based on a multitude of ESG indicators, serve as a primary information source for investors implementing ESG integration.

Theoretical models predict that investor demand for ESG investments could have profound effects on financial markets and corporate behavior and may create positive social impact (Broccardo, Hart, and Zingales, 2020; Hong, Wang, and Yang, 2021; Landier and Lovo, 2020; Oehmke and Opp, 2019; Pástor, Stambaugh, and Taylor, 2021; Heinkel, Kraus, and Zechner, 2001). In broad strokes, these models make three major predictions. First, investors with a preference for "green" companies—so, companies with high ESG performance—tilt their investment holdings toward them and away from "gray" companies, which have low ESG performance. Second, if there are enough such investors, this tilt drives up the asset prices of green companies, decreasing expected returns and consequently the cost of capital for green companies. Vice versa, the cost of capital for gray companies increases. Third, this change in asset prices should trigger changes in the real economy through two key channels: On the one hand, via a growth channel, where shifts in the cost of capital influence real investments—green firms would invest more and grow faster, gray firms would invest less and grow at a slower pace. On the other hand, via a reform channel, where

firms improve their ESG practices with the goal of attracting green investors and increasing their stock market valuation. Both channels would ultimately lead to a positive social impact on the real economy. Thus far, however, it remains unclear to what extent these predictions hold empirically.

In this study, we investigate the impact of ESG rating changes on financial markets and corporate behavior. For our sample of 3,665 listed U.S. companies, we observe 4,679 ESG rating changes between 2013 and 2020. We focus on the MSCI ESG rating, one of the most influential of its kind.[1] Given that ESG ratings are an essential information source for ESG investing, we expect ESG rating changes to have a measurable impact on investment choices. We employ a panel event study methodology (Schmidheiny and Siegloch, 2019; Clarke and Tapia-Schythe, 2021; Freyaldenhoven, Hansen, Pérez, and Shapiro, 2021), based on three considerations. First, this allows us to make causal inferences on the effects of ESG rating changes, given that the identifying assumption of the parallel development of treated and untreated firms holds. Second, we can separately analyze the effect of up- and downgrades, which may not be symmetric. Third, rather than making restrictive assumptions on how and when the effects of ESG rating changes unfold, we can estimate and visualize dynamic treatment effects.

First, we show that mutual fund holdings react to changes in ESG ratings. We investigate ESG ownership—so, the fraction of a firm's shares that are owned by domestic U.S. mutual equity funds with an explicit ESG objective. In September 2020, these funds collectively represented USD 71 billion in assets under management and owned 0.03% of the average company in our sample. ESG ownership reacts significantly to both ESG rating upgrades and downgrades. Two years after a downgrade, ESG ownership is on average 13.1% lower; two years after an upgrade, it is 17.1% higher

[1] A report by Opimas states that MSCI has the largest market share, with 31%: http://www.opimas.com/research/742/detail/.

than one month before the rating change. The response to rating changes is slow and gradual: ESG mutual funds adjust their holdings gradually over the two years following ESG rating changes.

Second, we show that ESG rating changes have long-lasting effects on stock returns. We detect significant negative effects on buy-and-hold returns, for holding periods of up to 24 months, after a downgrade, reaching a maximum of -3.78% for a holding period of 19 months. After upgrades, we detect a weaker and slower positive effect on buy-and-hold returns, reaching a maximum of 2.62% for a holding period of 22 months. Similar to our results on ESG ownership, the effect of ESG rating changes on buy-and-hold returns enfolds gradually over a prolonged time period.

Third, we explore how changes in ESG ratings affect corporate behavior, both via a growth and via a reform channel. We do not find evidence in support of the growth channel. ESG rating changes have no discernible effect on the subsequent level of firms' capital expenditure over a two-year time horizon. We find some evidence for the reform channel. We exploit the fact that MSCI ratings separately measure a firm's management of ESG issues and a firm's exposure to these issues. For each of the environmental, social, and governance dimensions, we construct a score solely reflecting firms' management practices. For the environmental and social management score, we do not find any significant reaction to ESG rating changes. For the governance score, we find that firms react to both upgrades and downgrades: following a downgrade, firms improve their governance practices; following an upgrade, firms tend to let their governance practices deteriorate.

Our study provides an empirical assessment of the economic impact of ESG rating changes. Our results are compatible with model predictions in that they confirm that changes in ESG performance affect the holdings of ESG-aware investors and stock returns. We find that, at least for ESG mutual funds, ESG commitments are not merely "cheap talk" and that ESG ratings do affect stock markets. However, the real economic impact of ESG investing seems limited, given our results. First, the

cost-of-capital advantage (disadvantage) for green (gray) firms does not seem to affect firms' real investment. Thus, we do not find evidence for a growth channel that might allow green firms to outgrow gray firms. Second, we only find evidence for the reform channel in the governance dimension, not in the social or the environmental dimension. Thus, the reform channel seems to function only for a subset of ESG issues. One speculative explanation for this is that reform of governance practices costs less and is less controversial than reforms in the environmental or the social domain.

Our paper contributes to the literature examining the effects of preferences for sustainability on financial markets. While there is a rich body of theoretical work on these effects (Broccardo, Hart, and Zingales, 2020; Gollier and Pouget, 2014; Heinkel, Kraus, and Zechner, 2001; Hong, Wang, and Yang, 2021; Landier and Lovo, 2020; Oehmke and Opp, 2019; Pástor, Stambaugh, and Taylor, 2021; Pedersen, Fitzgibbons, and Pomorski, 2020), our study adds to a relatively recent literature strand that tests theoretical predictions. Specifically, it contributes to three strands of the empirical literature.

First, our study contributes to empirical work investigating how preferences for sustainability affect investors' holdings and corporate ownership structures. Based on holdings data, which the authors connect with behavioral experiments, Riedl and Smeets (2017) show that pro-social preferences and social signaling explain why a considerable proportion of private investors hold sustainable mutual funds, financial motives being, comparatively, less influential. In line with this, Hartzmark and Sussman (2019) show that mutual funds labeled as sustainable attract inflows. At the same time, both Brandon, Glossner, Krueger, Matos, and Steffen (2021) and Kim and Yoon (2020) find that, at least in the U.S., portfolio-level ESG scores of PRI signatories hardly deviate from those of non-signatories, casting doubt on how strongly investors' sustainability preferences translate into investment decisions. Our study adds to this literature by showing that the holdings of mutual funds with an explicit ESG mandate react significantly to changes in ESG scores. Thus,

we document that there is a pool of money that responds to ESG rating changes, but that this pool of money is several magnitudes smaller than the combined assets of PRI signatories.

Second, our study contributes to the literature investigating the effects that taste and diverging beliefs have on asset prices. A broad literature on investor sentiment shows that price effects induced by non-rational beliefs about future cash flows and investment risks may not be fully eliminated by arbitrage (Shleifer and Vishny, 1997; Barberis, Shleifer, and Vishny, 1998; Baker and Wurgler, 2007). Related studies investigating the effects of inclusions, exclusions, or reweighting in popular stock market indices show that non-fundamentally driven changes in the demand for certain companies can have persistent stock price effects (Chang, Hong, and Liskovich, 2015; Kaul, Mehrotra, and Morck, 2000; Wurgler and Zhuravskaya, 2002). Very recently, Greenwood, Laarits, and Wurgler (2022) have shown that retail investors' preference for certain stocks exert strong price effects following fiscal stimuli. Thus, preferences for ESG performance may also have stock price effects. Indeed, several recent studies find that changes in ESG ratings affect asset prices on time scales of a few days to a few months. Glück, Hübel, and Scholz (2021) show that downgrades in the environmental and social dimensions of an MSCI ESG rating lead to negative abnormal stock returns within 11 days of a rating change. Shanaev and Ghimire (2022) also document an effect of MSCI rating downgrades over a one-month period. Rzeznik, Hanley, and Pelizzon (2022) show that a profound methodology change in Sustainalytics ESG ratings led to transitory price pressure for firms whose ratings changed the most, pressure that subsided five months after the event. We add to this literature by showing that ESG rating changes seem to have relatively persistent effects on share prices, which is arguably an important condition for knock-on effects on firms' capital expenditure or efforts to reform ESG practices.

Third, we contribute to empirical studies investigating the effect of ESG investing on corporate behavior in the real economy. Addressing the growth channel, Berk and van Binsbergen (2021) argue

that the effect of investors' ESG preferences on the cost of capital is negligible and that the inclusion or exclusion of a firm from a leading ESG index has no detectable effect on the firm's investment decisions. In contrast, Briere and Ramelli (2021) find that in quarters with higher non-fundamental demand for green assets, green firms increase both their capital investments and cash holdings. Our study provides an additional indication that improved ESG performance and the associated interest from ESG investors does not have a measurable effect on the level of corporate investment.

Regarding the reform channel, our study is closely related to that of Gantchev, Giannetti, and Li (2022), who show that firms improve their environmental and social practices following negative news coverage of these practices. While the authors document responses in the environmental dimension that are economically large, we detect no response in the environmental dimension. We only detect a response in the governance dimension, and one that is relatively small. This diverging finding can be due to many factors, including sampling (they study an international sample, as opposed to our U.S. sample), methodological differences, and data sources. While we also provide some support for the effectiveness of the reform channel, our conclusion is more cautious. Based on our results, we conclude that although ESG rating changes have a visible impact in financial markets and one that corresponds to theoretical predictions, these changes' impact on the real economy is barely detectable, at least so far.

2 MSCI ESG Rating Changes

In our study, we investigate the economic impact of changes in the MSCI ESG rating. MSCI is a leading provider of ESG ratings in the U.S. market.[2] The MSCI ESG rating assesses companies' management of financially relevant sustainability risks and opportunities along three dimensions:

[2]As concluded, e.g., in a report by Opimas: http://www.opimas.com/research/742/detail/.

environment (E), social aspects (S), and governance (G). Beneath those three dimensions, MSCI computes scores for 37 "key issues" (e.g., Carbon Emissions, Health and Safety, or Corruption and Instability), basing these scores on a wide variety of indicators sourced from corporate disclosure, internal modeling, and news reports.[3] MSCI evaluates firms' performance with regard to these issues on the one hand based on the firm's exposure to risk (exposure score), and on the other based on the firm's capability to manage risks (management score). For example, a company's exposure to emissions regulation would enter the exposure score, while its capability to drive down and manage emissions would enter the management score. The exposure score and the management score are combined in the issue score. Performance across all issues is aggregated in a raw ESG score, weighted based on MSCI's view of the financial materiality of the different issues. This raw ESG score is then benchmarked against the raw ESG scores of industry peers, resulting in a peer group–adjusted final ESG score. This score ranges from zero to ten, where zero indicates poor management of ESG risks.

Based on this final score, MSCI assigns an ESG rating that sorts companies into seven categories ranging from CCC to AAA, similar to the scales used by credit rating agencies. These seven rating categories are equally spaced with regard to the underlying ESG score; there are six predefined thresholds defining a company's ESG rating. MSCI updates its ESG scores continuously, but does not follow a strict reassessment schedule. When a company's ESG score passes a threshold, its ESG rating changes. MSCI ESG ratings can change for several reasons. First, when a company's ESG practices improve or deteriorate in the view of MSCI analysts. Second, when a company's exposure to specific ESG issues is believed to have increased or decreased. Third, when MSCI's view of the financial relevance of one issue relative to another changes. Fourth, since the final score is benchmarked within industries, when the ESG performance of industry peers changes. Of course, ratings can also change due to any combination of these four factors.

[3]For details, see https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf.

We observe, in a sample of 3,665 listed U.S. corporations, 4,679 rating changes that take place between February 2013 and September 2020. Figure 1 shows the distribution of underlying changes in the numerical ESG score for both up- and downgrades. We observe 2,545 ESG rating upgrades and 2,133 downgrades. Table 1 shows the descriptive statistics of all the firm-level variables that we use in our analysis.

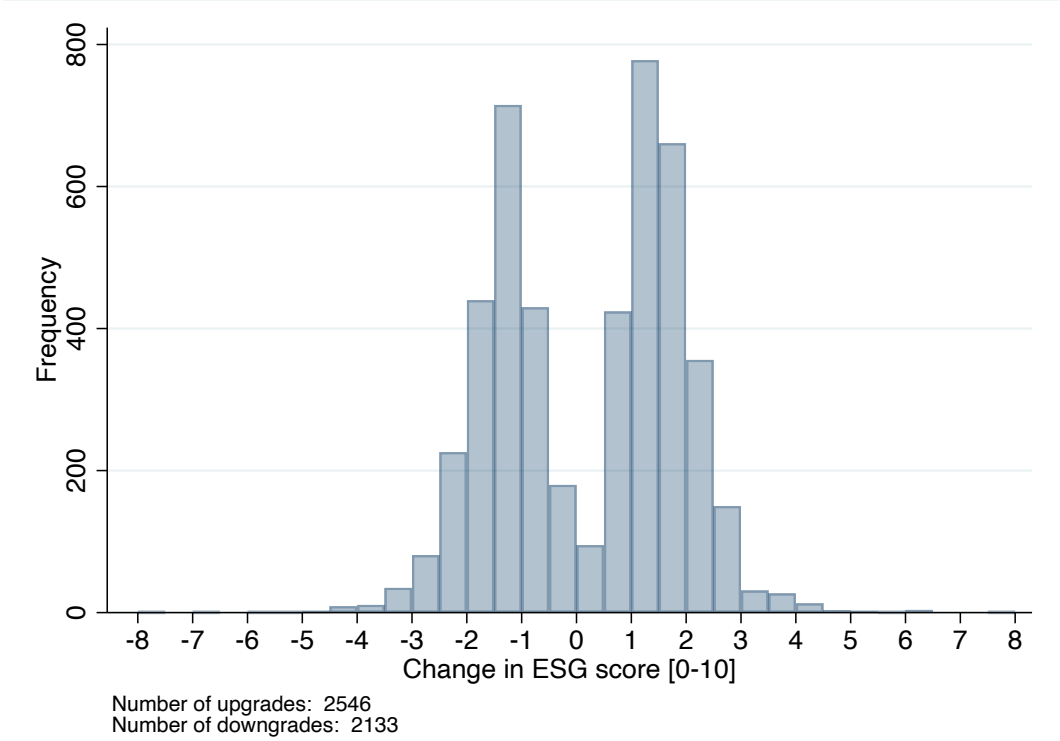

Figure 1. The size of ESG rating changes. This figure shows the distribution of the changes in the underlying ESG score for our sample of ESG rating changes. The ESG score changes are binned with a bin width of 0.5 score points. In total, we observe 2,546 ESG rating upgrades and 2,133 ESG rating downgrades.

