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The Sustainability Footprint of Institutional Investors: ESG Driven Price Pressure and Performance

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Abstract

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Keywords: ESG, sustainability footprint, environmental footprint, social footprint, risk-adjusted performance, price pressure, price impact, institutional investors, investment horizon, socially responsible investing, sustainable investing

JEL Classifications: G20, G23, G30, M14, Q01, Q50

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We propose a novel way of measuring the equity portfolio-level environmental and social characteristics of a 13F institution (the "sustainability footprint") and examine the relation between sustainability footprints and risk-adjusted investment performance. The analysis shows that 13F institutions with better sustainability footprints outperform. The positive effect of sustainability footprints on the risk-adjusted performance of 13F institutions' equity portfolios is concentrated in the environmental dimension and in more recent periods. Further tests show that the outperformance is explained by growing investor preferences for sustainable investing over time and the resulting price pressure that institutions exert on stocks with good environmental scores.

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1. Introduction

The practice of sustainable and responsible investing has witnessed unprecedented growth in recent years. For example, the United States Forum for Sustainable and Responsible Investment (USSIF) identified $569 billion in AUM managed according to sustainable and responsible investment principles in 2010 (USSIF, 2010). Since then, this figure has increased thirtyfold and reached $17.1 trillion in 2020 (see USSIF, 2020).

In this paper, we examine the question of whether and how the rise of sustainable investing has affected the risk-adjusted performance of institutional investors' equity portfolios. The main hypothesis of this paper is that stocks with good sustainability (or ESG) characteristics have experienced demand-driven price pressure, which has benefited investors with good portfolio-level sustainability characteristics and resulted in a positive link between portfolio sustainability and risk-adjusted portfolio performance. We present several pieces of evidence consistent with the described price pressure channel shaping the relationship between the portfolio-level sustainability characteristics of investors and their risk-adjusted performance.

We start by showing that measures of stock-level price impact introduced to the asset pricing literature in Koijen and Yogo (2019) are positively related to a stock's sustainability scores. The positive association between a stock's price impact in the sense of Koijen and Yogo (2019) and its sustainability score suggests that high sustainability stocks are subject to higher demand and thus higher price pressure. Next, we provide evidence that the positive relation between price pressure and sustainability scores exhibits plausible time-series variation: more specifically, the positive link is stronger in more recent periods of the sample, which coincides with the time period that was subject to the strongest growth in sustainable investing (see USSIF, 2020). We then move

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on to the institutional investor equity portfolio-level: first, we propose novel measures to quantify the environmental, social, and overall sustainability at the institutional investor stock portfolio-level. The measures we propose are based on a combination of (i) institutional investor equity holdings data as reported in quarterly 13F filings to the SEC and (ii) stock-level environmental and social scores collected from different data providers. We refer to these measures as *sustainability footprints*.[1] Secondly, we examine the relation between sustainability footprints and risk-adjusted performance at the institutional investor's equity portfolio-level.

To study the relation between investment performance and the sustainability footprints, we regress standard measures of risk-adjusted portfolio performance (i.e., Sharpe ratios and Fama and French (2015) five factor alphas) on the portfolio-level sustainability footprints. In a within-investor estimation framework, we find that risk-adjusted returns are higher for investors with better environmental footprints, which is consistent with our main hypothesis. The results on the relation between risk-adjusted performance and the social footprint are less systematic in that they are not significant. We then conduct auxiliary tests exploiting both the time series and the cross section to display plausible variation in the relation between portfolio performance and sustainability footprints. More specifically, we find that sustainability footprints are more strongly related to the portfolio performance in more recent periods (i.e. since 2010), which is consistent with the evidence of the Koijen and Yogo (2019) price impact measure also being more strongly related to ESG scores since 2010. Exploiting the cross section of institutions in terms of investment horizon, we also find that institutions with lower portfolio turnover have benefited more from the price pressure channel. The latter finding is plausible since buy and hold investors are more likely

[1] In this paper we calculate sustainability footprints in a way that *larger* values correspond to *better* sustainability outcomes at the portfolio-level.

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to remain invested in high sustainability stocks for longer periods of time and thus also more likely to benefit more from the positive price pressure that affected high sustainability stocks. In addition, low turnover investors also tend to invest more in stocks with high ESG scores (e.g., Starks, Venkat, and Zhu, 2018 or Glossner, 2019)

To provide further evidence consistent with a price pressure channel and to help with identification, we present evidence from a second empirical strategy that isolates more specific and temporary demand shocks (and thus transitory price pressure) on high sustainability stocks by focusing on the occurrence of natural disasters. The idea behind the second empirical strategy is that the occurrence of natural disasters close to an institutional investor's headquarters provides exogenous shocks to an institutional investor's sustainability preferences thus leading to the purchase and the temporary price pressure on high sustainability stocks. Indeed, research in environmental psychology (see Demski et al., 2017) shows that when individuals experience extreme weather events, they tend to become more inclined to act on sustainability related issues and we conjecture that the same behavioral effects should also apply to decision-makers working for the institutional investors we study in this paper.

Using twenty major natural disasters in the U.S. between 2002 and 2013 in combination with data on the geographic location of institutional investors' headquarters, we show that institutional investor-level sustainability footprints improve after the investors' headquarters are hit by natural disasters ("treatment"). In a second step, we then show that following the natural disaster treatment, our measures of portfolio performance are positively related to sustainability footprints for treated institutions, suggesting that investors with good sustainability footprints benefit from the temporary price pressure on high-sustainability stocks caused by the natural disasters.

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Taken together, our empirical evidence is consistent with the view that the growth of sustainable investing and the resulting price pressure on high sustainability stocks has caused stocks of firms with good sustainability performance to increase in value. In other words, stronger investor preferences for sustainability caused institutional investors to place larger bets and exercise price pressure on high sustainability stocks, resulting in a positive sustainability pricing effect. These results potentially reconcile various findings in the literature as to why high-sustainability stocks have increased in value and subsequently earn lower returns, while low-sustainability stocks bear more risks and earn higher returns in the cross section (e.g., Hong and Kacperczyk, 2009). Dynamically, the increase in value for high-sustainability stocks benefited institutional investors that had good sustainability footprints to start with and might reconcile why a possible wedge between expected and realized returns for sustainable investment portfolios exists (Pastor, Stambaugh, and Taylor, 2020). Our findings also carry important practical implications for the future performance of investors who are only starting to invest sustainably now, as our analysis highlights that such strategies might under-perform going forward, mainly because high sustainability stocks are already trading at a premium today.

We believe that this study makes several important contributions to the academic literature. First, to the best of our knowledge, this study is the first to propose measures that systematically quantify the environmental, social, and aggregate sustainability of 13F institutional investors' stock portfolios. Second, we contribute to the debate on the link between risk-adjusted investment performance and sustainability (see, for instance, Geczy, Stambaugh, and Levin, 2005; Pastor, Stambaugh, and Taylor, 2020; Pedersen, Fitzgibbons, and Pomorski, 2020) by showing that better sustainability is associated with better risk-adjusted investment performance through a price pressure channel. While prior evidence of pricing effects of sustainability exists at the firm-level

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(e.g., Flammer, 2015 or Krüger, 2015), we have mixed knowledge of these effects at the institutional investor portfolio-level. Given the economic importance of institutional investors, their effects on prices (e.g., Coval and Stafford, 2007; Basak and Pavlova, 2013), and the trends related to sustainable investing, it is important to understand how the two are intertwined and isolate the consequences for institutional investors' portfolio performance. We contribute importantly to the literature by providing empirical evidence consistent with the insights of a growing set of papers on the theoretical and asset pricing foundations of sustainable investing (e.g., Pastor, Stambaugh, and Taylor, 2020; Pedersen, Fitzgibbons, and Pomorski, 2020). For instance, our evidence is consistent with one of the mechanisms highlighted in the model of Pastor, Stambaugh, and Taylor (2020), which stipulates that if investor interest in ESG strengthens unexpectedly and sufficiently, sustainable investing can outperform. In addition, we explore the empirical consequence of the increasingly widespread adoption of ESG, which constitutes an important ingredient in the analysis of Pedersen, Fitzgibbons, and Pomorski (2020), who develop an ESG-efficient frontier. Consistent with our evidence, Pedersen, Fitzgibbons, and Pomorski (2020) also show that an increase in the proportion of ESG-motivated investors drives up the prices of high-ESG stocks.

2. Hypothesis development and related literature

2.1. Hypothesis development

While some papers have documented that assets with poor ESG characteristics (e.g., sin stocks) earn high returns in the cross section (see Hong and Kacperczyk, 2009), notably via a risk channel (Dunn, Fitzgibbons, and Pomorski, 2018), other interesting dynamics remain unexplored. For example, it is still an open question if the rise of sustainable investing has caused prices of stocks

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with good sustainability characteristics to increase in value over time. In this paper, we hypothesize that the increasing interest of institutional investors in sustainable investing has resulted in price pressure on stocks with good sustainability scores and that such price pressure can explain why investment performance at the institutional investor equity portfolio-level is positively related to an institutional investor's portfolio-level sustainability characteristics. Building on this idea and on the framework of Koijen and Yogo (2019), we state our first hypothesis:

Hypothesis H1*: Due to investor preferences for sustainability, stocks with good sustainability characteristics experience stronger price impact in the sense of Koijen and Yogo (2019).*

Building on Hypothesis H1, we conjecture that the demand-driven price impact for high sustainability stocks has intensified recently. This view is supported by anecdotal evidence that investment managers nowadays increasingly adopt sustainability principles in asset management. In 2010, for example, the United States Forum for Sustainable and Responsible Investment (USSIF) identified $569 billion in AUM managed according to sustainable and responsible investment principles (USSIF, 2010). Since then, this figure has increased more than thirtyfold and reached $17.1 trillion in 2020 (see USSIF, 2020). We thus hypothesize:

Hypothesis H1a: *Price impact on high sustainability stocks is stronger in more recent years of the sample period.*

According to Hypothesis H1, high sustainability stocks have experienced stronger price impact in the sense of Koijen and Yogo (2019). Next, we hypothesize if such price impact has also influenced the realized risk-adjusted portfolio performance of institutional investors who exhibit better sustainability characteristics. A relation between risk-adjusted portfolio performance and

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sustainability would arise from the following mechanism. First, investors have preferences for sustainability. Indeed, Pastor, Stambaugh, and Taylor (2020) build their theory around the shift of investors' sustainability preferences. In addition, Pedersen, Fitzgibbons, and Pomorski (2020) show empirically that investor demand for stocks is positively related to ESG scores. Thus, the extent to which investors are willing to allocate equity capital to a specific stock is increasing in the stock's sustainability score. Second, stocks with better sustainability characteristics are subject to stronger price pressure (Hypothesis H1) and increasingly so (Hypothesis H1a). Such price pressure for stocks with high sustainability scores should benefit institutional investors with good portfolio-level sustainability, i.e., institutional investors who bought stocks with good sustainability performance (provided that these investors intend to hold on to these stocks and that they are not contrarians). Our second hypothesis explores the implications of the mechanism outlined above:

> ***Hypothesis H2****: Due to the stronger price impact on high sustainability stocks, institutional investors with better equity portfolio-level sustainability exhibit higher risk-adjusted portfolio performance.*

We also examine two additional predictions regarding the relation spelled out in Hypothesis H2, one of which exploits the time series and one that exploits the cross section. In the time series, Hypothesis H1a states that the price pressure on high sustainability stocks has become stronger in more recent periods. Hence, we would also expect similar time-series variation in the relation between portfolio performance and the portfolio-level sustainability:

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Hypothesis H2a: *The positive relation between institutional investors‘ equity portfolio-level sustainability and risk-adjusted portfolio performance is more pronounced in more recent years.*

Exploiting cross-sectional heterogeneity among institutional investors, we also hypothesize that long-term oriented investors benefited more from demand-induced price pressure and the resulting increase in the value of high sustainability stocks. The idea behind the last hypothesis is that investors who hold stocks for longer periods of time without churning their portfolios should benefit more from demand-induced price impact for high sustainability stocks than investors who are more short term oriented and trade in and out of stocks more frequently:

Hypothesis H2b*: The positive relation between risk-adjusted portfolio performance and institutional investors' equity portfolio-level sustainability is stronger for long-term oriented investors.*

2.2. Related literature

Recent research in asset pricing focuses on the role of institutional investors in driving stock prices. Koijen and Yogo (2019) introduce a demand-system based asset pricing model where price movements stem from institutional investors. Using 13F institutional investor holdings data, they estimate demand shocks using an instrumental variable approach based on institutional investors' investment universes. Then, they apply this approach to derive a price impact measure, which we use in our analysis. The Koijen and Yogo (2019) framework allows to estimate the price impact of demand shocks and potentially explain the role of institutions as determinants of return volatility and predictability. In a follow up paper, Koijen, Richmond, and Yogo (2020) use their demand-based asset pricing approach to identify the characteristics (e.g., market beta or book-to-equity

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ratio) that matter for firm-level valuations in an international setting. They also illustrate which institutional investors matter for asset prices and to what extent. More importantly for us, Koijen, Richmond, and Yogo (2020) note that the demand system approach could be useful in understanding how investor demand plays a role in connecting asset prices to ESG factors, which is precisely what we do in this paper. In a related paper, Noh and Oh (2020) also explore the role of institutional investors' demand for green stocks in a demand system approach. However, their goal is to analyze the consequences of price impact on firms' environmental performance, while we focus on how the demand system approach can help understanding the link between investors' risk-adjusted performance and their portfolio-level sustainability. We build on the insights of this novel literature by using the demand-based asset pricing measure of price impact to test our hypothesis about higher price pressure for stocks with good sustainability characteristics.