Table 1
Descriptive statistics for firm characteristics

This table shows descriptive statistics of the firm-level characteristics we use in our studies. Our sample consists of 3,665 listed U.S. firms with available MSCI ESG rating data. Observations cover the period from February 2013 to September 2020. *ESG ownership* is calculated as the fraction of a company's outstanding shares owned by ESG mutual funds. *ESG weight* is the fraction that a company's shares represent in the portfolio value of a synthetic ESG mutual fund that aggregates the holdings of all ESG mutual funds. We obtain monthly stock returns from the CRSP Monthly Stock database. *ESG-score* is MSCI's assessment of how well companies manage sustainability risks relative to industry peers, on a scale from 1 to 10. *Environmental management score*, *social management score*, and *governance management score* measure a company's management practices, calculated as described in Section 6.1. We calculate *momentum* as the firms' average stock return between twelve and two months prior to an observation. We estimate *market beta* from regressions of monthly returns in excess of the 1-month treasury bill rate on the excess market return. *Capex* is firms' capital investments divided by the one-quarter lagged book value of their property, plants, and equipment in percentage points. *Leverage* is firms' long-term debt plus debt in current liabilities, divided by total assets in percentage points. *Size* is the log of firms' market capitalization. *Book-to-market* is firms' book value of equity divided by the market valuation. *Profitability* is income before extraordinary items over total assets.

	p5	p25	mean	p50	p75	p95	sd	count
Firm-level variables (monthly observations)								
ESG ownership (%)	0.004	0.015	0.063	0.030	0.072	0.234	0.089	200993
ESG weight (%)	0.000	0.001	0.031	0.003	0.015	0.171	0.088	200993
Monthly return	-0.149	-0.045	0.007	0.008	0.059	0.161	0.098	178317
ESG-score [0–10]	1.500	2.858	4.222	4.100	5.500	7.600	1.911	204995
Environmental management score [0–10]	0.000	1.700	3.351	2.717	4.300	8.000	3.083	150933
Social management score [0–10]	1.250	2.417	3.345	3.200	4.200	5.800	1.368	150921
Governance management score [0–10]	2.900	4.200	5.336	5.200	6.350	8.500	1.676	150933
Momentum	-0.043	-0.007	0.008	0.009	0.024	0.053	0.032	175060
Market beta	0.204	0.666	1.051	1.004	1.369	2.068	0.594	181847
Firm-level variables (quarterly observations)								
Capex	0.701	2.455	6.417	4.280	7.343	16.412	19.195	63862
Leverage	0.000	9.014	27.486	24.847	40.167	67.351	23.499	62640
Size	5.627	6.780	7.925	7.773	8.903	10.847	1.606	67716
Book-to-market	0.033	0.221	4.127	0.415	0.691	1.292	581.438	67669
Profitability	-5.051	0.106	0.963	0.755	1.824	4.359	79.992	67680

3 Do ESG Rating Changes Affect Stock Ownership?

In this section, we explore how ESG rating changes affect the holdings of dedicated ESG mutual funds. To do so, we run a panel event study with a measure of ESG ownership, showing that companies' ownership by domestic U.S. mutual equity funds with an explicit ESG objective reacts to both ESG rating upgrades and downgrades.

3.1 ESG Ownership

We define the variable *ESG ownership* as the fraction of a company's outstanding shares that is owned by funds with an explicit ESG or sustainability strategy. We identify ESG mutual funds by screening mutual funds' names and strategies for a set of ESG-related keywords.[4] We restrict our search to domestic U.S. equity funds that follow a capitalization, growth, growth-&-income, or income-based strategy. For each company covered by our sample of ESG rating changes, we compute the aggregate number of shares owned by the identified ESG mutual funds based on the CRSP U.S. Mutual Fund Holdings database. We retrieve the total number of shares outstanding for each company in our sample from the CRSP Monthly Stock database. We calculate *ESG ownership* by dividing the number of a company's shares owned by ESG mutual funds by the company's total number of shares outstanding. To reduce the effect of outliers, we trim the variable *ESG ownership* at the 1st and 99th percentiles for each month. *ESG ownership* provides a measure of how strongly ESG mutual funds concentrate their holdings in specific companies. For example, the identified ESG mutual funds jointly owned 0.15 percent of Tesla's stocks in September 2020.

The average proportion of shares owned by ESG mutual funds increases in the course of our sampling period. Figure 2 shows the temporal development of the average level of *ESG ownership* within our sample. While the percentage of companies' shares owned by ESG mutual funds was rather constant between 2013 and 2017, the figure experienced substantial growth between 2018 and 2020. The overall share of stocks owned by dedicated ESG mutual funds remains, however, limited: in September 2020, at the end of our sampling period, the share of the market

[4]Specifically, we define ESG mutual funds as funds that use any of the following letter sequences in their title or strategy description: "SRI," "social," "ESG," "green," "sustain," "environ," "impact," "responsible," "clean," and "renewable."

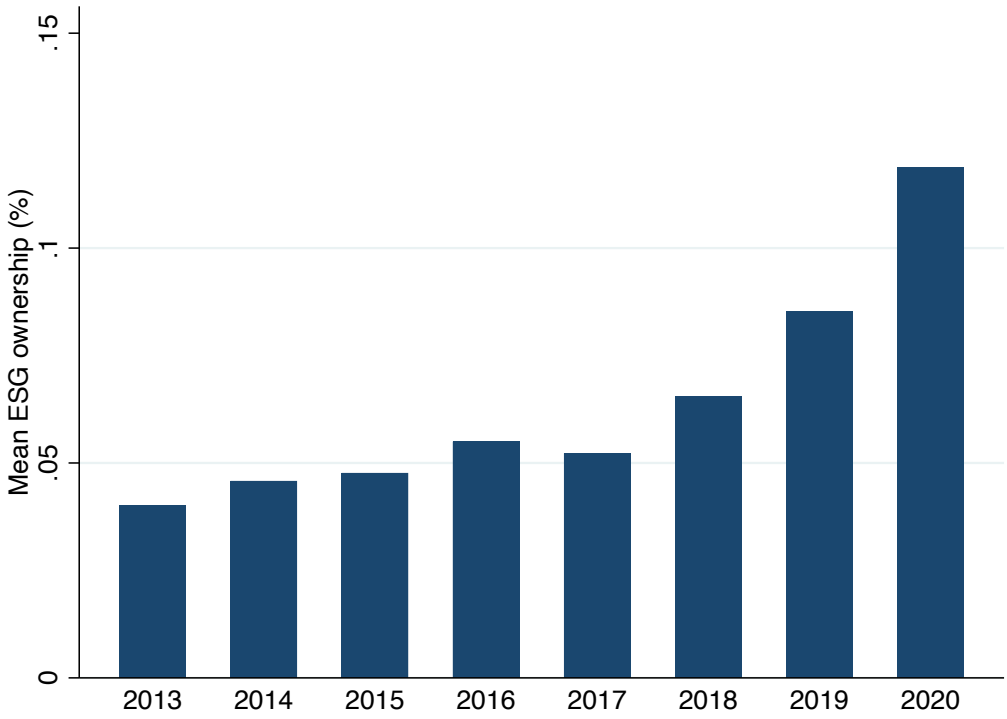

Figure 2. ESG ownership over time. This figure shows the temporal development of firms' average level of *ESG ownership*, from 2013 to 2017, in percentage points. *ESG ownership* is calculated as the fraction of a company's outstanding shares owned by ESG mutual funds.

capitalization of companies within our sample owned by ESG mutual funds amounts to USD 71 billion, compared to a total market capitalization of these firms of USD 36 trillion.

In the cross-section, *ESG ownership* tends to be higher for companies with a high ESG score; there is, however, substantial variation on the level of individual companies. Figure 3 plots companies' *ESG ownership* in September 2020 against their MSCI ESG score. There is a significant positive correlation between the two variables ($p<0.001$). However, we cannot make any causal inference from this correlation. It is, for example, possible that large companies, on

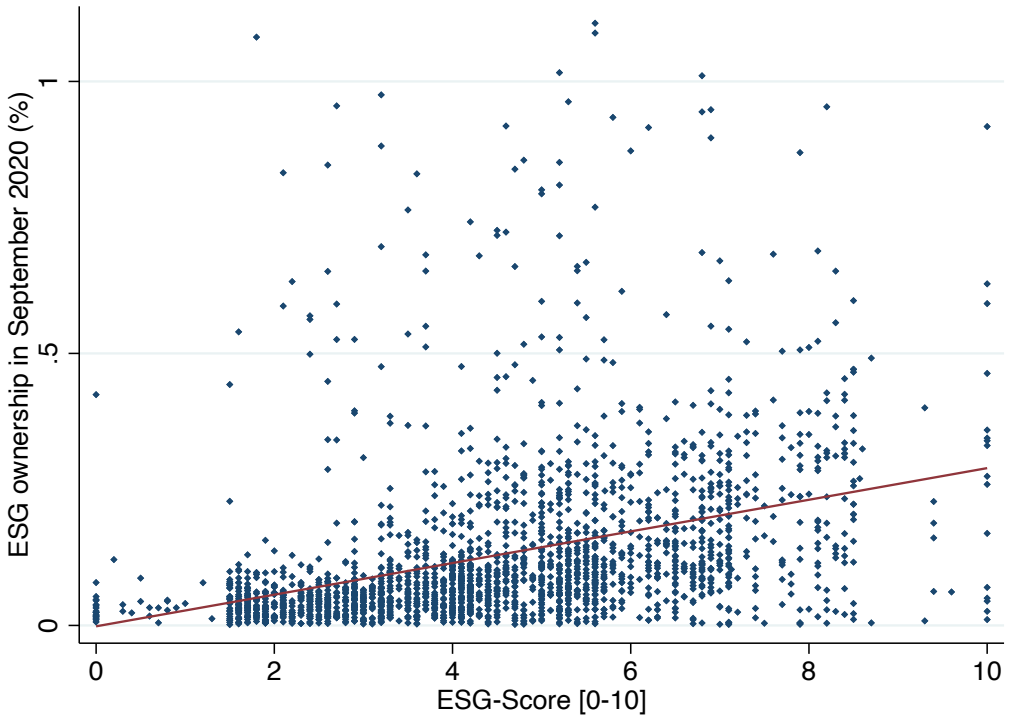

Figure 3. ESG ownership and ESG scores. This figure plots the distribution of firm-level *ESG ownership* against firms' ESG scores in the cross-section, for September 2020. The red line shows a linear correlation between the two variables at this date.

average, have better ESG ratings and are over-represented in ESG mutual funds. ESG mutual funds may also invest early in companies that later obtain favorable ESG ratings. To investigate whether mutual funds do indeed respond to ESG ratings, we analyze the effect of ESG rating changes in a panel event study design.

3.2 Analytical Methodology

We analyze the effect of ESG rating changes on ESG ownership using a panel event study model (Schmidheiny and Siegloch, 2019; Clarke and Tapia-Schythe, 2021; Freyaldenhoven, Hansen, Pérez, and Shapiro, 2021). A panel event study is a specific form of a staggered difference-in-difference design, which allows the estimation of dynamic treatment effects—that is to say, we do not have to make any restrictive assumptions regarding how and when the anticipated effects unfold; instead, we obtain non-parametric estimates of the treatment effect of the event on the outcome in any pre- and post-event period. Treatment effects of events are calculated against the counterfactual of "untreated" firms, which do not experience a rating change at the same time. The identifying assumption is that treated units would have behaved like untreated units had they not been treated. An important plausibility check for this assumption is a parallel trend of the outcome variable prior to the event for both treated and untreated firms. In addition to this, the panel event study specification accommodates firm and time fixed effects.[5]

We jointly estimate the effect of both MSCI ESG rating upgrades and downgrades on *ESG ownership*. Accordingly, we define dummy variables indicating the occurrence of ESG rating upgrades, (u_{it}), and downgrades, (d_{it}), at a specific company i at a specific month t:

$$u_{it} = \mathbb{1}[t \in \{\upsilon_{i,1},...,\upsilon_{i,n}\}] \tag{1}$$

$$d_{it} = \mathbb{1}[t \in \{\delta_{i1},...,\delta_{in}\}]. \tag{2}$$

[5]Given that ESG rating changes are relatively rare events, panel regressions with ESG ratings as a regressor usually do not perform well with firm fixed effects.

Here, δ_{i1} to δ_{in} denote the time periods (months, in this case) in which the company, i, receives an ESG downgrade, and $\upsilon_{i,1}$ to $\upsilon_{i,n}$ the periods in which it receives an upgrade.

To estimate the effect of ESG rating changes on *ESG ownership* we use the following specification:

$$y_{it} = \sum_{j=\underline{j}-1}^{j=\bar{j}+1} \beta_j b_{it}^j + \sum_{j=\underline{j}-1}^{j=\bar{j}+1} \gamma_j c_{it}^j + \mu_i + \theta_t + \varepsilon_{it}. \tag{3}$$

Here, y_{it} denotes the level of *ESG ownership* as described above; μ_i and θ_t are firm and month fixed effects, respectively. The unobserved error term is denoted by ε_{it}. Leads and lags for rating changes within treatment windows, ranging from $\underline{j}$ periods prior to the event to $\bar{j}$ periods after the event, are denoted by the variables b_{it}^j (for upgrades) and c_{it}^j (for downgrades). These are binary variables indicating whether a certain firm, i, is j periods away from a rating change in the time period t. As suggested by Schmidheiny and Siegloch (2019), we bin treatment leads and lags that exceed $\underline{j}$ periods before or $\bar{j}$ periods after an event to alleviate potential underidentification issues. We define b_{it}^j and c_{it}^j as

$$b_{it}^j = \begin{cases} \sum_{s=t-\underline{j}+1}^{\bar{t}} u_{is} & \text{if} \quad j=\underline{j}-1 \\ u_{i,t-j} & \text{if} \quad \underline{j} \leq j \leq \bar{j} \\ \sum_{s=\underline{t}}^{t-\bar{j}-1} u_{is} & \text{if} \quad j=\bar{j}+1 \end{cases} \tag{4}$$

$$c_{it}^j = \begin{cases} \sum_{s=t-\underline{j}+1}^{\bar{t}} d_{is} & \text{if} \quad j=\underline{j}-1 \\ d_{i,t-j} & \text{if} \quad \underline{j} \leq j \leq \bar{j} \\ \sum_{s=\underline{t}}^{t-\bar{j}-1} d_{is} & \text{if} \quad j=\bar{j}+1. \end{cases} \tag{5}$$

Here, $\underline{t}$ is the first time period in our panel, and $\bar{t}$ the last one. To investigate the effect of ESG rating changes on *ESG ownership* we consider a treatment window ranging from $\underline{j}=12$

months prior to a rating change to $\bar{j}=24$ months after a rating change. Following the standard approach, we omit $b_{it}^{j=-1}$ and $c_{it}^{j=-1}$ from the regression, which normalizes the remaining lead and lag coefficients to the level of our dependent variable one time period before the event. Thus, the coefficients of interest, $\beta_{j=0}$ to $\beta_{j=24}$ as well as $\gamma_{j=0}$ to $\gamma_{j=24}$, reflect the effect ESG rating upgrades and downgrades have on *ESG ownership* within the two years following an event, relative to its level one period before the event. Setting the post-event treatment window to two years allows us to capture relatively long-term effects of rating changes while keeping the treatment window in reasonable proportion to our sampling period.

Estimating coefficients for pre-event treatment leads, $\beta_{j=-12}$ to $\beta_{j=-2}$, as well as $\gamma_{j=-12}$ to $\gamma_{j=-2}$, allows us to assess the presence of pre-event trends in our dependent variable. While the absence of a pre-event trend does not prove that this assumption is justified, it makes such an assumption more plausible. We cluster standard errors both at the firm and at the month level to allow for autocorrelation within both dimensions (Petersen, 2009).

3.3 Results, Stock Ownership

ESG rating upgrades and downgrades have a long-term effect on *ESG ownership*, as shown in Figure 4. *ESG ownership* increases significantly after ESG rating upgrades and decreases significantly after ESG rating downgrades. The increase in *ESG ownership* is significant from the first month after an ESG rating upgrade. ESG rating downgrades show a significant effect after seven months. On average, two years after an upgrade ESG ownership is 17.1% higher than one month before the upgrade. Vice versa, ESG ownership is 13.1% lower two years after a downgrade compared to one month before the downgrade.

The adjustment in ESG ownership we observe following ESG rating changes happens relatively slowly, but it is persistent. Rather than adjusting immediately after a rating change, ESG ownership increases (respectively decreases) more or less gradually within the first two years following a rating change. We find that this adjustment is persistent. First, this is evident visually in Figure 4. Second, the coefficient for the post-event-windows bin for upgrades ($b_{it}^{j=25}$, which sums all upgrade lags beyond 24 months) is significantly positive, and the coefficient for the post-event-windows bin for downgrades ($c_{it}^{j=25}$) is significantly negative.

We do not observe any pre-event trends in *ESG ownership*, which is an important basis for interpreting the relationship between the ESG rating changes and the changes in *ESG ownership* as being a causal one. For both ESG rating upgrades and downgrades, we do not detect any significant differences in the level of *ESG ownership* between the month prior to an ESG rating change and the 11 months before. Also, we do not observe any evident trends in *ESG ownership* in the year before a rating change. While this does not prove the identification assumption that treated units would have followed a similar trend as untreated firms in the period after an event, it makes it unlikely that the observed effect is caused by factors other than ESG rating changes or concurrent confounding events. The lack of differences and trends prior to the event also helps to rule out that the observed effects are driven by non-concurrent changes in time-variant confounds. For example, if an improvement in management quality results in both increased ESG performance and increased *ESG ownership*, this should show up as a pre-event trend, as it likely would take a prolonged time until the improved management results in a rating upgrade. The only candidate for a plausible concurrent confounding event we can conceive of are media scandals regarding ESG-related issues at the same time as the ESG rating change. If firms are exposed in the press for poor ESG practices, this may trigger an ESG rating downgrade and reduce ESG ownership at the same time. One observation that speaks against this possibility is that the effects of up- and downgrades are nearly symmetric. While

negative news exposure with regard to ESG issues may be a reasonable explanation for downgrades, it is unlikely to trigger upgrades in the same way. Also, even if concurrent ESG-related media scandals were partly responsible for the observed effects, it would still mean that ESG mutual funds adjust their holdings based on novel information, which is reflected in the ESG ratings change.

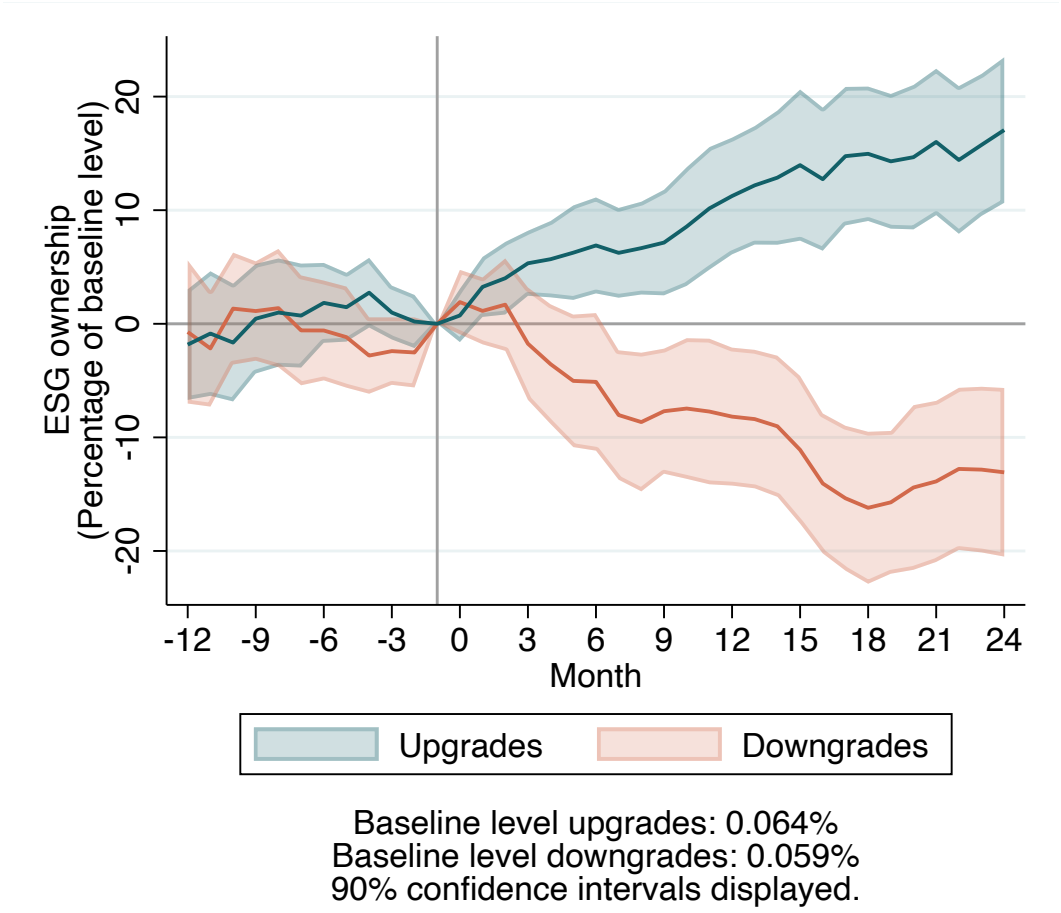

Figure 4. The reaction of ESG ownership to ESG rating changes. This figure shows the results of a panel event study with firms' level of *ESG ownership* as the dependent variable and up- and downgrades in the MSCI ESG rating as events. The observation period is February 2013 to September 2020. The figure shows regression coefficients for all treatment leads and lags from 12 months prior to the event to 24 months after. Coefficients are normalized to the baseline level, i.e., the average level of *ESG ownership* one month before a rating change. Coefficients are shown in percentage points of this baseline level. Confidence intervals are based on standard errors clustered at the firm and the month level.

To further explore why ESG mutual funds adjust their holdings in response to ESG rating changes, we run a series of regressions, finding that the nature of ESG rating changes does not significantly affect ESG mutual funds' reaction. Table 2 shows the regression coefficients for the 12-month post-event lag for ESG rating upgrades and downgrades. Focusing on the 12-month post-event lag allows us to assess how rating changes affect *ESG ownership* within the one year following such changes. Whereas specification (1) corresponds to the initial model as described in 3.2, specifications (2) to (5) add interactions between the 12-month post-event lag and indicator variables with regards to specific characteristics of the rating changes and their timing.

First, specification (2) explores whether the magnitude of the change in the numeric score that underlies the rating categories plays a role. Ratings can change due to small changes that barely cross the threshold to the next category, but they can also change due to large changes that go far beyond the threshold. The variable *High ESG score change* is a dummy variable indicating whether the change in the underlying ESG score that triggers an ESG rating upgrade is greater or equal to the median of all score changes leading to upgrades. For downgrades, it indicates whether the absolute change in the underlying ESG score is greater or equal to the median of all score changes leading to downgrades. There is no significant correlation between the interaction of the 12-month post-event lags with *High ESG score change* and *ESG ownership*. This suggests that ESG mutual funds are more sensitive to changes in the rating categories than to changes in the underlying scores.

Second, we show, in specification (3), that the ESG rating changes that shift companies into MSCI's ESG "leader" or "laggard" categories do not have a significantly different effect on *ESG ownership* than do other rating changes. MSCI classifies companies with an ESG rating of CCC or B as ESG "laggards" and ones with an ESG rating of AAA or AA as "leaders," arguably adding an even stronger signal on top of the letter ratings. Accordingly, the dummy variable *Leader* indicates rating changes where a company is upgraded into the "leader" category, and the dummy

variable *Laggard* ones where a company is downgraded into the "laggard" category. We do not find a significant correlation between the interaction of the 12-month post-event lag with *Leader* or *Laggard* and *ESG ownership*. This suggests that although a rating change has significant consequences for *ESG ownership*, a transition to the "leaders" or "laggards" category does not trigger a qualitatively different reaction from ESG mutual funds.

Third, we show that ESG rating changes that are associated with a higher level of changes in companies' ESG management practices do not significantly differ in their effect on *ESG ownership* from other rating changes. As discussed in Section 2, MSCI ratings can change for various reasons. To see whether there is a specific effect when companies adjust their management practices (as opposed to changes in risk exposure, the materiality assessment, or the peer benchmark), we run specification (4). The dummy variable *High ESG practice change* indicates ESG rating upgrades that feature a median or above change in the average of our E, S, and G management practice scores as described in detail in Section 6.1. It also indicates ESG rating downgrades that feature a median or above absolute change in this score. Again, there is no significant correlation between the interaction of the 12-month post-event lags with *High ESG practice change* and *ESG ownership*, suggesting that ESG funds do not put particular emphasis on why ESG ratings change.

Finally, we show that the effect that ESG rating changes have on *ESG ownership* does not significantly change over time. The dummy variable *Post 2016* indicates rating changes in the years after 2016, dividing the time period covered by our panel into two periods of similar length. Yet the interaction of the 12-month post-event lags with *Post 2016* does not significantly correlate with *ESG ownership*.