We also contribute to the literature on sustainable investing. Several recent theoretical finance papers address the asset pricing implications of sustainable investing. For instance, Pastor, Stambaugh, and Taylor (2020) use a general equilibrium framework to show that green assets have lower CAPM alphas than brown assets. This relation is due to investors' appetite for green assets and the resulting willingness to earn lower expected returns. In another study, Pedersen, Fitzgibbons, and Pomorski (2020) derive an ESG-adjusted capital asset pricing model in which assets with high ESG scores have lower required returns. Interestingly in their framework, an increase in the proportion of ESG-motivated investors drives up the prices of high-ESG stocks. Two other recent studies focus more on how investors can achieve social impact in the presence of frictions. First, Landier and Lovo (2020) show how search frictions and the presence of ESG investors can push companies to internalize their externalities and thus increase social impact. Second, Oehmke and Opp (2020) also study social impact but do so under financing constraints.

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They show how financial and socially responsible capital complement each other in furthering firms' behavior towards clean production.[2]

We also add to the literature that studies sustainability at the institutional investor-level. Hong and Kostovetsky (2012) show that democratically inclined fund-managers hold more sustainable investment portfolios. Relying on proprietary data from one large UK based institutional investor, Dimson, Karakaş, and Li (2015) study private (or behind-the-scene) sustainability-oriented shareholder engagements and show that successful engagements generate shareholder value. In a follow-up paper Dimson, Karakaş, and Li (2020) study collaborative ESG engagements. Using archival data, Dyck et al. (2019) show that firm-level sustainability is related positively to institutional ownership. They also show this relation to be strongest for ownership by institutional investors based in countries with strong social and environmental norms. Hoepner et al. (2020) show that institutional investors' shareholder engagements on ESG issues reduce firms' downside risk. Nofsinger, Sulaeman, and Varma (2016) study institutional ownership in firms with good and bad environmental and social performance. Amel-Zadeh and Serafeim (2018) survey senior investment professionals working at institutional investors to examine why and how investors currently use or plan to use ESG information in their investment process. Gibson Brandon et al. (2020) study responsible institutional investing around the world. Chen, Dong, and Lin (2020) show that higher institutional ownership and more concentrated shareholder attention induce corporate managers to invest more in sustainability activities. Looking at a different group of institutions, Liang and Renneboog (2020) find that sovereign wealth funds' ownership does not affect a firm's ESG performance, even if these institutions do consider ESG when making investment decisions. Using measures of sustainability that are different from ours and focusing on

[2] Other recent theoretical studies on sustainable investing include for instance Roth (2019) and Zerbib (2019).

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the firm-level, Starks, Venkat, and Zhu (2018) show that preferences for corporate ESG depend critically on investor horizons, a finding that we confirm in our paper. Barber, Morse, and Yasuda (2020) study impact funds, a class of investors with the dual objective of generating financial returns as well as positive externalities and document that such funds underperform conventional ones. Fernando, Sharfman, and Uysal (2017) show that institutional investors shun stocks with high environmental risk exposure.

Finally, our study also speaks to the literature providing mixed evidence about the performance implications of sustainable investing. For example, on the one hand early evidence in Geczy, Stambaugh, and Levin (2005) or Renneboog, Ter Horst, and Zhang (2008) suggests that socially responsible investment (SRI) funds underperform their domestic benchmarks in a majority of countries. Hartzmark and Sussman (2019) also document that high-sustainability mutual funds do not outperform their low sustainability peers. On the other hand, some studies find that specific ESG criteria can have positive effects on fund performance (e.g., Gil-Bazo, Ruiz-Verdu, and Santos, 2010). At the stock-level, the literature also points to conflicting evidence of both out- and underperformance of stocks based on ESG criteria. For example, Edmans (2011) shows that firms with high employee satisfaction earn higher risk-adjusted returns, while Hong and Kacperczyk (2009) find that sin stocks carry a positive risk premium. In a similar spirit, Dunn, Fitzgibbons, and Pomorski (2018) document a positive return premium for firms with low ESG scores and link this premium to firms' riskiness. These studies also highlight that differences in empirical results can result from the differences in ESG criteria, from analyzing the performance question from a firm's as opposed to an investor's perspective, or from using heterogeneous sample periods and different empirical settings. We aim to reconcile these views, and present a setting and rationale for a

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positive relation between sustainability and institutional investors' portfolio risk adjusted performance.

3. The sustainability footprint and data

3.1. Stock-level sustainability scores

To construct our sustainability footprint measures, we start by building a stock-level dataset. To do so, we obtain stock-level sustainability scores from Thomson Reuters Asset 4 (now Refinitiv ESG) and MSCI for U.S. stocks, which we merge with CRSP[3] and Compustat. The sample period runs from 2002 to 2015. Both Thomson Reuters and MSCI[4] provide sustainability scores at the stock-level. The scores are organized along three ESG pillars. We use the overall environmental and social pillar scores from Thomson Reuters (i.e., the variables *ENVSCORE* and *SOCSCORE)* and MSCI (i.e., the variables *ENVIRONMENTAL_PILLAR_SCORE* and *SOCIAL_PILLAR_SCORE).* These pillar scores capture mainly the social and environmental quality of the company's policies and processes.[5]

The stock-level coverage by the two data providers is low at the beginning of the sample period, but rises gradually. For instance, MSCI covers on average about 500 stocks between 2002 and 2011. The coverage increases to more than 2,000 firms by 2012. Coverage for Thomson

[3] We restrict ourselves to stocks with CRSP share codes 10 and 11.
[4] See http://goo.gl/M1j7Sd and http://goo.gl/65LDYu.
[5] For instance, Thomson Reuter's Asset4 social pillar score captures issues such as the firm's relation with its workforce, respect of human rights, relations with communities, and product responsibility. In a similar spirit, the environmental score captures issues like firms' overall resource use, all sorts of environmental emissions (i.e., including CO2), other environmental aspects of the production process such as the use of renewable energy as well as environmental innovation (which quantifies the extent to which the company offers environmentally friendly products and services). While MSCI and Thomson use proprietary methods to construct their scores, the set of relevant issues that feed into the construction of their scores are similar. However, it is important to mention that divergence exists among scores from different data providers, which has been highlighted in recent work (see, for example, Berg, Koelbel, and Rigobon, 2020; Gibson Brandon, Krueger, and Schmidt, 2020).

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Reuters is lower with, on average, about 400 stocks between 2002 and 2011 and about 700 stocks between 2011 and 2015. Panel A of Table 1 shows summary statistics for the MSCI-Thomson-CRSP-Compustat merged sample at the annual frequency.

----Table 1 about here----

We denote by *Envir_A4* (*Social_A4*) the environmental (social) score from Thomson, and analogously, by *Envir_MSCI* and *Social_MSCI* the corresponding scores from MSCI. While average values are quite similar for both the MSCI and Thomson Reuters scores (i.e., between 4 and 5), the cross-sectional dispersion is higher for Thomson's stock-level sustainability scores. However, Thomson does not use the full support of the distribution: while the minimum and maximum stock-level social scores are 0 and 10 for the MSCI scores, Thomson Reuters' minimum (maximum) social scores are 0.35 and 9.88 (respectively 0.83 and 9.75 for the environmental score).

To make scores comparable across data providers, we standardize the scores to have a mean of zero and a standard deviation of one. We denote the standardized scores by $z_t(x)$. Higher values indicate better stock-level sustainability performance. We now compute, whenever possible, a combined score using the standardized scores obtained from both data providers. Taking the environmental dimension as an example, we calculate

$$Envir_{it} = \frac{1_{MSCI,it} \times z_t(Envir\_MSCI_{it}) + 1_{A4,it} \times z_t(Envir\_A4_{it})}{1_{MSCI,it} + 1_{A4,it}},$$

where $1_{MSCI,it}$ ($1_{A4,it}$) is a dummy variable indicating if the MSCI (Thomson Reuters) environmental score is available for stock *i* in period *t*. This approach consists of using an average standardized score whenever both MSCI and Thomson scores are available, and using only the

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available standardized score whenever a stock covered one data provider only. We choose this approach for two reasons. First, we believe that even though ESG ratings can disagree taking an average is a better reflection of the true sustainability of a firm. Second, the approach allows obtaining the largest possible sample of stock-level sustainability scores. We repeat the same procedure to calculate the combined social score, which we denote by $Social_{it}$. We also calculate a stock-level sustainability score by taking the average environmental and social score at the stock-level, that is $Susty_{it} = 0.5 \times (Envir_{it} + Social_{it})$.

In order to get a better idea of the characteristics of stocks for which we observe sustainability scores, we report in Panel B of Table 1 summary statistics for the CRSP-Compustat universe over the same time period. Compared to the average CRSP-Compustat firm (Panel B, Table 1), stocks that are covered by MSCI and Thomson (Panel A, Table 1) tend to be larger (roughly three times the average market cap, assets, sales, and number of employees), have lower cash holdings, higher return on assets, lower book-to-market, higher gross profitability, and lower stock volatility. There seem to be no substantial differences in terms of capital expenditures or capital structures. About 40 percent of the firm-year observations belong to S&P500 firms suggesting that Thomson and MSCI also cover some small and midcap firms.

3.2. *Institutional investor-level sustainability footprints*

An important objective of this paper is to quantify the sustainability footprint at the institutional investor equity portfolio-level. To do so, we obtain institutional investor equity holdings data from 13F filings through the Thomson Reuters s34 database.[6] We focus on institutional-investor

[6] The Securities and Exchange Commission (SEC) requires all institutional investment managers who exercise investment discretion over $100 million or more in Section 13(f) securities to report, at the end of each calendar quarter, their holdings on Form 13F. Section 13(f) securities include equity securities that trade on exchanges, certain equity options and warrants, shares of closed-end investment companies, and certain convertible debt securities.

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holdings of common stocks that can be linked with CRSP and Compustat. We combine the annual stock-level sustainability scores described in Section 3.1 with the quarterly 13F stock holdings data to calculate quarterly footprint measures at the institutional investor equity portfolio level.

One issue is that the criteria and methodologies used to examine the sustainability at the stock-level could have changed over time. In other words, MSCI and Thomson might not have applied the same criteria to examine and measure the sustainability of stocks in 2005 than they did in 2015. To address this issue, we focus on a relative measure by calculating the normalized rank of stock *i* in period *t*. We calculate these ranks separately using the environmental, social, and overall footprint. We normalize ranks between 0 and 1 and denote them as $rk_t(Envir_{it})$, $rk_t(Social_{it})$, and $rk_t(Susty_{it})$. The normalized ranks give an indication of the relative sustainability position of a stock *i* at a given point in time *t*. Our main measure of the sustainability footprint of the institutional investor is defined as

$$Susty\_VW_{jt} = \sum_{i=1}^{N_{jt}} w_{ijt-1} \times rk_t(Susty_{it}).$$

In this equation, w_{ijt-1} denotes the value-weight of stock *i* in investor *j's* portfolio in year-quarter *t-1*, $rk_t(Susty_{it})$ is the normalized rank of the standardized sustainability score of stock *i* in year-quarter *t*, and N_{jt} the total number of stocks investor *j* holds in year-quarter *t* for which stock-level sustainability scores are available. This variable quantifies the sustainability footprint of institutional investor *j* in year-quarter *t* as the weighted average of the sustainability ranks of the stocks included in the institution's portfolio. The sustainability footprint of the investor thus

The shares of open-end investment companies (i.e., mutual funds) are not Section 13(f) securities. (see http://www.sec.gov/answers/form13f.htm)

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depends on (i) the rank of the sustainability scores of the individual stocks in the investor's portfolio and (ii) the size of each individual stock holdings. Analogously, we calculate the social and environmental footprints by individually using the environmental and social components of the stock-level sustainability score, that is $Social\_VW_{jt} = \sum_{i=1}^{N_{jt}} w_{ijt-1} \times rk_t(Social_{it})$ and $Envir\_VW_{jt} = \sum_{i=1}^{N_{jt}} w_{ijt-1} \times rk_t(Envir_{it})$. We also calculate equally-weighted footprints by setting $w_{ijt-1} = \frac{1}{N_{jt-1}}$.

----Table 2 about here----

In Table 2, we display summary statistics at the institutional investor-level. The median value-weighted sustainability footprint (i.e., *Susty_VW*) is 0.670 and the 75h percentile is 0.744. The median value-weighted footprint for the environmental criteria (*Envir_VW*) has the same order of magnitude with 0.665 and a slightly lower median for the social criteria (Social_VW) with 0.641.[7] In our analysis, we also use a holdings-based returns measure and a number of control variables at the institutional investor-level. More information on how we calculate these returns and the performance measures is provided in Appendix A.

4. Analysis

4.1. Institutional investors' preferences for sustainability

The past decade has witnessed an unprecedented rise in assets managed according to sustainable and responsible investment principles. For example, Gibson Brandon et al. (2020) provide evidence

[7] In our analysis we also control for the issue that sustainability scores are not available for all stocks. We do so by calculating a control variable which captures the fraction (in value terms) of an institution's overall equity portfolio for which sustainability scores are available. We denote this variable *Coverage (Value).* The average value for *Coverage (Value)* is 0.777 (see Table 2), suggesting relatively good sustainability coverage at the portfolio-level.