Summing up, we find that changes in companies' ESG ratings have a substantial effect on how many of their shares are owned by mutual funds with an explicit ESG strategy. This indicates that

ESG mutual funds do indeed react to changing ESG ratings: They increase their stock holdings following upgrades and decrease them following downgrades. These changes happen relatively slowly, and they accumulate over a period of two years. However, the nature of an ESG upgrade or downgrade does not seem to play an important role when it comes to how strongly ESG mutual funds adjust their portfolios. We do not find significant effects of how large the underlying change in companies' ESG scores is, whether a company enters the ESG "Leader" or "Laggard" category, or whether change is associated with a high level of change in corporate practices. Neither does the effect increase over time.

Table 2
ESG ownership and ESG rating change characteristics

This table shows the results of a panel event study with *ESG ownership* as the dependent variable and MSCI ESG rating up- and downgrades between February 2013 and September 2020 as events. All specifications include treatment leads and lags for the occurrence of ESG rating upgrades and downgrades, i.e., dummy variables indicating that a rating change takes place a specific number of months before (lags) or after (leads) a given observation. Coefficients are normalized to the level of *ESG ownership* one month before a rating change. All specifications include time and firm fixed effects. Specification (1) shows the coefficients for the 12-month lags of ESG downgrades and upgrades, estimating the reaction *ESG ownership* shows to ESG rating changes. Specification (2) interacts these lags with *High ESG score change*, a dummy variable indicating whether the change in the underlying ESG score that triggers an ESG rating change is greater or equal to the median of all score changes leading to changes. Specification (3) includes interactions of the 12-month lags with *Leader* or *Laggard*, dummy variables indicating whether a firm is upgraded into the "Leader" category of MSCI (AAA and AA) or downgraded into the *Laggard* category (CCC and B). Specification (4) includes interactions of the 12-month lags with *High ESG practice change*, which indicates whether an ESG rating change coincides with a median or above change in the average of our ESG management practice scores, as described in Section 6.1. Specification (5) includes interactions of the 12-month lags with the dummy variable *Post 2016*, indicating that a rating change takes place after 2016. t statistics are based on standard errors clustered at the firm and month level shown in parentheses. Stars mark coefficient estimates that are significantly different from zero (* $p<0.10$, ** $p<0.05$, *** $p<0.01$).

	(1)	(2)	(3)	(4)	(5)
	ESG ownership	*ESG ownership*	*ESG ownership*	*ESG ownership*	*ESG ownership*
Downgrade (12-month lag)	-0.0000483**	-0.0000499**	-0.0000445	-0.0000551**	-0.0000488**
	(-2.21)	(-2.01)	(-1.58)	(-2.34)	(-2.18)
Upgrade (12-month lag)	0.0000715***	0.0000626***	0.0000640***	0.0000790***	0.0000654***
	(3.60)	(2.71)	(3.18)	(3.54)	(3.00)
Downgrade (12-month lag) x *High ESG score change*		0.00000299			
		(0.10)			
Upgrade (12-month lag) x *High ESG score change*		0.0000174			
		(0.56)			
Downgrade (12-month lag) x *Laggard*			-0.00000978		
			(-0.23)		
Upgrade (12-month lag) x *Leader*			0.0000807		
			(1.26)		
Downgrade (12-month lag) x *High ESG practice change*				0.0000145	
				(0.61)	
Upgrade (12-month lag) x *High ESG practice change*				-0.0000177	
				(-0.77)	
Downgrade (12-month lag) x *Post 2016*					0.000000920
					(0.02)
Upgrade (12-month lag) x *Post 2016*					0.0000170
					(0.57)
Firm FE	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
Pre-event leads	Yes	Yes	Yes	Yes	Yes
Post-event lags	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.538	0.538	0.538	0.538	0.538
N	200950	200950	200950	200950	200950

3.4 Robustness

We corroborate the finding that ESG rating changes affect the holdings of ESG mutual funds in two robustness checks. First we confirm this finding using an alternative measure of ESG mutual funds' ownership of companies. Second, we run a placebo test, which shows that we do not find any significant effects for randomized event dates.

We define *ESG weight* as the fraction that a company's shares represent in the portfolio value of a synthetic ESG mutual fund that aggregates the holdings of all ESG mutual funds in our sample. As shown in Figure 2, *ESG ownership* increases over time, especially after 2017, reflecting the strong growth of the market for ESG investments. Although we control for time trends by including month fixed effects, this may raise some concerns with respect to our measurement of ESG mutual funds' ownership, especially regarding the upward trend following upgrades. *ESG weight* provides an alternative measurement of ESG mutual funds' ownership that is not directly affected by the growing volume of assets owned by ESG mutual funds. We use the same keyword search as described in Section 3.2 to identify U.S. domestic equity funds with an explicit ESG strategy based on the CRSP U.S. Mutual Fund Holdings database. Again, we compute the total number of companies' shares held by ESG mutual funds using this database for each month. In addition, we calculate the corresponding share of companies' market capitalization owned by these funds using stock price data from the CRSP Monthly Stock database. Further, we calculate the total market capitalization owned by all identified ESG mutual funds combined, based on the two databases, for each month. We define *ESG weight* as a company's market capitalization that is held by ESG mutual funds in a given month, divided by the total market capitalization held by ESG mutual funds in the same month.

The effect ESG rating changes have on *ESG weight* is very similar to that observed for *ESG ownership*. Figure A.1 summarizes the results of a panel event study investigating the effect

ESG rating changes have on *ESG weight*, applying the same specifications as for the study of *ESG ownership*. The results confirm our findings that ESG rating upgrades lead to a persistent increase in companies' weight within ESG mutual funds and that downgrades decrease this weight. Whereas the relative effect sizes are of a similar magnitude as for *ESG ownership*, the confidence intervals of the estimates are somewhat larger.

Next we run a placebo test. We generate random placebo upgrade and downgrade events. To do so, we set the probability of an upgrade taking place for a given company–month such that it generates roughly 2,500 events in total. We repeat the same procedure for downgrades. This gives us a number of randomized upgrades and downgrades close to the number of ESG rating changes that we observe in our sample. We apply the same panel event study method as described in Section 3.2. The results we obtain in this manner are summarized in Figure A.2. We do not find any significant effects of the placebo events on *ESG ownership*. This indicates that the effects we observe are unlikely to be artifacts of our method. Further, it provides reassurance that the observed patterns are not simply a property of the sample.

4 Do ESG Rating Changes Affect Stock Returns?

Next, we explore how ESG rating changes affect the stock returns of affected companies. We run a series of panel event studies with buy-and-hold returns (BHRs) with different holding periods as the dependent variables, showing that companies' stock returns react to ESG rating changes, particularly to downgrades.

4.1 Analytical Methodology

For each observation in our panel, we calculate BHRs for different forward-looking holding periods τ. The holding periods range from $\tau = 0$, which covers only the month of the event, to $\tau = 24$, which covers the event month and the following 24 months. We calculate the BHRs based on monthly stock returns obtained from the CRSP Monthly Stock database, which we trim at the 1st and 99th percentiles for every month.

As opposed to *ESG ownership*, the BHR is a cumulative measure, covering several time periods, and the underlying return data reflects changes in value rather than the level of stock prices. Thus, we have to use a different model specification for BHRs. Instead of estimating a single model including pre- and post-event leads and lags, we estimate an individual model for each holding period τ:

$$BHR_{\tau,it} = \sum_{j=-\tau}^{j=\tau} \beta_{j\tau} b_{it}^{j} + \sum_{j=-\tau}^{j=\tau} \gamma_{j\tau} c_{it}^{j} + \mu_{i\tau} + \theta_{t\tau} + X_{it}'\psi_{\tau} + \varepsilon_{it\tau}. \tag{6}$$

Here, $\mu_{i\tau}$ and $\theta_{t\tau}$ are firm and month fixed effects, $\varepsilon_{it\tau}$ denotes the unobserved error term, and X_{it} is a vector of firm-level time-varying controls with coefficients ψ_{τ}, as described in detail below. For this specification, we define b_{it}^{j} as $u_{i,t-j}$ and c_{it}^{j} as $d_{i,t-j}$. Again, $u_{i,t-j}$ is a dummy variable indicating the occurrence of a ESG rating upgrade at a specific company i at a specific month $t-j$, while $d_{i,t-j}$ indicates a rating downgrade, as defined in Equations 1 and 2.

The variables of interest are $b_{it}^{j=0}$ and $c_{it}^{j=0}$. These variables indicate whether an upgrade or a downgrade takes place for a firm i in month t. We also include pre- and post-event lags, $b_{it}^{j\neq 0}$ and $b_{it}^{j\neq 0}$, to control for the fact that τ-month BHRs for observations less than τ months before or after an event overlap with the holding period of interest. Not including controls for these observations

may bias our estimates downward.[6] Thus, the coefficients $\beta_{j\tau}$ and $\gamma_{j\tau}$ estimate "abnormal" BHRs for a holding period τ that companies experience after a rating upgrade or downgrade, relative to all other τ-month BHRs of observations that are at least τ months away from a rating change, controlling for month and firm fixed effects, as well as for time-variant firm-level characteristics.

Similar to Bolton and Kacperczyk (2021a,b), as well as Briere and Ramelli (2021), we control for the following time-variant firm characteristics, based on quarterly accounting data obtained from the Compustat North America Fundamentals Quarterly database: *leverage* (long-term debt plus debt in current liabilities, divided by total assets, in percentage points), *size* (log(market capitalization)), *book-to-market* (book value of equity divided by market valuation), and *profitability* (income before extraordinary items over total assets). In addition, for each observation we estimate *market beta* from regressions of monthly returns in excess of the 1-month treasury bill rate on the excess market return. For this, we use an estimation window reaching back 48 months prior to the observation. Further, we calculate *momentum* as the firms' average stock return between twelve and two months prior to the observation, following Bessembinder, Cooper, and Zhang (2019). Again, we cluster standard errors both at the firm and at the month levels. We trim these variables at the 1st and 99th percentiles for each month and lag them by one month.

To evaluate the presence of pre-event trends in the BHRs, we run the model as specified in Equation 6 with all ESG rating upgrade and downgrade event dates moved forward in time by 12 months, for holding periods from $\tau=0$ to $\tau=11$. This specification provides us with estimates for $\beta_{j\tau}$ and $\gamma_{j\tau}$ for "placebo" events taking place one year prior to the real events, with holding periods up to one month prior to the real events. This allows us to detect the presence of abnormal BHRs in the year prior to the event.

[6] Our findings are robust to excluding these leads and lags, as shown in A.4; however, the estimated coefficients for $\beta_{j\tau}$ and $\gamma_{j\tau}$ are substantially lower.

4.2 Results, Stock Returns

We find that ESG rating downgrades affect stock returns. Figure 5 shows the results of panel event studies investigating the effects of rating changes on buy-and-hold returns with different holding periods. ESG rating downgrades have a pronounced negative effect on BHRs. This effect is significant for holding periods of up to two years following an ESG rating downgrade. We observe the strongest negative abnormal BHRs 19 months after a downgrade, amounting to -3.78%. This corresponds to an annualized abnormal return of -2.37%. Compared to the average annualized return within our sample, of 8.98%, this is economically meaningful. We also find a positive reaction of BHRs to ESG rating upgrades; the effect, however, is weaker and takes longer to materialize than for downgrades. After an (insignificant) initial decrease in BHRs with holding periods of around six months following upgrades, the effect becomes positive for holding periods of over ten months. We detect significantly positive abnormal BHRs for holding periods of 17, 20, and 22 months, reaching a maximum abnormal BHR of 2.62% (1.42% p.a.) on average after 22 months.

We do not identify any evident pre-trends in BHRs before ESG rating changes, which supports a causal interpretation of the stock return reactions we observe. Looking at the BHRs for the placebo events 12 months in advance of the real rating changes, we do not observe any significant abnormal BHRs for holding periods of up to one month before the real events. While this indicates that the observed abnormal BHRs are caused by the ESG rating changes, again we cannot fully rule out the possibility of concurrent confounding events. However, as discussed above, the only candidate apparent to us—namely, concurrent media scandals regarding ESG issues—does not fundamentally change the interpretation of our results.

Additional regression analyses focused on the 12-month horizon are shown in Table 3, showing that the abnormal stock returns following ESG rating downgrades are significantly higher in the

years after 2016, while the nature of rating changes does not significantly affect these abnormal returns. Specification (1) corresponds to the initial model, as described in Equation 6, where we find a significant negative effect of downgrades and no significant effect for upgrades. We add interactions between upgrade and downgrade indicators ($b_{it}^{j=0}$ and $c_{it}^{j=0}$) and indicator variables regarding different characteristics of the rating changes and their timing. Specification (2) shows that the size of a rating change does not significantly affect the effect rating upgrades and downgrades have on 12-month BHRs (*High ESG score change*). As shown by specification (3), rating changes that take companies into the "leader" or "laggard" categories do not significantly differ in their effect size from the remaining rating changes (*Leader* or *Laggard*). Also, the effect size of rating changes that are associated with higher levels of change in companies' ESG management practices does not significantly differ from ones with a lower level (*High ESG practice change*), as shown by specification (4). Finally, specification (5) shows that while there is a significant negative effect of downgrades on 12-month BHRs from 2013 to 2016, this effect is significantly stronger from 2017 to 2020.

Summing up, we find that ESG rating downgrades lead to significantly reduced stock returns for a period of up to two years following a rating change and that this reduction is economically meaningful. For ESG rating upgrades, we find a weaker and slower significant positive effect on stock returns. Again, the nature of ESG upgrades or downgrades does not seem to greatly affect how stock markets react to such rating changes. Yet we find that the negative effect of downgrades on stock returns has become larger over time.