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that as of 2017, half of the institutionally owned global public equity is held by institutional investors who have signed the Principles for Responsible Investment (PRI) [8] and thus committed to responsible and sustainable investing.

These numbers suggest that institutional investors have preferences for sustainability, and increasingly so. The central idea in Hypothesis H1 is that investors have preferences for sustainability and that collectively investors have been bidding up the prices of high sustainability stocks, which has resulted in higher price impact in the sense of Koijen and Yogo (2019) for stocks with better sustainability scores. To investigate this idea, we start by providing some graphical evidence consistent with the view that investors have increased their exposure to stocks with good sustainability characteristics.

----Figure 1 about here----

In Figure 1, we plot the evolution of the value-weighted and equally-weighted average environmental and social scores for the universe of stocks in our sample. The upper (lower) panel of Figure 1 displays the averages for the environmental (social) score, that is the value- and equally-weighted averages of *Envir_raw* and *Social_Raw* (see Table 1). Consistent with our hypothesis that investors have shifted their focus to high sustainability stocks, the figures show a more pronounced positive upward trend for the value-weighted (green lines) than for the equally-weighted averages (red lines). The trend is particularly pronounced for the environmental score. For example, the value-weighted environmental score (green line) has increased by about 40% (=(6.7-4.7)/4.7) over the sample period (see upper panel of Figure 1). In contrast, no strong trend

[8] The PRI was founded in 2006 by a group of the world's largest institutional investors with support from the United Nations (UN). The PRI is the world's leading proponent of responsible investment and operates as an industry-led membership network.

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appears when analyzing the equally-weighted average environmental score. The fact that the value-weighted average environmental score has improved over time—while the equally-weighted score has remained largely flat—suggests that investors have indeed increased their exposure to stocks with better environmental characteristics. For the social score, the picture is less clear and we even observe a downward trend in the value-weighted score starting in 2010.

To formally test for the existence of investor preferences for stocks with high sustainability scores, we now examine institutional investors' portfolio weights. More specifically, we use a regression framework and test if institutional investors place larger bets on stocks with better sustainability scores. The dependent variable in these regressions is *Stock holdings*, which is the dollar amount invested by an institution in a given stock normalized by the dollar value of the institution's overall portfolio. Table 2 shows that the mean value is 0.0037 suggesting that the average holding makes up about 0.37% of the investor's portfolio. The main independent variables are the normalized environmental, social, and overall sustainability scores, i.e., *Envir*, *Social*, and *Susty* measured one quarter prior.[9] To ensure that our results are not driven by omitted variables at the stock-level, we control for several stock-level observables that are likely to affect portfolio weights, namely book-to-market, gross profitability, return on assets, market capitalization, beta, volatility, and past stock return.[10] The advantage of using holdings data at the investor-stock-level is that it allows us to control for a large number of high-dimensional fixed effects, further attenuating the possibility of an omitted variable issue. To this effect, we include time-varying investor fixed effects denoted as *Investor×Year-quarter*, which absorb any time-varying

[9] See section 3.1 for more details on the sustainability measures at the stock-level.

[10] We include these various firm and stock characteristics as these have been shown in the literature to be related to investors' preferences and affect stock returns (e.g., book-to-market, market capitalization and past stock return as in Cohen, Frazzini, and Malloy, 2008; return on assets and gross profitability as in Novy-Marx, 2013 or Bouchaud et al., 2019; beta as in Frazzini and Pedersen, 2014; and also, volatility as in Ang et al, 2009).

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institutional investor variation potentially affecting our results. We also include *Investor×Firm* fixed effects, allowing to control for any characteristic specific to a given investor-firm pair, such as, for example, geographical preferences for a certain firm or social connections between the investor and the board of the firm (Coval and Moskowitz, 1999; Cohen, Frazzini, and Malloy, 2008). Finally, we also control for time varying industry fixed effects *(Industry × Year-quarter)* and double-cluster standard errors at the *Firm×Year-quarter*- and *Investor×Year-quarter*-level.

----Insert Table 3 here----

The results are reported in Table 3. Across both dimensions (environmental and social), we find that investors place larger bets on firms with higher E or S scores—even after controlling for first order determinants of portfolio weights (e.g., profitability, size, risk, etc.). The analysis of Table 3 supports the view that institutional investors have preferences for stocks with better sustainability characteristics. For the overall sustainability score, we find a positive and statistically significant coefficient of 0.0162 with a *t*-stat of 5.77 (see Column (1), Table 3). For the mean investor stock holding, the estimated coefficient implies an about 4.5 percent (=0.0162/0.37*100) higher weighting for a stock when the sustainability increases by one standard deviation, which seems economically plausible.[11] When looking individually at the environmental and social components (see columns (2) and (3)), we find positive and significant effects of similar magnitudes.

[11] Note that in Table 3, we multiply the estimated coefficients by 100. Hence the estimated coefficient represents a 0.0162 percentage point increase in the average holding for a standard-deviation increase in the normalized sustainability score *Susty*. Moreover, it is worth noting that this test is performed on stocks where sustainability scores are available and thus captures the intensive margin effects of sustainability scores on holdings. In the Internet Appendix Table IA.1, we perform the same tests as in Table 3 using only stocks that belong to the S&P500 and find that the impacts are comparable albeit slightly stronger. This robustness test restricts the sample to stocks where the coverage of sustainability scores is more uniform, which allows us to have a coverage that is more comparable across institutions.

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4.2. Price impact and sustainability

The theories of Pastor, Stambaugh, and Taylor (2020) and Pedersen, Fitzgibbons, and Pomorski (2020) suggest that investors have displayed increased interest for green assets recently and have, as a result, bid up prices of stocks with high sustainability scores, especially when investors motivated by sustainability are numerous. As shown in the previous subsection, institutional investors in our sample exhibit preferences for stocks with better sustainability characteristics. We now examine if such preferences for sustainability have also resulted in stronger price pressure for high sustainability stocks.

To implement this analysis, we use a measure that was introduced in Koijen and Yogo (2019). The authors propose a demand system approach to asset pricing which is built on the idea that asset prices are—at least to some extent—determined by demand from institutional investors. They develop an asset pricing model with flexible heterogeneity in asset demand across investors and use 13F stock holdings to derive explicit measures of price impact for U.S. stocks. The idea behind these price impact measures is that investors face demand shocks which cause them to change portfolio holdings, which in turn result in price impact. In their context, price impact arises from large institutional investors and imperfectly elastic aggregate demand. In essence, the measures quantify the extent to which a demand shock from an investor impacts the price of a given stock and the measures are defined as elasticities. We use the aggregate price impact measure at the stock-level, which is essentially the sum of price impact measures for different classes of 13F investors.

To test Hypothesis H1, which states that investors have bid up prices of stocks with high sustainability scores resulting in price impact, we now study the relation between the price impact

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measure of Koijen and Yogo (2019) and sustainability scores. To do so, we regress the quarterly *Aggregate price impact* measure of Koijen and Yogo (2019) at the stock-level on sustainability scores and standard control variables. More specifically, our main independent variables are the stock-level sustainability scores *Susty*, as well as *Envir*, and *Social*. The set of controls consists of typical firm characteristics that can be thought of as first order determinants of investment decisions (e.g., size, book-to-market ratio, gross profitability, beta, volatility). All independent variables are lagged by one quarter. The results are presented in Table 4.

----Insert Table 4 here----

We find that price impact is significantly positively related to the overall sustainability score *Susty* (see Column (1) in Table 4). When looking at the two components of *Susty* separately in columns (2) and (3) of Table 4, we find that price impact is significantly related to the environmental score (*Envir*), but not to the social score (*Social*). In economic terms, we observe that stocks with a one standard deviation higher environmental score experience an approximately 55 basis points larger quarterly price impact following a 10% demand shock. Extrapolating to the annual level, a 2.2 percent larger price impact seems economically plausible.[12] Taken together, the evidence from columns (1) and (2) support the hypothesis that investors bid up prices of firms with high sustainability scores, at least for the environmental dimension.

We now examine time-series variation in the relation between price impact and sustainability. As described earlier in the paper, there is increasing evidence that sustainability

[12] Following Koijen and Yogo (2019), the average aggregate price impact, which represents the elasticity of price to demand for unobserved characteristics, is 2.978 (see Table 1, Panel A). It means that following a demand shock of 10%, i.e. a 10% increase in holdings from institutional investors, the estimated average stock price increases by 29.78% and 26% for the median stock as reported in Koijen and Yogo (2019). In our setting, when demand increases by 10%, stocks with a one standard deviation higher environmental score, will experience a price increase of 2.2% per year relative to other stocks.

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issues have recently become more important for both investors and society as a whole. In Hypothesis H1a we formalize this idea and conjecture that the relation between price impact and the sustainability scores has strengthened in more recent periods. To test Hypothesis H1a, we interact the sustainability scores with a *post2010* dummy, which marks all year-quarters from 2010 onwards. We find that the relation between *Aggregate price impact* and the interaction between the sustainability scores and the *post2010* dummy is highly significant, suggesting stronger price impact on high sustainability stocks in more recent years of the sample (see Column (4) of Table 4).[13] Interestingly, we also find a statistically significant coefficient for the interaction between the *post2010* dummy and the *Social* score. However, the estimated magnitude is lower: the coefficient on the interaction is about half the size of the interactions between *post2010 and Susty* and *Envir*. Weaker effects for the social dimension are also consistent with the graphical evidence presented in Figure 1. Overall, our results confirm Hypothesis H1a especially for the environmental and the overall sustainability score.

4.3 Risk-adjusted performance and sustainability footprints

In this section, we test whether the documented price impact on high sustainability stocks has resulted in a positive relation between institutional investors' sustainability footprints and the investment performance of their equity portfolios. Hypothesis H1 states that the increased interest of institutional investors in sustainable investment has led to price pressure on stocks with high sustainability scores. The resulting increase in the value of these stocks should have benefited

[13] The results in Table 4 suggest that environmental stocks had higher price impacts, ex-post, in the sense of Koijen and Yogo (2019). While we argue that this is due to higher demand for these stocks, it could be resulting from lower liquidity for these assets. We also show in Internet Appendix Table IA.3 that our results are robust to the inclusion of proxies for liquidity, i.e. bid-ask spread (Amihud, 2002) and share turnover (Chordia, Subrahmanyam, and Anshuman, 2001), as additional controls. These additional robustness checks that continue to show a positive relation between sustainability scores are price impact make us confident in concluding that higher demand for high sustainability stocks is not confounded with reduced liquidity as proxied by the bid-ask spread or the share turnover.

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institutional investors who follow buy and hold strategies and whose equity portfolios exhibit high sustainability footprints over time, resulting in a positive relation between sustainability footprints and their portfolios' investment performance.

To test the premise of Hypothesis H2, we use a within-investor estimation framework to establish the basic empirical relation between portfolio performance and sustainability footprints. In Table 5, we relate several forward rolling investment performance measures to the overall sustainability (Panel A), the environmental (Panel B), and the social footprint (Panel C).[14] We include investor fixed effects such that identification comes entirely from within-institution changes in the footprints over time. To avoid look-ahead bias, we relate forward rolling performance measures between year-quarter t and $t+9$ to footprints in year-quarter t. We also include *Institution-type×Year-quarter* and *Country×Year-quarter* fixed effects to account for the fact that 13F institutions of different legal types (e.g., investment advisors, bank, insurance companies, pension funds, etc.) and from different countries are likely to be subject to different investment styles and legal restrictions (e.g., fiduciary duties). We also control for other portfolio characteristics, such as *Turnover*, *ln(# Stocks)*, the *# Industries<=2* dummy variable, and *ln(Assets)*, *Coverage (Value)*, which is the percentage of the investor's portfolio value for which stock-level sustainability scores are available. Given that ESG scores are likely to be correlated with other stock-level characteristics (see also the analysis in Appendix B), we control for value-weighted average characteristics of the portfolio's stock holdings. We focus on book-to-market, gross profitability, the natural logarithm of market capitalization, and total volatility and denote the

[14] See Appendix A for more information on how we construct portfolio returns and estimate the performance measures.

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value weighted averages as *BM_VW*, *GP_VW*, *ME_VW*, and *GP_VW*. In order to make the table more readable, we do not report the coefficient estimates for the control variables.

----Insert Table 5 here----

In Column (1), we use *Mean portfolio return* as the dependent variables. Columns (2), (3), and (4) display the relation for *Total portfolio risk*, *Sharpe ratio*, and a five factor alpha, which we denote by *Alpha FF5* (see Fama and French, 2015). Column (1) of Panel A shows that *Mean portfolio return* is positively and statistically related to the overall sustainability footprint. Column (2) shows a negative and significant relation between Total *portfolio risk* and the overall sustainability footprint.[15] This result supports prior findings on a negative relation between risk measures and sustainability (e.g., Dunn, Fitzgibbons, and Pomorski, 2018; Hoepner et al., 2020). Most importantly for Hypothesis H2, Column (4) of Table 4 shows a positive and significant relation between *Alpha FF5* and the sustainability footprint of institutional investors' equity portfolios.

In Panel B and C of Table 5, we estimate the panel regressions independently for the environmental and social footprints. It turns out that the relation is much stronger for the environmental (Panel B) and absent for the social footprint (Panel C). The risk-adjusted performance measures are positively and robustly related to the environmental footprint, while the evidence for the social dimension is inconclusive: *Mean portfolio return*, *Total portfolio risk*, and *Sharpe ratio*, and *Alpha FF5* seem to be either negatively or unrelated to the social footprint.

[15] While prior literature has documented a negative relationship between risk and sustainability (e.g. Dunn, Fitzgibbons, and Pomorski, 2018), the relatively low statistical significance can be explained by the inclusion of portfolio-level characteristics, notably the value-weighted average of total volatility *(TVOL_VW)*. In unreported analysis, we find a strong negative relationship between our sustainability footprint and total portfolio risk when we exclude the average stock characteristics from our set of control variables.

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The strong and positive relation between the five factor Alpha and the environmental footprint supports Hypothesis H2. Most importantly, the evidence on the relation between risk adjusted investment performance and sustainability footprints presented in Table 5 mirror exactly the price impact results of Table 4: first, there is no relation between price impact and the social scores at the stock-level and similarly no such relation exists between *Alpha FF5* and the social footprint at the investor-level (see Panel C, Table 5). However, we do observe a positive and strongly significant effect of the environmental footprint on both stock-level price impact in the sense of Koijen and Yogo (2019) (see Table 4) and risk-adjusted performance at the institution-level (see Panel B, Table 5). The combined evidence lends support to the view that price impact and the resulting stock price pressure on stocks with high environmental performance stand behind the positive footprint-performance relation at the institutional equity portfolio level.[16]

4.4 Risk-adjusted performance and sustainability: The role of time-series variation

The evidence presented in Table 4 on the link between price impact in the sense of Koijen and Yogo (2019) and the firms' sustainability scores suggests that the sensitivity of price impact with respect to sustainability has increased in the most recent time periods. If the price impact mechanism we put forward in this paper is indeed behind the documented sustainability-performance link (Table 5), we would expect similar time-series variation in the relation between institutional investors' equity portfolio performance and their sustainability footprints. In Table 6, we examine whether the relation between risk-adjusted performance measures (i.e., *Sharpe ratio*

[16] As an additional robustness check we use an alternative strategy to control for the fact that some institutional investor portfolios have better sustainability score coverage than others. Note that in the regressions of Table 5 we already control for *Coverage (Value)*, i.e. our tests compare two institutions with similar sustainability score coverage but differences in the quality of portfolio footprints. In Internet Appendix Table IA.2, we use a set of stocks that is more homogeneous across institutions to calculate the sustainability footprint. More specifically, we restrict the calculation of investor sustainability footprints to S&P500 firms. The results in Internet Appendix Table IA.2 remain highly significant and do not change our conclusions.

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and *FF5 Alpha*) and sustainability footprints is indeed stronger in more recent periods (as formalized in Hypothesis H2a). To this effect, we regress these performance measures on interaction terms between the sustainability footprints and a *post2010* dummy variable. Consistent with Hypothesis H2a (and the evidence presented in Table 4), we find that all performance measures depend more strongly on sustainability post 2010. Interestingly, institutional investors equity portfolio-level performance measures are also strongly positively related to their social footprints post 2010, evidence that mirrors the time series patterns of the relation between individual firms' social scores and price impact, which was also positive and significant post 2010 (see Column (6), Table 4)

4.5 Risk-adjusted performance and sustainability: The role of investment horizon

The previous section exploits time-series variation to shed more light on the mechanism behind the link between sustainability and risk adjusted performance. A cross-sectional implication of the mechanism we put forward in this paper is that long-term investors should have benefited more from the demand-induced price pressure on high sustainability stocks. Long-term investors trade less frequently and are thus more likely to hold on to the stocks with good sustainability characteristics. This implies that the performance benefits from demand-driven price pressure on high sustainability stocks should have predominantly benefited long-term investors.[17] We proxy for long term orientation using portfolio turnover and examine the hypothesis that long-term investors benefited more strongly from the price impact on high sustainability stocks (Hypothesis H2b) by interacting the sustainability footprints with tercile dummies of *Turnover*.[18] In line with

[17] In addition, recent research shows that more long term oriented institutions tend to invest more in firms with high sustainability scores (e.g., Starks, Venkat, and Zhu, 2018 or Glossner, 2019). We confirm this finding in Internet Appendix Table IA.4.

[18] We calculate these tercile dummies in each quarter to avoid look-ahead bias.

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the previous analysis, we use *Sharpe ratio* and *Alpha FF5* as dependent variables. The results are reported in Table 7.

----Insert Table 7 here----

We find evidence that the link between risk-adjusted performance and the institutional investors' sustainability footprint depends monotonically on the investment horizon which confirms Hypothesis H2b (see Column (2) of Table 7). In other words, the performance-sustainability link is systematically weaker (or non-existent) for institutions with higher portfolio turnover. In line with prior analysis, the results are concentrated in the environmental dimension (columns (3) and (4)) and nonexistent for the social dimension.

Our results show that better sustainability footprints—in particular in the environmental dimension—are positively related to risk-adjusted performance, especially for low turnover institutional investors and in more recent periods. Overall, the presented evidence is consistent with the price pressure channel being at the origin of the positive relation between institutional investors' equity portfolios' risk adjusted performance and their sustainability footprints.

5. Natural disasters as temporary shocks to sustainability preferences

In Section 4, we find evidence of a positive relation between risk-adjusted investment performance of institutional investors' equity portfolios and their sustainability footprints. We also provide evidence that this link arises because of investor preferences for high sustainability stocks and the resulting price pressure on such stocks. To strengthen the case that the relation between institutional investors' sustainability footprints and the risk-adjusted performance of their equity portfolios is the result of sustainability-preferences of institutional investors and the resulting price impact, we now present evidence based on another empirical strategy that exploits the occurrence of natural

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disasters as temporary shocks to institutional investors' sustainability preferences. While the analysis in the previous section captures the implications of slow-moving changes in the sustainability preferences of institutional investors, this section isolates specific and well identified temporary shocks to the sustainability preferences of institutions. More specifically, we exploit the occurrence of natural disasters in the close vicinity of an institutional investor's headquarters as a shock to local investors' sustainability preferences. We hypothesize that investors located near natural disasters will experience a positive shock to their sustainability preferences, increasing their demand for high sustainability stocks, thus creating temporary price pressure on more sustainable stocks ultimately leading to higher risk-adjusted performance.

Research in behavioral finance has shown that experiencing macroeconomic shocks can have a profound impact on individual risk-taking behavior (see Malmendier and Nagel, 2011). We conjecture that experiencing natural disasters (in particular, those related to extreme weather events) affects individual attitudes and preferences towards sustainability issues in similar ways.[19] Indeed, Demski et al. (2017) show that the direct experience of extreme weather events in the UK leads to both an increased salience of sustainability issues and to more a pronounced emotional response to such issues.[20] We build on this research in environmental psychology by hypothesizing that the sustainability preferences of portfolio managers working for institutional investors should also be temporarily affected by the experience of natural disasters. The mechanism is as follows: when natural disasters occur close to an institutional investor's headquarter, the institution's

[19] The identification strategy is motivated by the availability heuristic (see Tversky and Kahneman, 1974), which stipulates that judgements and individual behavior are disproportionally influenced by information and examples that are salient to the decision-maker.

[20] Using survey methods in the context of a single natural disaster in the UK (i.e., the winter flooding of 2013), Demski et al. (2017) compare individuals personally affected by an extreme weather event ("treatment") with a representative "control" sample: the authors show that "direct flooding experience can give rise to behavioral intentions beyond individual sustainability actions, including support for mitigation policies, and personal climate adaptation in matters unrelated to the direct experience."

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employees become more concerned with environmental and social issues and, as a result, the institution's portfolio-level sustainability improves. Subsequently, the improvement creates temporary price pressure on stocks with high sustainability scores. In contrast, institutional investors headquartered in areas unaffected by the natural disasters serve as the "control group" since their preferences are unaffected by these shocks.

We focus on the effect of natural disasters on the overall footprint because natural disasters affect both social and environmental preferences of the institutions' employees simultaneously and it is difficult to separate shocks to either the environmental or social component. For instance, fund managers are likely to become not only more aware of environmental issues but also more empathic towards disaster victims and as such also more concerned about social issues (e.g., the well-being of communities or employees).[21]

Similar to prior studies, we use natural disaster data from SHELDUS (Spatial Hazard and Loss Database for the United States). For each natural disaster in the U.S., SHELDUS provides information on the start date, the end date, and the Federal Information Processing Standards (FIPS) code of all affected counties. Following Barrot and Sauvagnat (2016), we use only major disasters, which are defined as disasters lasting less than 30 days with total estimated damages above $1 billion (in constant 2013 U.S. dollars).

----Table 8 about here----

[21] Prior studies in economics and finance have exploited the occurrence of natural disasters for identification purposes. For instance, Barrot and Sauvagnat (2016) use natural disasters to study how idiosyncratic firm-level shocks propagate in production networks. Dessaint and Matray (2017) examine whether corporate managers' risk perceptions respond to hurricane strikes. Bernile, Bhagwat, and Rau (2017) and Bernile, Bhagwat, Kecskes, and Nguyen (2018) examine how managers and fund-managers are affected by disasters.

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Table 8 displays the list of disasters used in this study. The table shows that the majority of the disasters are hurricane strikes. However, the list also includes other natural disasters such as floodings or blizzards. We obtain the ZIP codes of the institutional investors' headquarters from SEC filings and link them to FIPS codes. We restrict the analysis to U.S. based institutions and focus on the period 2002-2013, mainly because we use forward rolling performance measures for which we need 10 quarters of data.[22]

----Figure 2 about here----

We provide a graphical representation of the geographic data in Figure 2. Panel A shows the geographic distribution of institutional investor headquarters. The map shows concentrations of headquarters around New York, Boston, Stamford, Chicago, Seattle, San Diego, and San Francisco. Panel B of Figure 2 displays a map highlighting the counties affected by the natural disasters. Note that some counties are hit several times.

Our identification strategy rests on two steps: First, we show that institutional investor-level sustainability footprints improve when natural disasters occur close to institutional investors' headquarters. Secondly, we show that institutional investors' risk-adjusted equity portfolio performance is more strongly related to sustainability footprints following disaster treatment.

5.1. Sustainability footprints improve as a result of natural disasters

To show that institutions improve their sustainability footprints following a natural disaster, we code dummy variables indicating whether the county in which the institutional investor is

[22] While we used a sample of about 4,000 unique 13F institutions (including foreign institutions) in the analysis of Section 4, we now restrict the analysis to U.S. based institutions. The restriction to U.S. based 13F institutions and the availability of information on the location of the 13F institution's headquarter from SEC filings reduces the analysis to about 2,800 institutions in this section.

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headquartered is hit by a natural disaster in year-quarter *t-n.* We use dummy variables with a horizon of up to 3 quarters (i.e., *t, t-1*, *t-2*, and *t-3)*. For instance, the variable *Disaster hits investor*$_{jt}$ indicates that institution *j* is subject to a disaster in year-quarter *t*. In a similar spirit, the variable *Disaster hits investor*$_{jt-1}$ indicates that the institution was hit by a natural disaster one quarter ago. In Table 9 we provide the results from estimating specifications of the following type

$$y_{jglt} = \eta_j + \sum{}_{n=0}^{3} a_n \, Disaster\ hits\ investor_{jt-n} + b_n' \, X_{jt} + \theta_{gt} + \pi_{lt} + \epsilon_{jt},$$

where y_{jglt} measures the sustainability footprint of investor *j*, with institution type *l*, headquartered in state *g,* in year-quarter *t*. Institution types are based on Bushee (2001). In the above specification, η_j are investor fixed effects, *Disaster hits investor*$_{jt-n}$ are the dummies indicating if the county of the institution's headquarters is subject to a natural disaster in Year-quarter *t-n*, θ_{gt} are the Headquarters state × Year-quarter fixed effects, and π_{lt} are Institution type × Year-quarter fixed effects. X_{jt} is a vector of control variables which are the same controls as those included in Table 5 and in previous analysis.

----Table 9 about here----

In Column (1), we use the sustainability footprint *Susty_VW* as the dependent variable. The regression produces positive and highly significant coefficient estimates for the variables *Disaster hits investor*$_{jt}$, *Disaster hits investor*$_{jt-1}$, and *Disaster hits investor*$_{jt-2}$ suggesting that footprints improve in the disaster quarter but also during the two subsequent quarters. Thus, investor responses to natural disasters emphasize the role of preferences in the channel through which price pressure on high sustainability stocks leads to performance. In our mechanism, disasters create a temporary shock to sustainability preferences for local institutional investors, who tilt their portfolios towards stocks with high sustainability scores.

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One concern might be that the disaster induced changes in the sustainability footprint are driven by the institution's holdings of local stocks: Coval and Moskowitz (1999) show that institutions invest predominantly in stocks that are located close to institutional investors' headquarters and since the sustainability footprint is also a function of the portfolio weights—and thus of the market prices of the stocks—it might be that natural disaster induced price effects of local stocks are behind the improving footprints. To address this issue, we now deliberately exclude local stock holdings from the calculation of the institution's sustainability footprint by excluding stocks that are headquartered in the same state as the institutional investor. We denote this footprint measure as *Susty_VW_HQ* and report the regression results using this measure as the dependent variable in Column (2) of Table 9. Again, the coefficient estimates on the variables *Disaster hits* $investor_{jt-n}$ are significant for $n=1,2$ and the coefficients are of similar magnitude when compared to those based on the footprint using all stock holdings (see Column (1)). In Column (3) we use equally weighted footprints which are—by definition—independent of the stock prices of the portfolio firms and again find a positive effect for *Disaster hits* $investor_{jt-n}$ at $n=1,2$. Taken together, the results from columns (1), (2), and (3) suggest that fund managers experience of natural disasters does positively affect their sustainability preferences.