4.3 Robustness

We corroborate our finding on the effects ESG rating changes have on stock returns by running a placebo test, in which we do not detect any significant effects on stock returns for randomized

event dates. Again, we generate random placebo upgrade and downgrade events. To do so, we set the probability of an upgrade taking place for a given company such that it generates roughly 2,500 events in total. We repeat the same procedure for downgrades. We apply the model specification for BHRs as described in Section 4.1. Figure A.3 summarizes the results we obtain in the placebo test. We do not find any significant effects of the placebo events on BHRs, indicating that the observed effects are not an artifact of the analytical method or an inherent property of our sample.

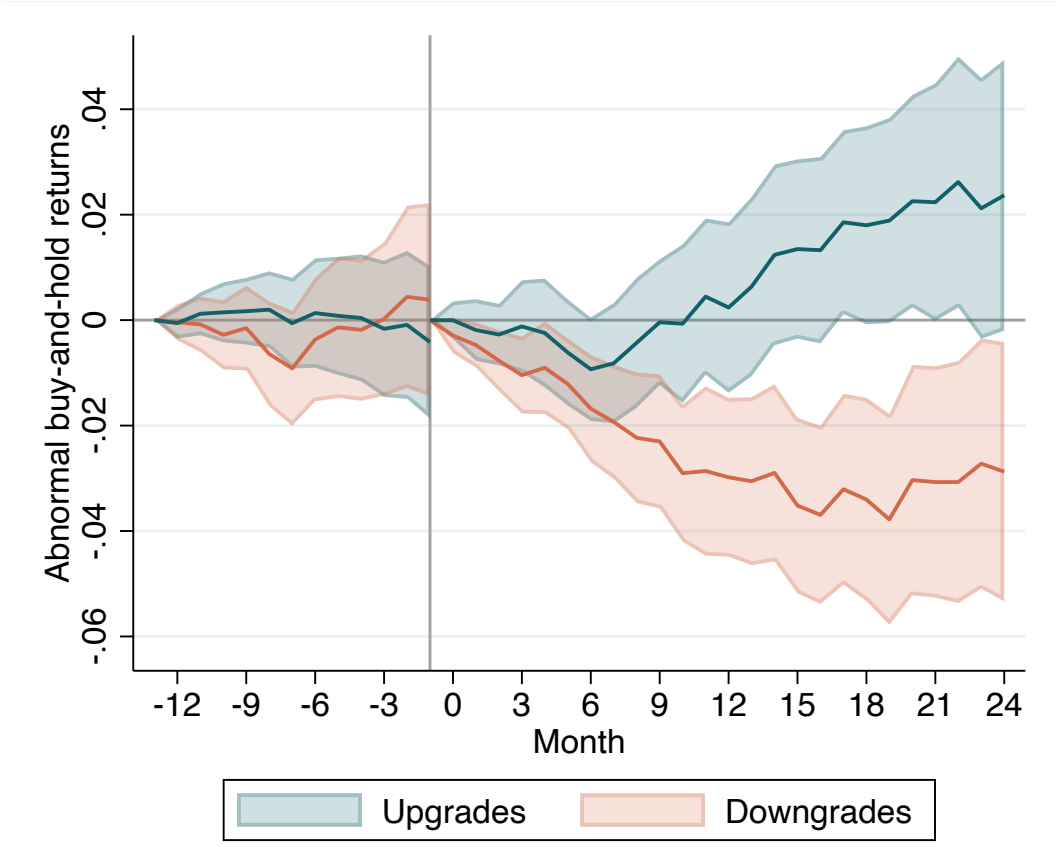

Figure 5. The reaction of stock returns to ESG rating changes. This figure shows the results of a series of panel event studies with BHRs for different holding periods as the dependent variables and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. For the months greater or equal to zero, the graph displays the abnormal BHRs for holding periods of up to 24 months (corresponding to $\beta_{j\tau}$ and $\gamma_{j\tau}$ in Equation 6). For the months smaller than zero, the graph displays abnormal BHRs following placebo events 12 months prior to real events, for holding periods of up to one month prior to the real events. All panel event studies include treatment leads and lags covering a time period corresponding to the holding period before and after ESG rating upgrades and downgrades, as well as firm and month fixed effects and lagged time-variant firm-level controls. Confidence intervals are based on standard errors clustered at the firm and at the month level.

Table 3
Stock returns and ESG rating change characteristics

This table shows the results of a panel event study with 12-month BHRs as the dependent variable and MSCI ESG rating changes between February 2013 and September 2020 as events. Specification (1) shows coefficients for *Upgrade* and *Downgrade*, dummy variables indicating that a corresponding rating change takes place in a given month. Specification (2) includes interactions of these indicators with *High ESG score change*, a dummy variable indicating whether the change in the underlying ESG score that triggers an ESG rating upgrade is greater or equal to the median of all score changes leading to upgrades. Specification (3) includes interactions with *Leader* or *Laggard*, dummy variables indicating whether a firm is upgraded into the "Leader" category of MSCI or downgraded into the "Laggard" category. Specification (4) includes interactions with *High ESG practice change*, which indicates whether an ESG rating change features a median or above change in the average of our ESG management practice scores, as described in Section 6.1. Specification (5) includes with the dummy variable *Post 2016*, indicating rating changes that take place after 2016. All specifications include treatment leads and lags 12 months before and after ESG rating changes, as well as firm and month fixed effects and lagged time-variant firm-level controls. t statistics based on standard errors clustered at the firm and month level are shown in parentheses. Stars mark coefficient estimates that are significantly different from zero (* $p<0.10$, ** $p<0.05$, *** $p<0.01$).

	(1)	(2)	(3)	(4)	(5)
	Buy-and-hold return t+12	*Buy-and-hold return t+12*	*Buy-and-hold return t+12*	*Buy-and-hold return t+12*	*Buy-and-hold return t+12*
Downgrade	-0.0242***	-0.0224**	-0.0255***	-0.0293***	-0.0150**
	(-3.12)	(-2.16)	(-2.79)	(-3.15)	(-2.12)
Upgrade	0.00339	0.000768	0.00266	0.00901	-0.00233
	(0.37)	(0.08)	(0.26)	(0.81)	(-0.20)
Downgrade x *High ESG-Score Change*		-0.00346			
		(-0.30)			
Upgrade x *High ESG-Score Change*		0.00533			
		(0.37)			
Upgrade x *Leader*			0.00749		
			(0.32)		
Downgrade x *Laggard*			0.00347		
			(0.31)		
Downgrade x *High ESG-Practice Change*				0.0108	
				(0.82)	
Upgrade x *High ESG-Practice Change*				-0.0132	
				(-1.05)	
Downgrade x *Post 2016*					-0.0488**
					(-2.59)
Upgrade x *Post 2016*					0.0163
					(1.05)
Market beta	-0.0173	-0.0172	-0.0173	-0.0173	-0.0172
	(-1.50)	(-1.50)	(-1.50)	(-1.50)	(-1.50)
Leverage	-0.000526	-0.000526	-0.000526	-0.000526	-0.000526
	(-1.49)	(-1.49)	(-1.49)	(-1.49)	(-1.49)
Log(market cap)	-0.200***	-0.200***	-0.200***	-0.200***	-0.200***
	(-8.75)	(-8.75)	(-8.75)	(-8.75)	(-8.75)
Book-to-market	-0.0299	-0.0299	-0.0299	-0.0299	-0.0298
	(-1.11)	(-1.11)	(-1.11)	(-1.11)	(-1.11)
Profitability	0.00169*	0.00169*	0.00169*	0.00169*	0.00169*
	(1.94)	(1.94)	(1.94)	(1.94)	(1.94)
Momentum	-1.041***	-1.041***	-1.041***	-1.040***	-1.040***
	(-5.75)	(-5.75)	(-5.75)	(-5.75)	(-5.75)
Firm FE	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
Post-event lags (L1-L12)	Yes	Yes	Yes	Yes	Yes
R-squared	0.419	0.419	0.419	0.419	0.419
N	109004	109004	109004	109004	109004

5 Does Corporate Investment React to ESG Rating Changes?

As a next step, we explore the "growth" channel by investigating whether ESG rating changes affect corporate investment decisions. Assuming that ESG rating changes affect returns, it is conceivable that firms experience this as a change in their cost of capital and subsequently adjust their corporate investment activity. To investigate this channel, we run a panel event study with firms' capital expenditure as the dependent variable. In this case, we do not detect any significant effects of ESG rating changes on capital expenditure.

5.1 Analytical Methodology

We define the variable *capex* as firms' capital investments divided by the one-quarter lagged book value of their property, plants, and equipment, expressed in percentage points. We obtain the data from the Compustat North America Fundamentals Quarterly database. We trim the obtained observations at the 1st and 99th percentiles for each month.

We run a panel event study investigating the effect of ESG rating changes on *capex*, using the model specification described in Equation 3. As *capex* is based on accounting data, we have to rely on quarterly observations. Accordingly we set the treatment window to a range from $\underline{j}=4$ quarters prior to a rating change to $\overline{j}=8$ quarters after a rating change. In addition, we include *market beta*, *profitability*, *book-to-market*, and *size* as time-variant firm-level controls.

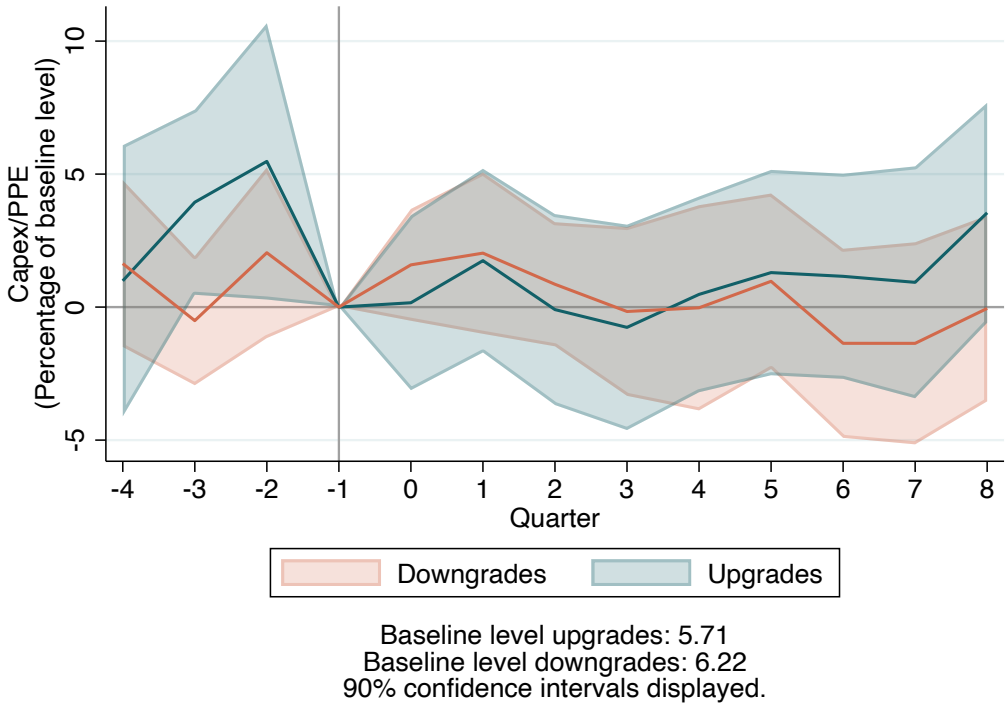

Figure 6. The reaction of corporate investment to ESG rating changes. This figure shows the results of a panel event study with firms' *capex* as the dependent variable and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. The figure shows the regression coefficients for all treatment leads and lags from 4 quarters prior to the event to 8 quarters after. Coefficients are normalized to the baseline level, i.e., the average level of *capex* one quarter before a rating change. Coefficients are shown in percentage points of this baseline level. Confidence intervals are based on standard errors clustered at the firm and the quarter level.

5.2 Results Corporate Investment

Figure 6 shows the effects of rating changes on firms' real investment. We do not find any significant reactions of firms' capital expenditure to either ESG rating upgrades or downgrades for the two years following rating changes. Looking at the pre-event period, we do not find any significant differences in *capex* in the year prior to ESG rating downgrades. We detect increased levels of

capex in the two quarters prior to a rating upgrade, compared to the quarter before the event, but not in the third one. While a positive pre-event trend may mask a potentially negative effect ESG rating upgrades have on *capex*, we cannot discern a clear pre-event trend from the obtained results.

In sum, these results indicate that, while the holdings of ESG mutual funds, as well as stock returns, react to ESG rating changes, companies do not change their level of capital investment.

6 Do Firms' ESG Practices React to ESG Rating Changes?

Finally, we investigate the "reform" channel by analyzing how firms' ESG practices react to ESG rating changes. Given that ESG rating changes affect the holdings of ESG mutual funds and stock returns, we can assume that managers have an incentive to optimize their firm's ESG performance. The rationale is that managers can increase their firm's valuation by expending some optimal level of effort on ESG practices, which is a key prediction of the models by Heinkel, Kraus, and Zechner (2001) and Pástor, Stambaugh, and Taylor (2021).