In Column (4) of Table 9, we further address the possible critique that the changes in the sustainability footprint are not due to institutions' preferences for sustainability but are more likely driven by institutions' preferences for other stock characteristics (e.g., risk, market capitalization, growth, value, or quality). The idea behind this critique is as follows: when a natural disaster hits the area of an institutional investor, portfolio managers reduce the risk of the portfolio by investing, for instance, in large-cap, low-volatility, or quality stocks. Given that these characteristics are somewhat correlated with sustainability, the question is whether the disaster-induced improvement

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in the footprint is due to changes in sustainability preferences or changes in investor-level preferences for other stock characteristics (e.g., size, risk, quality). We already addressed this concern by including value-weighted portfolio-level characteristics (e.g., size, book-to-market) as in our previous tests (see Table 5 for details). An alternative way to address this issue is by using sustainability footprints based on *residual* sustainability, which isolates the component of sustainability not explained by other stock-characteristics (see Appendix B for more details on how we construct the residual sustainability footprint measure). In calculating the residual footprint, we again exclude local stock holdings and denote this measure by *Susty_VW_R_HQ*. The analysis continues to show a significant effect for the disaster dummies which is of similar magnitude to those documented in columns (1)—(3) of Table 9.

5.2. Risk-adjusted performance is more strongly related to sustainability footprints after natural disasters

Having shown that institutions improve portfolio-level sustainability footprints following temporary shocks to sustainability preferences induced by natural disasters, we now interact the residual sustainability footprint in year-quarter *t-n* (i.e., $Susty\_VW\_R\_HQ_{jt-n}$) with the corresponding dummies (i.e., *Disaster hits investor*$_{jt-n}$) to show that the positive impact of sustainability footprint on risk-adjusted investment performance is resulting from the shift in preferences and its related price pressure. We use as dependent variables *Total portfolio risk (HQ), Mean portfolio return* (HQ), *Sharpe ratio (HQ), and Alpha FF5 (HQ),* where HQ indicates that we

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calculate the performance metrics excluding holdings of local stocks.[23] We estimate specifications of the following type:

$$
\begin{aligned}
y_{jglt(t,t+9)} = \eta_j & \\
& + \sum_{n=0}^{2} (a_n \, Disaster\ hits\ investor_{jt-n} \\
& + b_n \, Disaster\ hits\ investor_{jt-n} \times Susty\_VW\_R\_HQ_{jt-n} \\
& + c_n \, Susty\_VW\_R\_\ HQ_{jt-n}) + b_n' \, X_{jt} \ + \theta_{gt} + \pi_{lt} + \epsilon_{jt},
\end{aligned}
$$

where $y_{jgl(t,t+9)}$ is the forward investment performance measure for investor *j*, of type *l*, located in state *g*, and measured in year-quarter *t*. $Susty\_VW\_R\_HQ_{jt-n}$ denotes the institution-level residual sustainability footprint in year-quarter *t-n* excluding any holdings of local stocks. $Disaster\ hits\ investor_{jt-n}$ denote the disaster dummies as previously defined. The equation again includes investor fixed effects as well as *Headquarters state*×*Year-quarter*, and *Institution type*×*Year-quarter* fixed effects. To avoid look-ahead bias, we regress *forward rolling* investment performance measures (i.e., measures between period *t* and *t+9)* on *lagged* and *current* disaster dummies and sustainability variables (i.e., between *t and t-n*). Given that disaster dummy leads to changes in portfolio in quarter t, t+1 and t+2 (see Table 10), we let *n* go from 0 to 2 in that equation.

We are mainly interested in the coefficient estimates for the interaction effects $Disaster\ hits\ investor_{jt-n} \times Susty\_VW\_R\_HQ_{jt-n}$ that is the estimates for $\boldsymbol{b_n}$. These coefficients measure whether and how portfolio sustainability is related to risk-adjusted performance for institutional investors

[23] In line with prior analysis, we calculate these performance metrics on a forward-rolling basis using windows of 10 quarters.

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experiencing natural disasters. We report the regression results for the four performance metrics in Table 10.

----Table 10 about here----

In column (2) of Table 10 we use *Mean Portfolio Return* as the dependent variable. The coefficient estimates on the interaction terms *Disaster hits investor*$_{jt-1}$ × *Susty_VW_HQ*$_{jt-1}$ and *Disaster hits investor*$_{jt-2}$ × *Susty_VW_HQ*$_{jt-2}$ are significantly positive, suggesting that following natural disasters the portfolios of higher sustainability investors earn higher returns. When we use the *Sharpe ratio* as the dependent variable, we observe a strongly positive and significant relation between the interaction terms for periods *t, t-1,* and *t-2*, suggesting that institutional investors' risk-adjusted performance and portfolio-level residual sustainability footprints are more strongly positively related following disasters (see Column (3), Table 10). We find similar positive effects when the five-factor alpha serves as the dependent variable (Column (4), Table 10).

Thus, to summarize: after natural disasters, institutional investors headquartered in affected areas experience a positive shock to their sustainability preferences and tilt their portfolios towards stocks with higher sustainability scores. The higher portfolio-level sustainability footprint leads to higher risk-adjusted performance for these institutional investors.[24] Like our prior analysis, the evidence based on natural disasters presented in this section also suggests that the link between institutional investors' sustainability footprints and portfolios' risk–adjusted performance results from price impact.

[24] Note that the direct effect of a natural disaster on risk-adjusted performance tends to be significantly negative. The interpretation of this coefficient estimate is difficult, however, because natural disasters can affect risk-adjusted performance for many reasons unrelated to sustainability (e.g., heightened risk-aversion post disaster). The direct effect absorbs all these confounding factors which we do not study in this paper and allows us to better identify the impact of higher sustainability on risk-adjusted performance, which is entirely captured by the interaction term between the dummy and the institutional-level sustainability footprint.

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6. Conclusion

In this paper, we propose a measure of the social, environmental, and overall sustainability of 13F institutional investors ("sustainability footprint"). Second, we examine the relation between sustainability footprints and risk-adjusted performance at the equity portfolio-level. We find that risk-adjusted performance of institutional investors is positively associated with their portfolios' sustainability footprints. This relation is mainly concentrated in the environmental component of the footprint, in more recent periods of the sample, and for investors with longer investment horizons.

We hypothesize that stronger sustainability preferences from investors and the resulting price pressure on stocks with higher sustainability scores explains the documented positive relation between sustainability footprints and risk-adjusted performance. We test this mechanism and find that high sustainability stocks are indeed subject to stronger price impact in the sense of Koijen and Yogo (2019), which is in line with anecdotal evidence showing that more institutions implement sustainable investing approaches in more recent years of our sample (since 2010). Consistent with this view, we also provide evidence that price pressure on high sustainability stocks is indeed stronger in more recent years.

Finally, to strengthen the case for the price pressure mechanism driving the positive relation between sustainability footprints and institutional investors' equity portfolio performance, we implement a second empirical strategy based on the occurrence of natural disasters. The evidence confirms a positive impact of the sustainability footprint on the risk-adjusted performance of those institutional investors' who experienced a natural disaster.

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Our results contribute to the literature on the relation between institutional investors' financial performance and the intensity of their environmental and social investment policies. We highlight that one of the drivers behind better risk-adjusted performance of institutional investors with better portfolio-level sustainability is the recent and growing interest of investors for stocks with high sustainability scores. This interest that led to positive price pressure on stocks with high sustainability stocks, which is essentially what explains the positive within-investor relation between sustainability footprints and risk-adjusted performance. One important practical implication of our research is that the sustainable investment might under-perform going forward, mainly because high sustainability stocks are already trading at a premium today.

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Tables and Figures

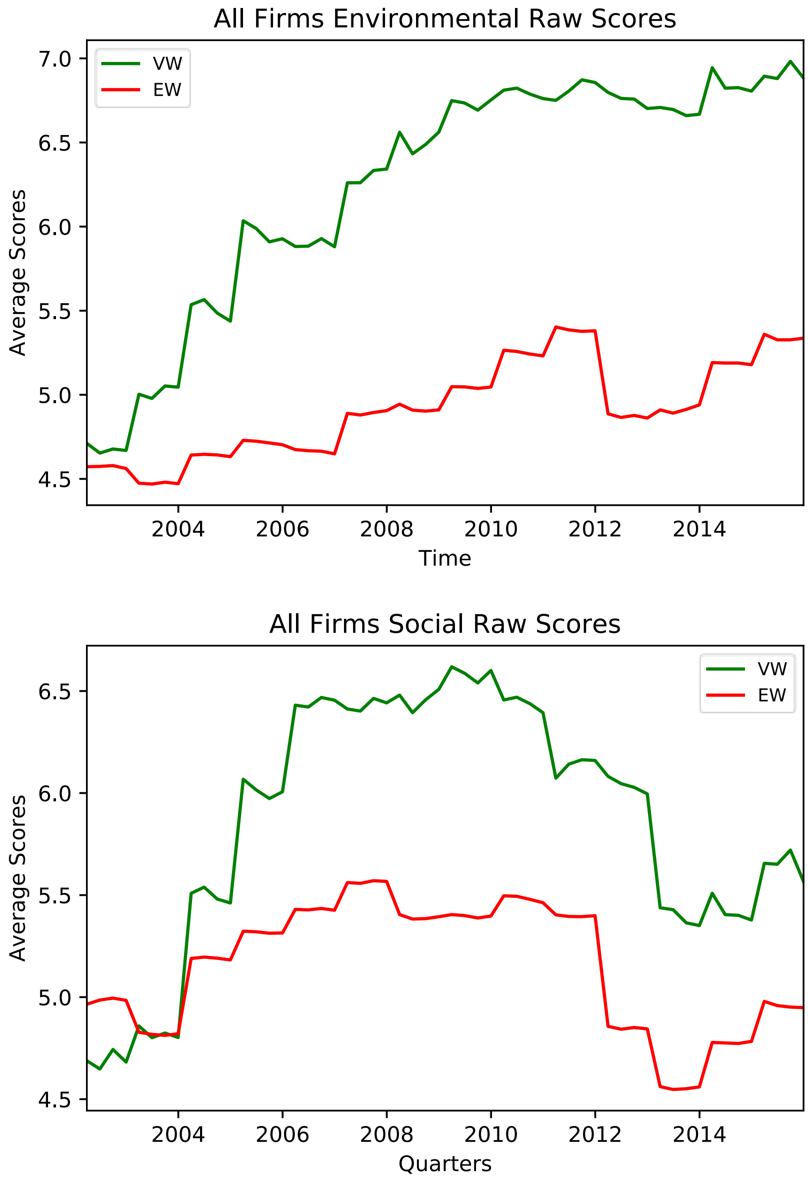

Figure 1
This figure plots the evolution of value- and equally-weighted averages for the environmental and social scores of all firms in the sample. To construct these time series, we calculate in each year-quarter the value- and equally weighted averages of the variables *Envir_Raw* and *Social_Raw* (see Table 1, Panel A).

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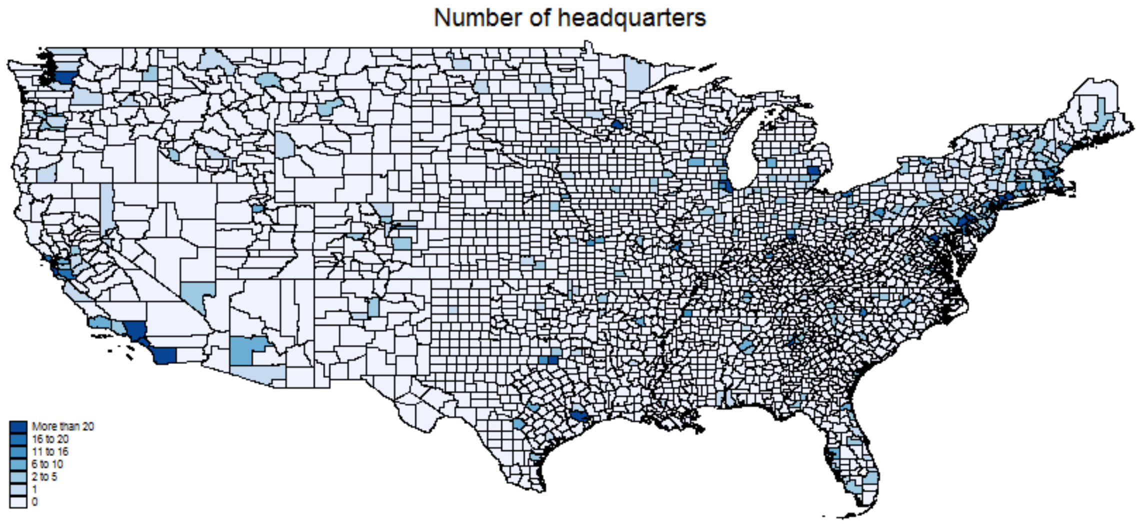
Panel A: Geographical distribution of institutional investor headquarters



Panel B: Geographical distribution of natural disasters

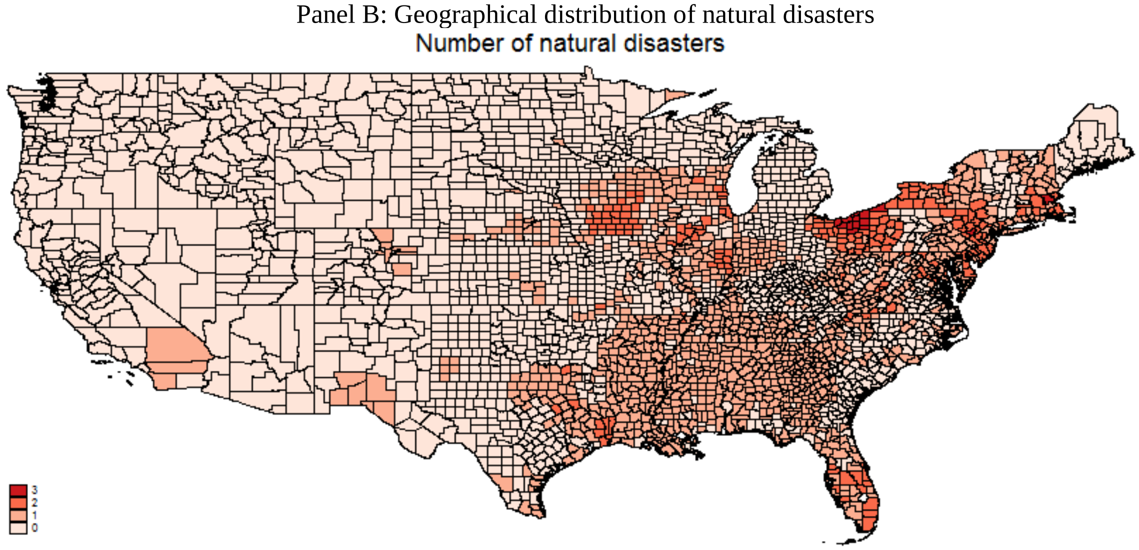


Figure 2
Panel A displays the geographic distribution of the headquarters of the 13F institutional investors. We obtain the headquarter location of the 13F institutional investors from SEC filings. Panel B shows the frequency with which counties are hit by natural disasters between 2002 and 2013.

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Table 1. Stock-level summary statistics

This table shows summary statistics of the main stock-level variables. The sample period is 2002-2015. Panel A shows summary statistics for the sample of stocks for which sustainability scores are available. For comparison, Panel B reports summary statistics for stocks belonging to the CRSP-Compustat universe over the same time period. *Envir_A4 (Social_A4)* is the stock-level environmental (social) score from Thomson Reuters (Refinitiv). *Envir_MSCI and Social_MSCI* are the corresponding stock-level scores from MSCI. *Envir_Raw* and *Social_Raw* are the average scores across MSCI and Thomson Reuters. *Susty*, *Envir*, and *Social* are the combined *z*-transformed MSCI and Thomson Reuters scores at the stock-level. *S&P 500* is a dummy variable indicating S&P500 membership. *Market cap*, *Assets*, and *Sales* are in Million \$. *Employees* is in thousands. *Roa* is return on assets. *Book to market* is book equity to market equity. *Gross profitability* is defined as in Novy-Marx (2013). *Tvol* is the rolling volatility of the firm's quarterly stock returns. *Aggregate price impact* is aggregate price impact measure for firm *j* in in quarter *t* from Koijen and Yogo (2019).

Panel A: MSCI-Thomson-CRSP-Compustat sample								
	count	mean	sd	min	p25	p50	p75	max
Envir_A4	7961	4.5557	3.191	0.826	1.550	3.549	8.023	9.747
Social_A4	7961	4.9416	2.806	0.353	2.386	4.771	7.485	9.878
Envir_MSCI	14282	4.4038	1.966	0.000	3.000	4.400	5.700	10.000
Social_MSCI	13170	4.4437	1.621	0.000	3.310	4.460	5.410	10.000
Envir_Raw	15819	4.3094	2.153	0.000	2.589	4.070	6.000	10.000
Social_Raw	15066	4.4744	1.852	0.000	3.109	4.400	5.700	10.000
Susty	15819	-0.0023	1.001	-2.820	-0.776	-0.105	0.712	3.380
Envir	15819	-0.0010	1.000	-2.198	-0.826	-0.115	0.760	2.784
Social	15066	-0.0033	1.002	-4.129	-0.730	-0.029	0.677	3.577
S&P 500	15819	0.4002	0.490	0.000	0.000	0.000	1.000	1.000
Market cap	15812	11,478.927	30,747.488	10.562	1,078.158	3,116.472	8,917.875	682,427.49
Assets	15818	25,478.194	121,206.63	7.121	1,261.676	3,746.807	12,119.000	2573126.0
Sales	15816	9,222.7322	24,809.163	-4,234.472	781.906	2,463.482	7,424.650	483,521.00
Employees	15740	26.1949	79.409	0.000	2.000	7.000	22.005	2,300.000
Capex / Fixed assets	14946	0.2567	0.208	-0.156	0.123	0.197	0.318	1.499
Liabilities / Assets	15768	0.5897	0.255	0.003	0.419	0.588	0.754	2.845
Cash/Fixed assets	15818	0.1596	0.183	0.000	0.033	0.091	0.216	0.996
Roa	15562	0.0380	0.093	-0.477	0.010	0.041	0.081	0.503
Book to market	14926	0.5933	0.464	0.001	0.274	0.479	0.781	3.757
Gross profitability	14994	0.2977	0.252	-1.317	0.120	0.262	0.424	2.071
Tvol	15776	0.0236	0.012	0.000	0.015	0.021	0.029	0.148
Aggregate price impact	615789	2.9780	0.852	0.114	2.389	2.940	3.464	23.267
Panel B: CRSP-Compustat sample								
	count	mean	sd	min	p25	p50	p75	max
S&P 500	71141	0.1042	0.306	0.000	0.000	0.000	0.000	1.000
Market cap	70522	3,180.2981	15,822.938	0.471	75.418	301.099	1,261.885	682,427.49
Assets	71076	7,051.2451	59,501.306	0.000	102.278	460.238	1,904.238	2573126.0
Sales	71011	2,638.7234	12,533.798	-4,234.472	48.900	236.326	1,152.118	483,521.00
Employees	70095	8.6656	42.346	0.000	0.198	0.876	4.407	2,300.000
Capex / Fixed assets	57085	0.2686	0.249	-0.654	0.104	0.192	0.348	1.500
Liabilities / Assets	70767	0.5549	0.300	0.000	0.320	0.541	0.781	2.845
Cash/Fixed assets	71071	0.2022	0.236	-0.002	0.033	0.099	0.290	1.000
Roa	66124	0.0030	0.121	-0.480	-0.013	0.018	0.062	0.507
Book to market	61407	0.7181	0.582	0.000	0.320	0.573	0.934	3.759
Gross profitability	62677	0.2792	0.299	-1.578	0.068	0.249	0.433	2.071
Tvol	70375	0.0361	0.022	0.000	0.020	0.030	0.045	0.155

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Table 2. Institutional investor-level summary statistics

This table shows summary statistics at the institutional investor-level. *Susty_VW* is the value-weighted sustainability footprint of the institutional investor. *Susty_VW_HQ* is the value-weighted sustainability footprint of the institutional investor calculated excluding holdings of stocks with headquarters located in the same state as the institutional investor. *Susty_VW_R* is the residual sustainability footprint, where the stock level sustainability residual rank is calculated using the difference between the actual stock level-sustainability rank and a predicted stock-level sustainability rank, where the predictors are market equity, book-to-market, gross profitability, and total volatility (see Appendix B for more details). *Susty_EW* is the equally weighted sustainability footprint. We also calculate these footprints individually for the social and environmental dimension. *Turnover* is the four quarter rolling average quarterly portfolio turnover. *Return (Quarterly)* is the investor's quarterly holdings return. *Mean portfolio return* is the ten quarter forward rolling average of the quarterly holdings return (calculated between period t and $t+9$). *Total portfolio risk* is the forward rolling standard deviation of the holdings returns. *Sharpe ratio* is forward rolling Sharpe ratio. *Alpha FF5 is* the alpha from a Fama & French (2015) five factor model estimated using rolling windows of 10 quarters. *Beta_mkt*, *Beta_smb*, *Beta_hml*, and *Beta_qcma,* and *Beta_qrmw* are the corresponding factor exposures. *Assets* is the size of the institutional investor's common stock holdings (in bn. $). *# Stocks* is the number of stocks in the investor's portfolio. *# Industries<=2* is a dummy variable indicating if the institutional investor's portfolio firms belong to two or fewer two-digit SIC industries. Appendix A provides more information on holdings returns, performance measures, and controls at the institutional investor-level. *Stock holdings* is the dollar value invested by institutional investor i in a given firm j in year-quarter t, divided by the total value of the stock portfolio of investor. *Coverage (Value)* is the percentage of the investor's portfolio value for which stock-level sustainability scores are available. *BM_VW, GP_VW*, *ME_VW*, and *TVOL_VW* are value-weighted average of characteristics of the institution's equity portfolio (book-to-market, gross profitability, the natural logarithm of market capitalization, and total volatility). To reduce the impact of statistical outliers, all variables except the footprint measures are trimmed by removing observations for which the value of a variable deviates from the median by more than five times the interquartile range.

	count	mean	sd	min	p25	p50	p75	max
Susty_VW	147413	0.638	0.150	0.001	0.559	0.670	0.744	0.999
Susty_VW_HQ	107592	0.640	0.153	0.001	0.559	0.672	0.749	0.997
Susty_VW_R	147122	0.073	0.120	-0.630	0.016	0.095	0.150	0.880
Envir_VW	147408	0.638	0.148	0.001	0.560	0.665	0.742	0.999
Envir_VW_HQ	107584	0.641	0.151	0.002	0.561	0.669	0.748	0.999
Envir_VW_R	147117	0.078	0.121	-0.671	0.019	0.099	0.155	0.934
Social_VW	147160	0.615	0.143	0.001	0.542	0.641	0.711	1.000
Social_VW_HQ	107378	0.615	0.144	0.001	0.542	0.642	0.713	0.999
Social_VW_R	146863	0.054	0.115	-0.646	0.004	0.073	0.121	0.807
Susty_EW	147413	0.609	0.126	0.001	0.539	0.619	0.694	0.999
Envir_EW	147408	0.609	0.124	0.001	0.539	0.615	0.692	0.999
Social_EW	147160	0.591	0.118	0.001	0.530	0.602	0.667	1.000
Turnover	132709	0.124	0.123	0.000	0.039	0.080	0.166	0.702
Return (Quarterly)	147559	2.137	10.897	-77.866	-2.434	2.858	7.882	432.031
Mean portfolio return	97734	2.602	2.850	-14.829	1.211	2.964	4.290	20.469
Mean portfolio DGTW return	96914	0.046	1.106	-5.329	-0.484	0.014	0.516	5.410
Total portfolio risk	97696	0.085	0.044	0.005	0.049	0.079	0.109	0.381
Sharpe ratio	97779	0.373	0.415	-1.827	0.089	0.391	0.622	2.596
Alpha FF5	96974	0.117	2.254	-9.938	-0.844	0.025	1.008	10.029
Beta_mkt	121241	1.002	0.362	-0.599	0.841	0.986	1.139	2.571
Beta_smb	121549	0.128	0.655	-2.933	-0.187	0.052	0.397	3.044
Beta_hml	121442	0.037	0.628	-2.799	-0.230	0.019	0.301	2.838
Beta_qcma	121371	-0.116	0.812	-3.687	-0.432	-0.045	0.250	3.607
Beta_qrmw	120830	-0.026	0.769	-3.239	-0.323	0.035	0.326	3.301
Assets	150840	4.196	27.398	0.000	0.137	0.335	1.281	1,413.680
# Stocks	150845	193.974	405.771	1.000	30.000	69.000	158.000	4,282.000
# Industries<=2	150845	0.047	0.213	0.000	0.000	0.000	0.000	1.000
Stock holdings	21500000	0.0037	0.008	0.000	0.000	0.000	0.003	0.060
Coverage (Value)	150845	0.777	0.278	0.000	0.664	0.903	0.985	1.000
BM_VW	148804	0.537	0.212	0.003	0.403	0.492	0.618	1.591
GP_VW	149741	0.295	0.092	-0.137	0.256	0.301	0.343	0.740
ME_VW	150845	10.390	1.450	1.602	9.744	10.920	11.412	13.494
TVOL_VW	150336	0.021	0.009	0.002	0.015	0.019	0.025	0.070

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Table 3. Institutional investors' stock holdings and sustainability scores

This table shows the results from regressions in which we relate institutional investors' individual stock holdings to the stock's sustainability scores. The dependent variable is the dollar value invested by institutional investor *i* in a given firm *j* in year-quarter *t*, divided by the total value of the stock portfolio of investor *i* in quarter *t*, which we denote by *Stock holdings*. The main independent variables are firm *j*'s lagged overall sustainability, environmental, and social scores. We control for various lagged firm characteristics that are likely to affect the weights, namely book-to-market, gross profitability, return on assets, stock returns, market capitalization, market beta, and stock return volatility. We multiply the estimated coefficients by 100. The regressions include Investor×Firm fixed effects, time varying investor fixed effects, and time varying industry fixed effects. Standard errors are double-clustered at the Investor × Year-quarter and Firm × Year-quarter level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
Susty	0.0162***		
	(5.77)		
Envir		0.0122***	
		(5.04)	
Social			0.0117***
			(6.58)
Control variables	Yes	Yes	Yes
Investor × Firm FE	Yes	Yes	Yes
Investor × Year-quarter FE	Yes	Yes	Yes
Industry × Year-quarter FE	Yes	Yes	Yes
R-squared	0.802	0.802	0.804
Observations	15793207	15781456	15370327