Under these assumptions, ESG rating changes may represent shocks that update a manager's view of the optimal level of ESG effort. After a downgrade, all else being equal, a higher level of effort may be justified to reverse the rating change. After an upgrade, a lower level may be justified given that the next threshold is hard to reach. Several of our findings support the view of ESG rating changes acting as shocks to management: First, as we document for the MSCI ESG rating, investors seem to respond primarily to changes in firms' aggregated ESG ratings and not directly to changes in firms' management practices. Second, even if ESG practices affect firms' ESG ratings, managers can only partially foresee rating changes because such changes also depend on MSCI's assessment of firms' exposure to ESG issues, the financial relevance of these

issues, and industry peers' performance. Third, ESG rating changes are relatively rare events; the average company in our sample experiences 0.695 upgrades and 0.582 downgrades.[7]

To investigate how corporate ESG practices react to ESG rating changes, we derive specific measurements for firms' environmental, social, and governance practices and run a panel event study investigating how the results of these measurements develop before and after ESG rating changes.

6.1 ESG Management Scores

As discussed in Section 2, the MSCI ESG rating is based on several components, combining an assessment of risk exposure and management capability. In this section, we rely on the management capability component to determine whether firms react to rating changes by adjusting their management practices. To measure companies' ESG practices, we rely on management scores provided by MSCI that measure companies' management of 37 specific ESG issues within the social, environmental, and governance dimensions. These scores reflect the quality of a firm's management practices concerning a specific issue on a scale of 0 to 10, where higher scores indicate better practices. We calculate *environmental management score* and *social management score* as the unweighted average of all available management scores within the respective dimension. Within the governance dimension, MSCI does not measure exposure to issues grouped under the "Corporate Governance Theme." All metrics within this theme measure corporate practices relative to peers, in percentiles. We calculate the management score for the governance dimension as the average of the aggregated corporate governance score, which is scaled from 0 to 10, and the management scores for all remaining issues in the governance dimension as *governance management score*. These three measurements react directly to any changes in MSCI's assessment of a firm's ESG management prac-

[7]The maximum number of rating changes per firm is 7; for upgrades the maximum is 5, and for downgrades the maximum is 4.

tices but are not influenced by changes in MSCI's assessment of a firm's exposure to certain issues or the financial materiality of specific risks. The governance score is partially influenced by peer effects.

6.2 Analytical Methodology

We run three panel event studies investigating the effect ESG rating changes have on *environmental management score*, *social management score*, and *governance management score*, using the model specification described in Equation 3. We set the treatment window to a range from $\underline{j}=12$ months prior to a rating change to $\overline{j}=24$ months after a rating change.

The underlying measurements we use to derive the ESG management scores are also reflected in the MSCI ESG rating. Thus, the ESG rating changes we observe may include an adjusted assessment of firms' ESG management practices. This can lead to a jump in ESG management scores from one month before a rating change ($j=-1$) to the month of the rating change ($j=0$). To explore whether companies adjust their ESG practices after a rating change, we omit $b_{it}^{j=0}$ and $c_{it}^{j=0}$ from the regression. This normalizes coefficients to the level of ESG management scores immediately after a rating change, enabling us to determine whether the management scores changed significantly in the following months. To investigate pre-trends in ESG management scores, we run a separate regression, using the same specifications but omitting $b_{it}^{j=-1}$ and $c_{it}^{j=-1}$ from the regression. This normalizes coefficients to the level of management scores immediately before a rating change, which enables us to determine whether there are any significant changes in ESG management scores in the year prior to an ESG rating change.

As the measurements we use to derive the ESG management scores are also considered in the ESG ratings, the relationship between ESG management scores and ESG rating changes is at least partly endogenous. A causal interpretation of observed changes in the practice scores may therefore

not be warranted. Nevertheless, we can observe how companies' ESG management practices develop before ESG rating changes and whether companies adjust their ESG management practices following rating changes. Also, our analysis relies on the assumption that ESG management scores react to actual changes in firms' practices in a timely manner. While MSCI's policy is to update the underlying metrics on an ongoing basis, we cannot exclude that some adjustments of corporate practices are captured with a delay.[8] Given that we observe the development of the management scores over two years, however, it seems unlikely that such delays substantially affect our findings.

6.3 Results, ESG Practices

We do not find evidence that companies substantially adjust their environmental management practices after ESG rating changes. Figure 7 shows the development of environmental management practices before and after ESG rating changes. Coefficients for the 24 months following a rating change ($j>0$) are normalized to the level of *environmental management scores* immediately after a rating change and thus indicate how this score reacts to rating changes. We find a slightly but significantly increased average level of *environmental management scores* 13 months after an upgrade, but no significant reaction for any of the other 24 months. For ESG rating downgrades, we do not find any significant change in companies' *environmental management score* following a rating change. Coefficients for the 11 months before a rating change ($j<-1$) are normalized to the level of *environmental management scores* immediately before a rating change. Here we observe a slightly negative trend in *environmental management scores* before downgrades, with levels being significantly higher one year before a rating change compared to the month before a downgrade.

[8] MSCI's methodology summary states that "Companies are monitored on a systematic and ongoing basis, including daily monitoring of controversies and governance events. New information is reflected in reports on a weekly basis and significant changes to scores trigger analyst review and re-rating. Companies typically receive an in-depth review on an annual basis."

This indicates that the *environmental management scores* of firms that are close to receiving an ESG rating downgrade deteriorate in the year before the change. While we do not find a significant reduction after rating changes, we can exclude that there is a trend reversal—that is to say, that firms significantly improve their *environmental management scores* following a downgrade.

Also, we do not find clear evidence showing that firms substantially alter their social management practices after ESG rating changes. Figure 8 shows how social management practices change before and after ESG rating changes. We do not find any significant changes in the *social management score* in the two years following ESG rating upgrades. We find a clear negative pre-trend in *social management scores* before upgrades, potentially indicating that the development of firms' social management practices stabilizes after ESG rating upgrades. Further, we observe that *social management scores* fall significantly starting six months after ESG rating downgrades. However, we also observe a clear negative pre-trend in *social management scores* before downgrades; thus, we cannot infer that the companies actively adjust their social management practices after downgrades. We can, in any case, exclude that downgrades are followed by any significant improvements in *social management scores*.

Concerning the governance dimension, our results indicate that companies adjust their governance efforts after ESG rating changes. Figure 9 shows the development of firms' *governance management score* around ESG rating changes. We find that the *governance management score* significantly deteriorates after ESG rating upgrades, while *governance management scores* in the year prior to an upgrade do not significantly differ from the level immediately before an upgrade. In contrast, companies' *governance management score* significantly increases in the two years after ESG rating downgrades. In the year before ESG rating downgrades, we observe a clear downward-facing trend in the *governance management score*. Thus, we observe a clear trend reversal in firms' governance practices after downgrades, supporting a causal interpretation of the observed improvement.

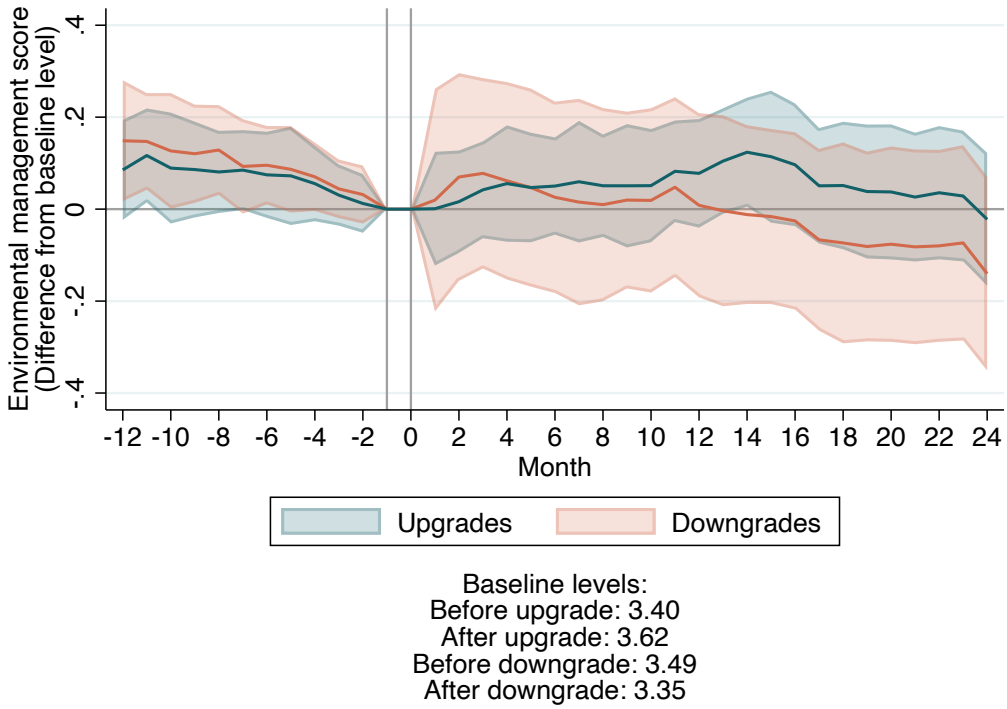

Figure 7. The reaction of environmental management practices to ESG rating changes. This figure shows the results of a panel event study with firms' *environmental management score* as the dependent variable and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. The figure shows the regression coefficients for treatment leads and lags from 12 months prior to the event to 24 months after. Coefficients for months before an ESG rating change are normalized to the level of *environmental management scores* immediately before the change (month -1). Coefficients for months after an ESG rating change are normalized to the level of *environmental management scores* immediately after the change (month 0). We display 90% confidence intervals, based on standard errors clustered at the firm and the month level.

In sum, we find that companies barely adjust their environmental and social practices following ESG rating changes. However, companies seem to adjust their governance after ESG rating changes, improving it after downgrades and letting it deteriorate to some extent after upgrades.

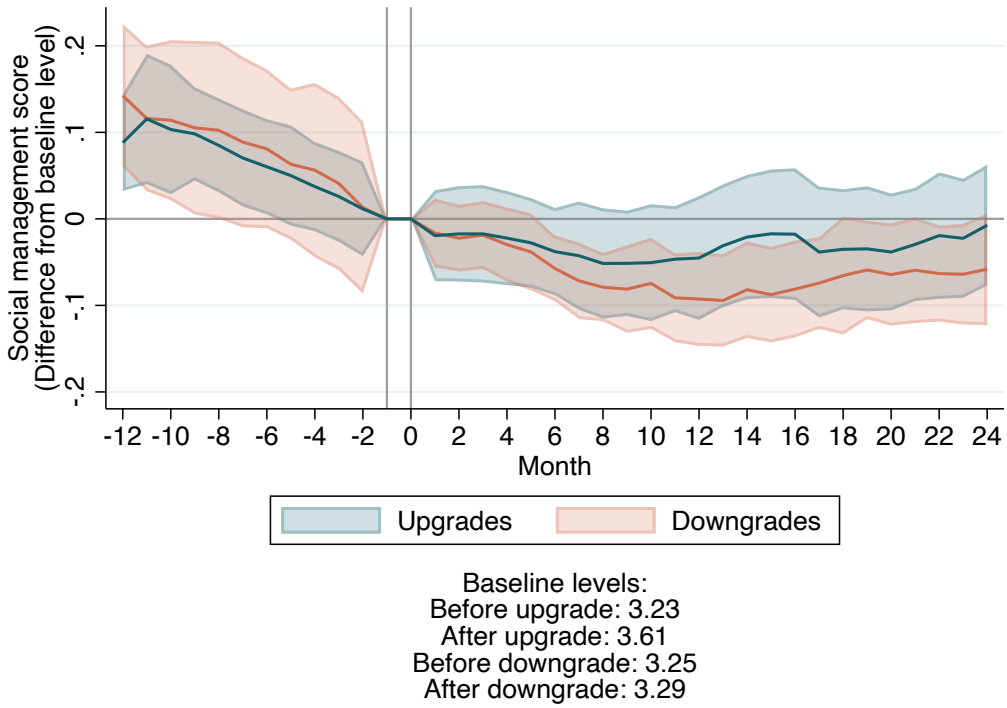

Figure 8. The reaction of social management practices to ESG rating changes. This figure shows the results of a panel event study with firms' *social management score* as the dependent variable and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. The figure shows the regression coefficients for treatment leads and lags from 12 months prior to the event to 24 months after. Coefficients for months before an ESG rating change are normalized to the level of *social management scores* immediately before the change (month -1). Coefficients for months after an ESG rating change are normalized to the level of *social management scores* immediately after the change (month 0). We display 90% confidence intervals, based on standard errors clustered at the firm and the month level.