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Table 4. Price impact (Koijen and Yogo, 2019) and sustainability scores

This table shows the results from regressions in which we relate institutional investors' aggregate price impact to firms' sustainability scores. The dependent variable is institutional investors' aggregate price impact on stock *j* in year-quarter *t* (as defined in Koijen and Yogo, 2019). The measure is described in Section 4.2. The main independent variables are the overall firm-level sustainability score *(Susty)*, as well as individual the components *(Envir* and *Social)*. We control for various firm characteristics, namely book-to-market, gross profitability, return on assets, stock returns, market capitalization, market beta, and stock return volatility. We include time varying industry fixed effects. Standard errors are double clustered at the firm and year-quarter level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Aggregate price impact	(2) Aggregate price impact	(3) Aggregate price impact	(4) Aggregate price impact	(5) Aggregate price impact	(6) Aggregate price impact
Susty	0.0445**			-0.0332		
	(2.24)			(-1.31)		
Envir		0.0555***			-0.0278	
		(3.19)			(-1.19)	
Social			0.0116			-0.0309
			(0.70)			(-1.38)
post2010 × Susty				0.1311***		
				(4.34)		
post2010 × Envir					0.1296***	
					(4.68)	
post2010 × Social						0.0662**
						(2.50)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.393	0.394	0.390	0.394	0.396	0.391
Observations	145732	145622	142157	145732	145622	142157

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Table 5. Investment performance as a function of sustainability footprints

This table shows the results from panel regressions of standard investment performance measures computed at the institutional investors' equity portfolio level on the overall sustainability (Panel A), the environmental (Panel B), and the social (Panel C) footprints. Performance metrics are calculated using forward rolling windows of ten quarters, that is between quarter t and $t+9$. Sustainability footprints are measured as of quarter t. In column (1), the dependent variable is the institution's mean quarterly portfolio return. The dependent variable in column (2) is the standard deviation of the investor's portfolio returns. The dependent variable in column (3) is the Sharpe ratio and in column (4) the alpha resulting from a Fama and French 5 Factor model. All regressions control for *Turnover, Ln(# Stocks), the # Industries<=2* dummy, the natural logarithm of the total value of the investor's stock portfolio, that is *ln(Assets), Coverage (Value)*, which is the percentage of the investor's portfolio value for which stock-level sustainability scores are available. We also control for the value-weighted average of portfolio characteristics *BM_VW, GP_VW, ME_VW*, and *TVOL_VW* (book-to-market, gross profitability, the natural logarithm of market capitalization, and total volatility). Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Sustainability footprint				
	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
Susty_VW	0.675***	-0.004*	0.070***	0.558**
	(3.12)	(-1.80)	(2.98)	(2.47)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.817	0.856	0.861	0.276
Observations	95062	95033	95075	92866
Panel B: Environmental footprint				
	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
Envir_VW	1.346***	-0.003	0.146***	0.734***
	(6.27)	(-1.46)	(6.10)	(3.33)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.817	0.856	0.862	0.277
Observations	95058	95029	95071	92864
Panel C: Social footprint				
	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
Social_VW	-0.358*	-0.003	-0.052**	0.037
	(-1.66)	(-1.51)	(-2.30)	(0.17)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.827	0.875	0.863	0.287
Observations	89653	89630	89666	87458

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Table 6. Investment performance as a function of sustainability footprints: Differences in the time-series

In this table we examine whether the relation between institutional investors' equity portfolio level risk-adjusted performance and sustainability footprints is different in the later part of the sample period. In the regressions, we interact the sustainability footprint measures with a *post2010* dummy. We use the same control variables as in Table 5. Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Sharpe ratio	(2) Alpha FF5	(3) Sharpe ratio	(4) Alpha FF5	(5) Sharpe ratio	(6) Alpha FF5
Susty_VW	0.008 (0.32)	0.184 (0.79)				
Envir_VW			0.077*** (3.31)	0.356 (1.57)		
Social_VW					-0.100*** (-4.33)	-0.313 (-1.37)
post2010=1 × Susty_VW	0.302*** (8.24)	2.001*** (6.25)				
post2010=1 × Envir_VW			0.329*** (8.67)	1.986*** (6.16)		
post2010=1 × Social_VW					0.250*** (6.35)	2.032*** (5.87)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.854	0.292	0.854	0.292	0.853	0.292
Observations	84461	82127	84461	82127	84349	82014

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Table 7. Investment performance as a function of sustainability footprints: The role of investment horizon

This table shows the relation between institutional investors' equity portfolio level risk-adjusted performance and sustainability footprints for different levels of portfolio turnover. In the regressions, we interact tercile dummies based on *Turnover* with the sustainability footprint measures. Tercile dummies are calculated in each year-quarter. The regressions examine the relation between risk-adjusted performance and the sustainability footprint for investors with low, medium, and high turnover. Turnover is defined as the lesser of dollar purchases or sales since the last portfolio holdings snapshot divided by the average dollar value of holdings during the quarter (see Carhart, 1997). We use a four quarter moving average of turnover. We use the same control variables as in Table 5. Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Sharpe ratio	(2) Alpha FF5	(3) Sharpe ratio	(4) Alpha FF5	(5) Sharpe ratio	(6) Alpha FF5
Medium turnover	0.05024**	0.03137	0.07593***	0.28535	0.01073	-0.30268
	(2.17)	(0.13)	(3.16)	(1.23)	(0.47)	(-1.15)
High turnover	0.06520**	0.32116	0.10505***	0.60900**	0.00193	-0.07960
	(2.29)	(1.16)	(3.58)	(2.30)	(0.07)	(-0.27)
Susty_VW	0.11377***	0.75823**				
	(2.99)	(2.19)				
Medium turnover × Susty_VW	-0.05478*	-0.03647				
	(-1.67)	(-0.11)				
High turnover × Susty_VW	-0.06298	-0.43041				
	(-1.56)	(-1.09)				
Envir_VW			0.22870***	1.23867***		
			(5.74)	(3.80)		
Medium turnover × Envir_VW			-0.09430***	-0.41979		
			(-2.73)	(-1.27)		
High turnover × Envir_VW			-0.12585***	-0.87651**		
			(-2.99)	(-2.29)		
Social_VW					-0.06763*	-0.17478
					(-1.81)	(-0.47)
Medium turnover × Social_VW					0.00431	0.47235
					(0.13)	(1.25)
High turnover × Social_VW					0.03451	0.18454
					(0.86)	(0.44)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.852	0.290	0.853	0.290	0.853	0.290
Observations	84461	82127	84461	82127	84349	82014

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Table 8. Sample of natural disasters

This table summarizes information on the natural disasters we use in the present study. The columns show the name of the disaster, the date of its occurrence, and the states with counties affected by the disaster. The natural disaster data come from SHELDUS (Spatial Hazard and Loss Database for the United States). For each natural disaster, the database provides information on the start date, the end date, and the Federal Information Processing Standards (FIPS) code of all affected counties. Following Barrot and Sauvagnat (2016), we use only major disasters, which are defined as disasters lasting less than 30 days with total estimated damages above $1 billion (in constant 2013 dollars).

Natural disaster	Date	Affected states
Hurricane Isabel	2003q3	DE, MD, NC, NJ, NY, PA, VA, VT, WV
Southern California Wildfires	2003q4	CA
Hurricane Jeanne	2004q3	FL, GA, MD, NC, SC, VA
Hurricane Frances	2004q3	AL, FL, GA, KY, MD, NC, NY, OH, PA, SC, VA, WV
Hurricane Ivan	2004q3	AL, FL, GA, KY, MD, MS, NC, NH, NY, PA, SC, TN, WV
Hurricane Charley	2004q3	FL, GA, NC
Hurricane Rita	2005q3	AL, AR, LA, MS, TX
Hurricane Katrina	2005q3	AL, AR, FL, GA, IN, KY, LA, MI, MS, OH, TN
Hurricane Dennis	2005q3	AL, FL, GA, MS, TN
Hurricane Wilma	2005q4	FL
Midwest Floods	2008q2	IA, IL, IN, MN, MO, NE, WI
Hurricane Ike	2008q3	AR, LA, MO, TN, TX
Hurricane Gustav	2008q3	AR, LA, MS
Blizzard Groundhog Day	2011q1	CT, IA, IL, IN, KS, MA, MO, NM, NY, OH, OK, PA, TX, WI
Tropical Storm Lee	2011q3	AL, GA, LA, MS, NJ, NY, PA, TN, VA
Hurricane Irene	2011q3	CT, MA, MD, NJ, NY, VA, VT
Hurricane Isaac	2012q3	FL, LA, MS
Hurricane Sandy	2012q4	CT, DE, MA, MD, NC, NH, NJ, NY, OH, PA, RI, VA, WV
Flooding and Severe Weather Illinois	2013q2	IL, IN, MO
Flooding Colorado	2013q3	CO

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Table 9. Sustainability footprint around natural disasters

This table shows the results from regressions in which we relate the institutional investor's equity portfolio sustainability footprint in quarter *t* to dummy variables indicating whether the county of the institutional investor's headquarters is hit by a natural disaster in quarter *t-n*. For example, the variable *Disaster hits investor*$_{jt}$ is equal to one if the county of the institutional investor *j's* headquarters is subject to a natural disaster in quarter *t*, and equal to zero otherwise. In a similar way, the variable *Disaster hits investor*$_{jt-1}$ indicates that an institution was hit by a disaster one quarter ago. The dependent variable in column (1) is the value-weighted sustainability footprint. In column (2) we use the value-weighted sustainability footprint excluding the institution's holdings of firms that are headquartered in the same state as the institutional investor. In column (3) we use the equally weighted sustainability footprint (calculated using all the holdings of the institution). In column (4) we use the footprint based on the *residual* sustainability as the dependent variable. In calculating the residual sustainability footprints we also exclude holdings of stocks that are headquartered in the same state as the institutional investor. We use the same control variables as in Table 5. In column (4), we exclude controls based on firm characteristics. Standard errors are clustered at the institutional investor level and ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Susty_VW	(2) Susty_VW_HQ	(3) Susty_EW	(4) Susty_VW_R_HQ
Disaster hits investor (t)	0.0077**	0.0047	0.0028	0.0085**
	(2.11)	(1.29)	(0.91)	(2.33)
Disaster hits investor (t-1)	0.0081**	0.0076*	0.0061*	0.0078**
	(2.09)	(1.96)	(1.84)	(2.15)
Disaster hits investor (t-2)	0.0070*	0.0091**	0.0076**	0.0082**
	(1.75)	(2.20)	(2.31)	(2.09)
Disaster hits investor (t-3)	0.0016	0.0017	0.0028	0.0009
	(0.35)	(0.34)	(0.81)	(0.19)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
HQ State × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.757	0.741	0.735	0.581
Observations	67292	66952	67292	67571

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Table 10. Investment performance, sustainability footprints, and natural disasters

In this table we regress forward rolling institutional investors' equity portfolio performance measures (*Total portfolio risk*, *Mean portfolio return*, *Sharpe ratio*, and *Alpha FF5)* on dummy variables indicating whether the county of the institutional investor's headquarters is hit by a natural disaster in quarter *t* (i.e., *Disaster hits investor*$_{jt-n}$*)*, the residual sustainability footprint in quarter *t* calculated excluding holdings of stocks that are headquartered in the same state as the institutional investor (i.e., *Susty_VW_R_HQ*$_{jt-n}$*)*, and the corresponding interaction terms *Disaster hits investor*$_{jt-n}$ × *Susty_VW_R_HQ*$_{jt-n}$. In calculating the performance metrics, we use forward rolling windows of 10 quarters (between *t* and *t+9*) based on a time series of institution-level quarterly portfolio returns that excludes holdings of stocks that are headquartered in the same state as the institutional investor. All regressions include control variables *# Industries<=2*, ln(*# Stocks)*, *Turnover*, and *ln(Assets)*. Standard errors are clustered at the institutional investor level and ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Total portfolio risk (HQ)	(2) Mean portfolio return (HQ)	(3) Sharpe ratio (HQ)	(4) Alpha FF5 (HQ)
Disaster hits investor (t)	-0.0004	-0.1517**	-0.0337**	-0.4660***
	(-0.36)	(-1.96)	(-2.56)	(-3.38)
Susty_VW_R_HQ(t)	0.0011	0.3353	0.0277	0.4231
	(0.42)	(1.54)	(1.36)	(1.48)
Disaster hits investor (t) × Susty_VW_R_HQ(t)	0.0076	0.4686	0.2591***	3.5321***
	(1.12)	(0.92)	(3.31)	(3.51)
Disaster hits investor (t-1)	-0.0011	-0.1553**	-0.0119	-0.4575***
	(-1.12)	(-1.97)	(-0.87)	(-2.99)
Susty_VW_R_HQ(t-1)	0.0025	0.3130**	0.0310**	0.1906
	(1.23)	(2.17)	(2.38)	(0.82)
Disaster hits investor (t-1) × Susty_VW_R_HQ(t-1)	0.0049	1.0838**	0.0869	3.4266***
	(0.83)	(1.97)	(1.14)	(3.25)
Disaster hits investor (t-2)	-0.0018*	-0.1536*	-0.0100	-0.2606*
	(-1.82)	(-1.71)	(-0.69)	(-1.92)
Susty_VW_R_HQ(t-2)	-0.0017	-0.1030	-0.0076	-0.5229**
	(-0.77)	(-0.54)	(-0.37)	(-2.03)
Disaster hits investor (t-2) × Susty_VW_R_HQ(t-2)	0.0110*	1.1091*	0.1221	2.5556**
	(1.93)	(1.84)	(1.39)	(2.56)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
HQ State × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.866	0.802	0.849	0.296
Observations	56111	56113	56136	53697

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Appendix A: Holdings returns, performance measures, and control variables

A.1. Portfolio returns

In this paper we examine whether risk-adjusted portfolio performance is associated with investors' sustainability footprints. To this end, we calculate a holdings-based return measure at the institutional investor portfolio-level based on reported holdings in quarterly 13F filings. We denote this holdings-based return by *Return (Quarterly).* The variable measures the value-weighted quarterly portfolio return of the institutional investor as the hypothetical holdings returns of the long portion of the institutional investor's equity portfolio. The portfolio return is computed assuming that positions are held until the new quarterly holdings are observed and that trades occur only at the end of the quarter. This is a constraint imposed by the 13F holdings data, which is only available at the quarterly frequency. We thus miss all positions that were traded in and out during the quarter. We also miss returns from other securities (e.g., fixed income) as well as fees and transaction costs. Our return measure based on 13F filings should thus be seen as reflecting the return on the long leg of institutions' equity holdings. For a sample of mutual funds at the monthly frequency, Kacperczyk, Sialm, and Zheng (2008) compare returns calculated from holdings data with reported returns. They find dispersion in the difference between reported and holdings returns, but document that the difference is on average close to zero.