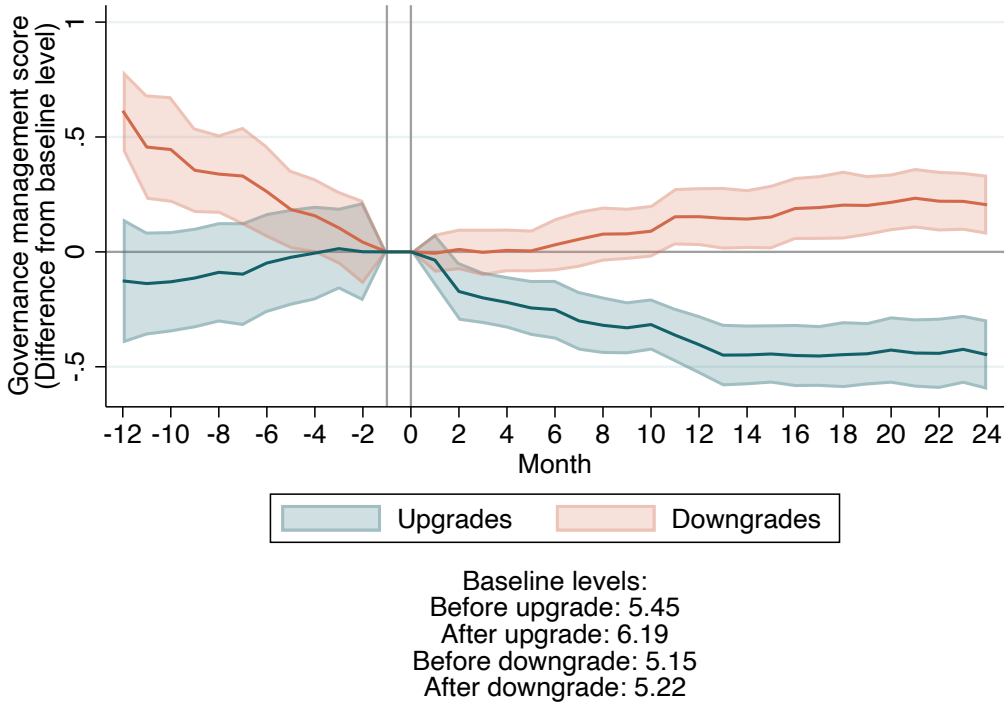

Figure 9. The reaction of governance practices to ESG rating changes. This figure shows the results of a panel event study with firms' *governance management score* as the dependent variable and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. The figure shows the regression coefficients for treatment leads and lags from 12 months prior to the event to 24 months after. Coefficients for months before an ESG rating change are normalized to the level of *governance management scores* immediately before the change (month -1). Coefficients for months after an ESG rating change are normalized to the level of *governance management scores* immediately after the change (month 0). We display 90% confidence intervals, based on standard errors clustered at the firm and the month level.

7 Discussion

Our results shed light on the question of whether ESG ratings are economically relevant. This is an important question as regulators discuss whether and how to regulate ESG ratings. It also provides important empirical insights into the question of whether and how ESG investing has market relevance, which has so far been mostly studied at the theoretical level.

Our results provide some empirical support to theoretical models that predict an impact of ESG performance on stock prices. In general, such models assume that a fraction of the market derives non-pecuniary utility from holding "green" companies (Heinkel, Kraus, and Zechner, 2001; Pástor, Stambaugh, and Taylor, 2021; Landier and Lovo, 2020; Pedersen, Fitzgibbons, and Pomorski, 2020; Oehmke and Opp, 2019). However, in their study of PRI signatories, Brandon, Glossner, Krueger, Matos, and Steffen (2021) find that U.S. signatories do not hold portfolios that are significantly different from those of non-signatories with regard to these portfolios' ESG performance. This questions whether there actually are investors with genuine ESG preferences, and suggests that investors' ESG commitments may be primarily "cheap talk." In contrast, our results on the holdings of dedicated ESG mutual funds provide evidence that there is a part of the market that expresses ESG preferences and consequently adjusts holdings to changes in ESG ratings.

We acknowledge that we cannot discern whether ESG mutual funds adjust their holdings due to a belief that ESG ratings are a signal for future cash flows or due to a taste for holding companies with good ESG ratings. Both interpretations are consistent with the observation that ESG rating changes trigger an adjustment of holdings, and it is likely that both drivers are present in reality. Also, the fact that information on adjusted ESG ratings is integrated relatively slowly over the course of two years suggests that the "taste" channel is at least part of the explanation. The fact that we do not detect any influence of the change in underlying ESG scores or management

practices adds to this notion. If ESG ratings contained novel cash-flow-relevant information, we would expect more rapid holdings adjustments, and a stronger reaction to greater underlying changes in firms' ESG characteristics. A slow, unspecific adjustment is consistent with ESG mutual funds periodically (e.g., quarterly) adjusting holdings to maintain a certain portfolio-wide ESG performance. With such a process in place, funds' positions in downgraded companies would be slowly reduced, and their positions in upgraded companies would be increased.

An important caveat to our support for theoretical models of the effect of ESG investing is the market relevance of ESG mutual funds. Pástor, Stambaugh, and Taylor (2021) show that pricing effects of ESG investing should increase in two key parameters: First, the strength of investors' preference for ESG performance, and second, the share of ESG investors in the market. While we present evidence for the influence of ESG preferences in investment decisions of dedicated ESG mutual funds, these funds owned less than 0.2 percent of the total assets in our sample in September 2020. Thus, the overall numbers of investors with a genuine taste for ESG performance could be small. Along these lines, Ceccarelli, Glossner, Homanen, and Schmidt (2021) show that while PRI signatories manage more than USD 100 trillion globally, there is only a small subset of PRI signatories who contribute time and effort to engagement activities.

Nonetheless, we document an impact of ESG rating changes on stock returns. This is in line with theoretical models, in the sense that investors with a taste for ESG performance will bid up stock prices once a rating improves (and drive prices down when a rating deteriorates). Interestingly, the price response to ESG rating changes is slow, suggesting that there could be opportunities for arbitrage. While the temporal dynamic of the stock price reactions to ESG rating changes aligns well with the effect such changes have on the holdings of ESG mutual funds, we cannot determine whether the stock price effect is driven by the observed holding changes. The observed price impact may also be caused by additional segments of the market

that respond, perhaps less strongly, to ESG rating changes. In sum, our findings lend support to model predictions that firms' ESG performance has stock price implications.

Our results provide only very limited evidence, however, for the theoretically predicted impact of ESG investing on the real economy, which is perhaps the most important and interesting aspect of ESG investing. We find no evidence for the growth channel, where "green" firms grow faster due to a reduced cost of capital and "gray" firms grow more slowly. We do not observe any short- or long-term changes in firms' capital expenditure following ESG rating changes. Potentially the advantage in the cost of capital is too small to be economically relevant, as argued by Berk and van Binsbergen (2021).

Regarding the reform channel, where firms become "greener" to increase their valuation, our findings suggest that ESG investing encourages the picking of low-hanging fruit. We cannot detect any improvement in environmental and social management practices following downgrades. However, we do find that firms improve governance practices following downgrades. Our interpretation of this finding is that managers are aware of valuation losses caused by ESG rating downgrades and thus try to improve their rating after such events. Improvements in the governance domain may offer the cheapest way of improving firms' ESG ratings. Also, such improvements may easily find the support of institutional investors, even if these do not have a particular preference for ESG performance. In contrast, improvements in the environmental and social domains may be more costly to achieve and more controversial. We also find that governance practices deteriorate after rating upgrades, suggesting that management's attention to governance issues may decline once a targeted ESG rating upgrade is achieved.

8 Conclusion

This paper investigates the economic impact of ESG rating changes. We find that ESG rating upgrades lead to an increase in firms' ownership by mutual funds with an explicit ESG strategy and increased buy-and-hold returns over a window of up to two years. We find the opposite effect for downgrades. Regarding impact on the real economy, we find no evidence indicating that firms' growth is affected by ESG rating changes. We do find that firms improve their governance practices in response to downgrades, but not their social or environmental practices. Taken together, our results suggest that ESG rating changes matter for a relatively small subset of mutual funds with a clear ESG mandate and have pricing effects but little real economic impact. This picture could change in the future if more investors become more serious about ESG integration.

References

Baker, Malcolm, and Jeffrey Wurgler, 2007, Investor sentiment in the stock market, *Journal of economic perspectives* 21, 129–152.

Barberis, Nicholas, Andrei Shleifer, and Robert Vishny, 1998, A model of investor sentiment, *Journal of Financial Economics* 49, 307–343.

Berk, Jonathan, and Jules H van Binsbergen, 2021, The impact of impact investing, *Working Paper*.

Bessembinder, Hendrik, Michael J Cooper, and Feng Zhang, 2019, Characteristic-based benchmark returns and corporate events, *The Review of Financial Studies* 32, 75–125.

Bolton, Patrick, and Marcin Kacperczyk, 2021a, Do investors care about carbon risk?, *Journal of financial economics* 142, 517–549.

Bolton, Patrick, and Marcin Kacperczyk, 2021b, Global pricing of carbon-transition risk, Discussion paper, National Bureau of Economic Research.

Brandon, Rajna Gibson, Simon Glossner, Philipp Krueger, Pedro Matos, and Tom Steffen, 2021, Do responsible investors invest responsibly?, *Working Paper*.

Briere, Marie, and Stefano Ramelli, 2021, Green sentiment, stock returns, and corporate behavior, *Available at SSRN 3850923*.

Broccardo, Eleonora, Oliver Hart, and Luigi Zingales, 2020, Exit vs. voice, NBER working paper, available at: https://www.nber.org/papers/w27710.

Ceccarelli, Marco, Simon Glossner, Mikael Homanen, and Daniel Schmidt, 2021, Which Institutional Investors Drive Corporate Sustainability?, *Working Paper*.

Chang, Yen-Cheng, Harrison Hong, and Inessa Liskovich, 2015, Regression discontinuity and the price effects of stock market indexing, *The Review of Financial Studies* 28, 212–246.

Clarke, Damian, and Kathya Tapia-Schythe, 2021, Implementing the panel event study, *The Stata Journal* 21, 853–884.

Freyaldenhoven, Simon, Christian Hansen, Jorge Pérez Pérez, and Jesse M Shapiro, 2021, Visualization, identification, and estimation in the linear panel event-study design, Discussion paper, National Bureau of Economic Research.

Gantchev, Nickolay, Mariassunta Giannetti, and Rachel Li, 2022, Does money talk? Divestitures and corporate environmental and social policies, *Review of Finance* forthcoming.

Glück, Maximilian, Benjamin Hübel, and Hendrik Scholz, 2021, ESG rating events and stock market reactions, *Available at SSRN*.

Gollier, Christian, and Sébastien Pouget, 2014, The "washing machine": Investment strategies and corporate behavior with socially responsible investors, *Working Paper*.

Greenwood, Robin, Toomas Laarits, and Jeffrey Wurgler, 2022, Stock market stimulus, Discussion paper, National Bureau of Economic Research.

GSIA, 2021, Global sustainable investment review 2020, available at: http://www.gsi-alliance.org/wp-content/uploads/2021/08/GSIR-20201.pdf.

Hartzmark, Samuel M., and Abigail B. Sussman, 2019, Do investors value sustainability? A natural experiment examining ranking and fund flows, *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, Neng Wang, and Jinqiang Yang, 2021, Welfare consequences of sustainable finance, Discussion paper, National Bureau of Economic Research.

Kaul, Aditya, Vikas Mehrotra, and Randall Morck, 2000, Demand curves for stocks do slope down: New evidence from an index weights adjustment, *The Journal of Finance* 55, 893–912.

Kim, Soohun, and Aaron Yoon, 2020, Analyzing active managers' commitment to esg: Evidence from united nations principles for responsible investment, *Working Paper*.

Landier, Augustin, and Stefano Lovo, 2020, ESG investing: How to optimize impact?, Working paper, available at SSRN: https://www.ssrn.com/abstract=350893.

Oehmke, Martin, and Marcus M. Opp, 2019, A theory of socially responsible investment, Discussion paper, available at SSRN: https://papers.ssrn.com/abstract=3467644.

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

Petersen, Mitchell A, 2009, Estimating standard errors in finance panel data sets: Comparing approaches, *The Review of Financial Studies* 22, 435–480.

Pástor, Lubos, Robert F. Stambaugh, and Lucian A. Taylor, 2021, Sustainable investing in equilibrium, *Journal of Financial Economics* 142, 550–571.

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

Rzeznik, Aleksandra, Kathleen Weiss Hanley, and Loriana Pelizzon, 2022, Investor reliance on esg ratings and stock price performance, .

Schmidheiny, Kurt, and Sebastian Siegloch, 2019, On event study designs and distributed-lag models: Equivalence, generalization and practical implications, .

Shanaev, Savva, and Binam Ghimire, 2022, When ESG meets AAA: The effect of ESG rating changes on stock returns, *Finance Research Letters* 46, 102302.

Shleifer, Andrei, and Robert W Vishny, 1997, The limits of arbitrage, *The Journal of finance* 52, 35–55.

Wurgler, Jeffrey, and Ekaterina Zhuravskaya, 2002, Does arbitrage flatten demand curves for stocks?, *The Journal of Business* 75, 583–608.

A Appendix

A.1 Appendix A

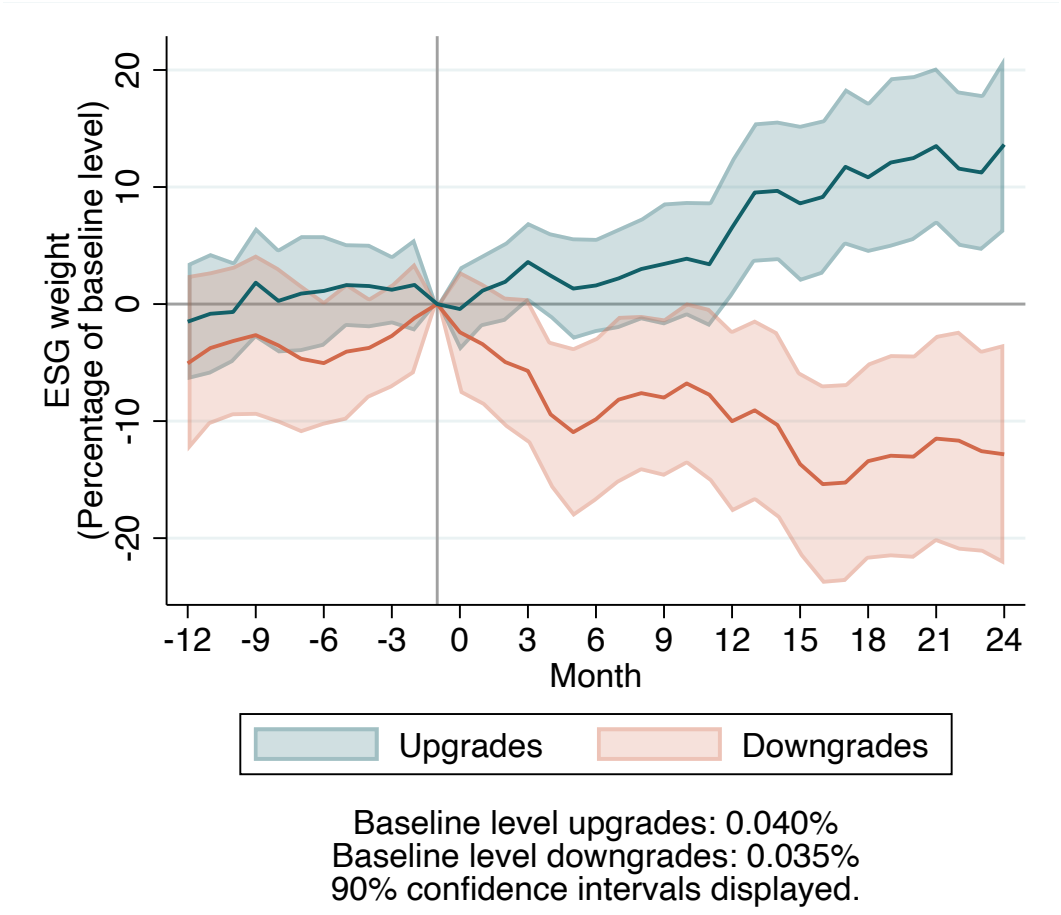

Figure A.1. The reaction of *ESG weight* to ESG rating changes. This figure shows the results of a panel event study with firms' level of *ESG weight* as the dependent variable and up- and downgrades in the MSCI ESG rating as events. The observation period is February 2013 to September 2020. The figure shows regression coefficients for all treatment leads and lags from 12 months prior to the event to 24 months after. Coefficients are normalized to the baseline level, i.e., the average level of *ESG weight* one month before a rating change. Coefficients are shown in percentage points of this baseline level. Confidence intervals are based on standard errors clustered at the firm and the month level.

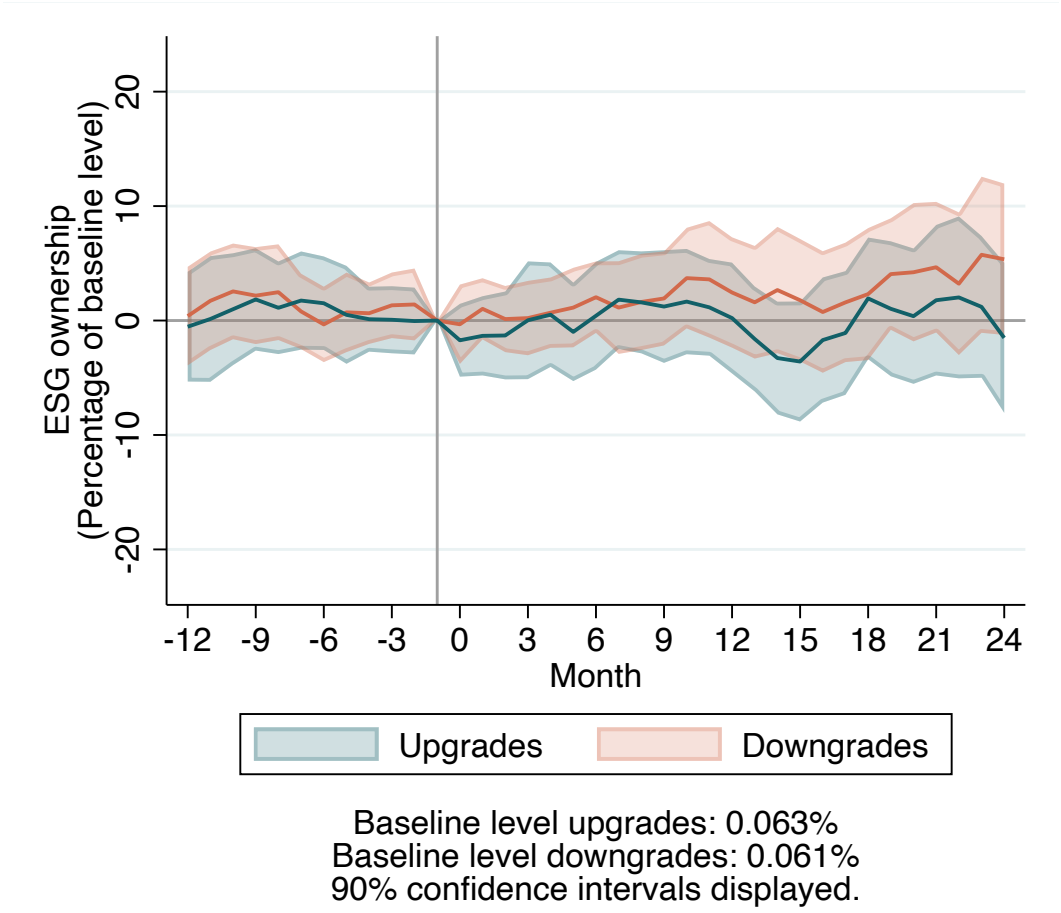

Figure A.2. Placebo panel event study, *ESG ownership*. This figure shows the results of a panel event study with firms' level of *ESG ownership* as the dependent variable and roughly 2,500 simulated placebo upgrade and 2,500 placebo downgrade events. The observation period is February 2013 to September 2020. The figure shows regression coefficients for all treatment leads and lags from 12 months prior to the placebo events to 24 months after. Coefficients are normalized to the baseline level, i.e., the average level of *ESG ownership* one month before a placebo event. Coefficients are shown in percentage points of this baseline level. Confidence intervals are based on standard errors clustered at the firm and the month level.

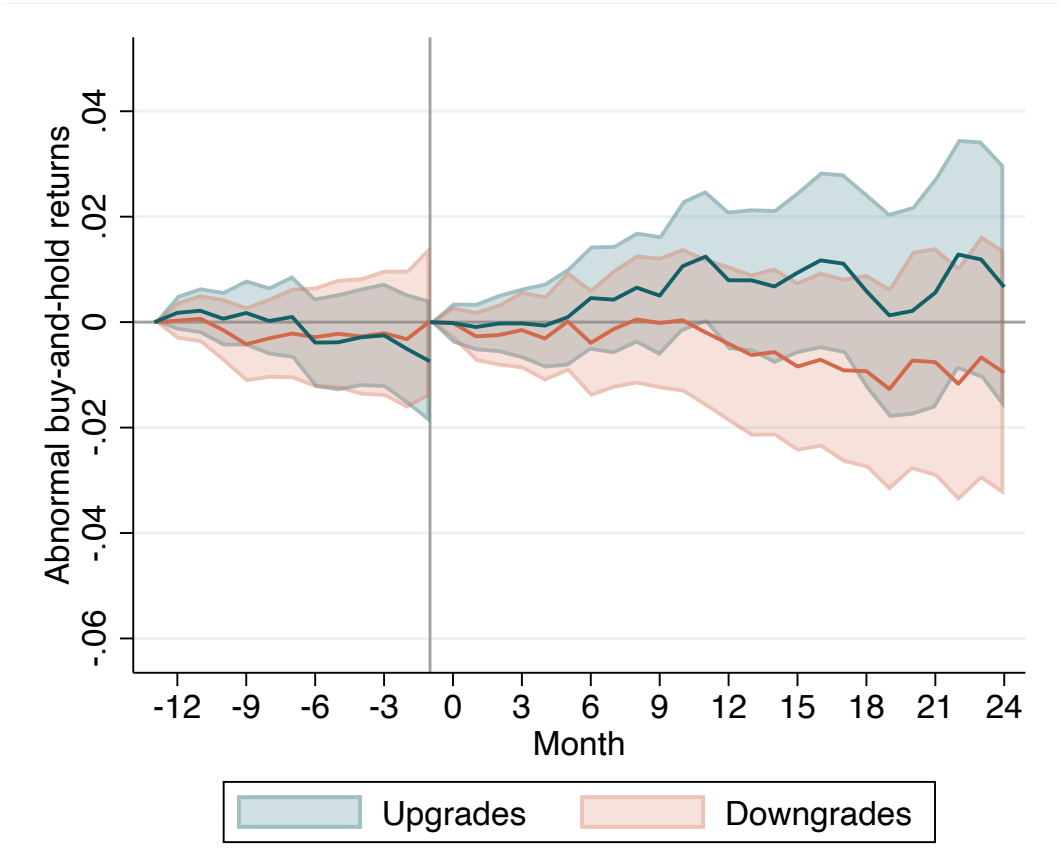

Figure A.3. Placebo panel event study, BHRs. This figure shows the results of a series of panel event studies with BHRs for different holding periods as the dependent variables and roughly 2,500 simulated placebo upgrades and 2,500 placebo downgrades between February 2013 and September 2020 as events. For the months greater or equal to zero, the graph displays the abnormal BHRs for holding periods of up to 24 months (corresponding to $\beta_{j\tau}$ and $\gamma_{j\tau}$ in Equation 6). For the months smaller than zero, the graph displays abnormal BHRs following placebo events 12 months prior to the simulated events, for holding periods reaching up to one month prior to the real events. All panel event studies include treatment leads and lags covering a time period corresponding to the holding period before and after ESG rating upgrades and downgrades, as well as firm and month fixed effects and lagged time-variant firm-level controls. Confidence intervals are based on standard errors clustered at the firm and the month level.

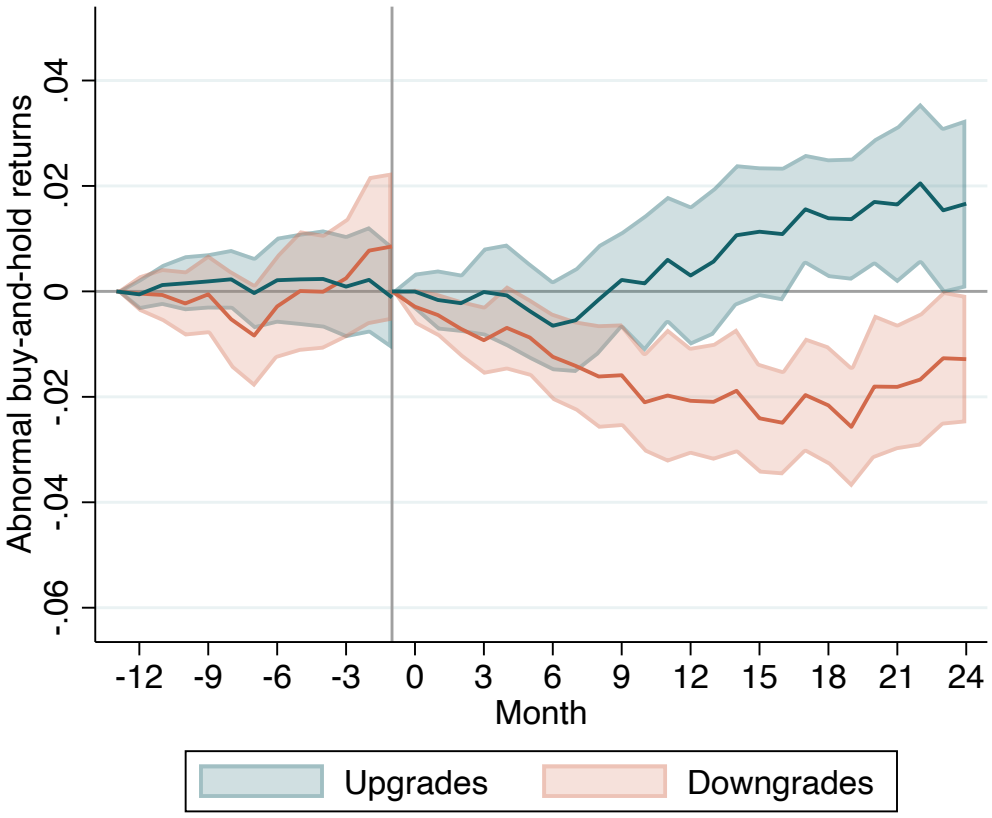

Figure A.4. Panel event study, BHRs without pre- and post-event leads and lags. This figure shows the results of a series of panel event studies with BHRs for different holding periods as the dependent variables and up- and downgrades in the MSCI ESG rating between February 2013 and September 2020 as events. For the months greater or equal to zero, the graph displays the abnormal BHRs for holding periods of up to 24 months (corresponding to $\beta_{j\tau}$ and $\gamma_{j\tau}$ in Equation 6). For the months smaller than zero, the graph displays abnormal BHRs following placebo events 12 months prior to real events, for holding periods of up to one month prior to the real events. The panel event studies include firm and month fixed effects and lagged time-variant firm-level controls, but they do not include treatment leads and lags. Confidence intervals are based on standard errors clustered at the firm and the month level.