Based on the quarterly holdings return time series we calculate several risk-adjusted performance metrics at the investor-level. To avoid look-ahead bias, we focus on performance metrics calculated on a forward rolling basis using windows of 10 quarters (i.e., between year-quarters t and $t+9$). The main dependent variables are *Mean portfolio return*$_{j(t,t+9)}$, which is the mean quarterly return of investor j between year-quarter t and $t+9$. *Total portfolio risk*$_{j(t,t+9)}$ denotes the standard deviation of quarterly returns of investor j between periods t and $t+9$. *Sharpe*

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ratio$_{j(t,t+9)}$ is simply the ratio between the mean quarterly return of investor *j* between *t* and *t+9* in excess of the risk free rate normalized by *Total portfolio risk*. Using the same rolling forward windows, we also calculate a Fama and French (2015) five factor alpha denoted by *Alpha_FF5* and the corresponding five factor exposures *Beta_mkt*, *Beta_smb*, *Beta_hml*, *Beta_qcma*, and *Beta_qrmw*.

Table 2 reports cross sectional summary statistics for the distribution of our risk-adjusted performance metrics. The quarterly average *Mean portfolio return* is 2.6 percent. For comparison, the 10-quarter rolling average return on the value-weighted CRSP market return for the same period was 2.5 percent, thus of similar magnitude. The average rolling quarterly *Sharpe ratio* is about 0.373. The average five factor alpha is 0.117 percent.

A.2. Control variables

We calculate several other characteristics at the institutional investor portfolio-level, such as the size of the common stock holdings *(Assets)*, number of stocks *(# stocks)*, and the number of SIC2 industries in which the investor holds positions.

Froot, Perold, and Stein (1992) suggest that portfolio turnover can be used as a proxy of investor horizon. We follow this proposition and calculate portfolio turnover at the institutional investor-level, in line with Carhart (1997), as the minimum of the absolute values of aggregated sales and aggregated purchases during a quarter divided by the average total net asset value of the investor's portfolio during the quarter, that is

$$\text{Turnover}_{\text{jt}} = \min(|Buy_{jt}|, |Sale_{jt}|)/0.5 \times (TNA_{jt} + TNA_{jt-1}),$$

where Buy_{jt} is the total dollar value of buys, $Sale_{jt}$ the total dollar value of sales since the last filing, and TNA_{jt} is the total net asset value of all equity holdings of investor *j* at date *t*. We assume

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that all trading happens at date *t* and at prices at the end of period *t-1* (see Wermers (2000), Brunnermeier and Nagel (2004), or Ben-David, Franzoni, and Moussawi 2012). Because *Turnover* is calculated using quarterly holding snapshots, it does not capture trading at frequencies higher than one quarter and thus understates trading activity. As Chen, Jegadeesh, and Wermers (2000) note, the above definition of turnover captures institutional investor trading that is unrelated to investor inflows or redemptions.

Finally, we also use an investor classification based on Bushee (2001) and Abarbanell, Bushee, and Raedy (2003) to control for the fact that the behavior of institutional investors is likely to depend on their legal type. It seems plausible that different institutions may be subject to differences in preferences, investment horizons, incentives, trading, and investment strategies driven in part by the regulatory constraints that these investors are facing (see, for instance, Gompers and Metrick, 2001; Bennett, Sias, and Starks, 2003; or Cella, Ellul and Giannetti, 2013). The classification distinguishes between banks, insurance companies, corporate pension funds, public pension funds, investment companies, independent investment advisors, university and foundation endowments, and a category of miscellaneous institutions. We refer to this classification as *Institution type.*

As Table 2 shows, the average (median) size of the investor's common stock holdings (i.e. the variable *Assets*) is \$4.196bn (\$0.335bn). There is considerable skewness and dispersion in terms of the size of the investors' equity holdings: some institutions are negligibly small, while others are gigantic with common stock holdings in excess of \$1tn. The average (median) institution holds 194 (69) stocks and less than 5 percent of investor-Year-quarter observations belong to institutions that are invested in two or fewer SIC2 industries. Thus, overall institutional investors' stock holdings appear to be relatively well diversified. The variable *Coverage (Value)* shows that on

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average, about 78 % of the institutional investor's portfolio value is covered by stock-level sustainability scores, suggesting that our stock-level sustainability scores generally cover the majority of stocks in which the average 13F investor invests. When looking at the median investor, *Coverage (Value)* is even higher (about 90 percent).

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Appendix B: Controlling for the possibility that the sustainability footprint is simply a proxy for other stock-level characteristics

The idea of residual sustainability is to isolate the portion of a stock's sustainability that is not explained by other stock-level characteristics. To calculate residual sustainability, we run a cross-sectional regression of sustainability on stock characteristics in each year-quarter *t*. Excess or residual sustainability is then simply the residual from this cross-sectional regression. We use market equity *(me)*, book-to-market *(bm)*, gross profitability *(gp)*, and total volatility *(tvol)* as predictors in this regression (see Dunn, Fitzgibbons, and Pomorski, 2018). Given that we use normalized ranks of sustainability in the calculation of our footprint measures, we also rank transform the stock-level characteristics in the estimation of residual sustainability. Formally, we estimate

$$rk_t(y_{it}) = a + b_{me} rk_t(me_{it}) + b_{bm} rk_t(bm_{it}) + b_{gp} rk_t(gp_{it}) + b_{tvol} rk_t(tvol_{it}) + e_{it}$$

at each date *t*. In this regression y_{it} is either *Envir*, *Social*, or *Susty* (see Table 1, Panel A). Residual sustainability is simply the residual from this regression and captures the component of sustainability not explained by the characteristics used in the regression.

To rule out that other stock characteristics are driving our performance results, we repeat the performance analysis from Table 5 using residual sustainability at the stock-level to construct the institutional sustainability footprints. We denote footprints based on residual sustainability firms' scores as *Susty_VW_R*, *Envir_VW_R*, and *Social_VW_R.* The results are reported in Table B.1.

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Table B.1. Investment performance as a function of *residual* sustainability footprints

This table shows regressions of investment institutional investors' equity portfolio level performance measures on the footprints calculated using residual sustainability. Panel A shows results for the overall sustainability footprint. Panel B, C, and D display the results for the environmental, social, and governance dimension individually. All regressions control for *Turnover*, *Ln(# Stocks)*, the *# Industries<=2* dummy, and the natural logarithm of the total value of the investor's stock portfolio denoted by *ln(Assets)*. Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Sustainability footprint				
	(1) Mean portfolio return	(3) Total portfolio risk	(4) Sharpe ratio	(5) Alpha FF5
Susty_VW_R	0.421**	-0.005**	0.064***	0.550**
	(2.04)	(-2.16)	(2.65)	(2.48)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.803	0.872	0.846	0.289
Observations	85267	85243	85282	82857
Panel B: Environmental footprint				
Envir_VW_R	1.061***	-0.006**	0.129***	0.764***
	(5.22)	(-2.45)	(5.42)	(3.54)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.804	0.872	0.846	0.290
Observations	85267	85243	85282	82857
Panel C: Social footprint				
Social_VW_R	-0.427**	-0.003	-0.034	0.057
	(-2.12)	(-1.34)	(-1.45)	(0.26)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.803	0.873	0.846	0.290
Observations	85134	85110	85149	82729

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Internet appendix to

The Sustainability Footprint of Institutional Investors: ESG Driven Price Pressure and Performance

Rajna Gibson Brandon, Philipp Krueger, and Shema F. Mitali

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Section IA.1. Robustness checks: Alternative ways of controlling for coverage and liquidity

Internet Appendix Table IA.1. Institutional investors' stock holdings and sustainability scores – S&P 500 only

This table shows the results from regressions in which we relate institutional investors' individual stock holdings in S&P 500 firms to their sustainability scores. The dependent variable is the dollar value invested by institutional investor *i* in a given firm *j* in year-quarter *t*, divided by the total value of the stock portfolio of investor *i* in quarter *t*, which we denote by *Stock holdings*. The main independent variables are firm *j*'s lagged overall sustainability, environmental, and social scores. The sample is restricted to S&P500 stocks. We control for various lagged firm characteristics that are likely to affect the weights, namely book-to-market, gross profitability, return on assets, stock returns, market capitalization, market beta, and stock return volatility. We multiply the estimated coefficients by 100. The regressions include Investor×Firm fixed effects, time varying investor fixed effects, and time varying industry fixed effects. Standard errors are double-clustered at the Investor × Year-quarter and Firm × Year-quarter level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
Susty	0.0209***		
	(5.14)		
Envir		0.0190***	
		(5.45)	
Social			0.0134***
			(4.79)
Control variables	Yes	Yes	Yes
Investor × Firm FE	Yes	Yes	Yes
Investor × Year-quarter FE	Yes	Yes	Yes
Industry × Year-quarter FE	Yes	Yes	Yes
R-squared	0.792	0.792	0.794
Observations	10994752	10986588	15370327

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Internet Appendix Table IA.2. Investment performance as a function of sustainability footprints (Footprint calculated

This table shows the results from panel regressions of standard investment performance measures computed at the institutional investors' equity portfolio level on the overall sustainability (Panel A), the environmental (Panel B), and the social (Panel C) footprint. The sustainability footprints are calculated using only the 13F institution's holdings in S&P500 firms. Performance metrics are calculated using forward rolling windows of ten quarters, that is between quarter *t* and *t+9*. Sustainability footprints are measured as of quarter *t*. In column (1), the dependent variable is the institution's mean quarterly portfolio return. The dependent variable in column (2) is the standard deviation of the investor's portfolio returns. The dependent variable in column (3) is the Sharpe ratio and in column (4) the alpha resulting from a Fama and French 5 Factor model. All regressions control for *Turnover*, *Ln(# Stocks), the # Industries<=2* dummy, and the natural logarithm of the total value of the investor's stock portfolio that is *ln(Assets)*. We also control for the value-weighted average of portfolio characteristics *BM_VW*, *GP_VW*, *ME_VW*, and *TVOL_VW* (book-to-market, gross profitability, the natural logarithm of market capitalization, and total volatility). Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Sustainability footprint

	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
SUSTY_ALL_VW_SP	0.419**	-0.004	0.050**	0.680***
	(2.02)	(-1.63)	(2.25)	(3.06)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.816	0.883	0.854	0.293
Observations	82998	82980	83011	80914

Panel B: Environmental footprint

	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
E_ALL_VW_SP	0.956***	-0.003	0.121***	0.904***
	(4.95)	(-1.13)	(5.57)	(4.14)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.817	0.883	0.855	0.293
Observations	82998	82980	83011	80914

Panel C: Social footprint

	(1) Mean portfolio ret.	(2) Total portfolio risk	(3) Sharpe ratio	(4) Alpha FF5
S_ALL_VW_SP	-0.313	-0.003	-0.052**	0.104
	(-1.51)	(-1.44)	(-2.49)	(0.50)
Control variables	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes
Institution type × Year-quarter FE	Yes	Yes	Yes	Yes
Country × Year-quarter FE	Yes	Yes	Yes	Yes
R-squared	0.817	0.883	0.855	0.293
Observations	82856	82838	82869	80773

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Internet Appendix Table IA.3. Price impact (Koijen and Yogo, 2019) and sustainability scores - Controlling for liquidity

This table shows the results from regressions in which we relate institutional investors' aggregate price impact to firms' sustainability scores. The dependent variable is institutional investors' aggregate price impact on stock *j* in year-quarter *t* (as defined in Koijen and Yogo, 2019). The measure is described in Section 4.2. The main independent variables are the overall firm-level sustainability score *(Susty)*, as well as individual the components *(Envir* and *Social)*. We control for various firm characteristics, including liquidity measures (daily bid-ask spread averaged within a quarter in Panel A and daily share turnover averaged within a quarter in Panel B, which is the number of shares traded divided by the number of shares outstanding). We also control for book-to-market, gross profitability, return on assets, stock returns, market capitalization, market beta, and stock return volatility. We include time varying industry fixed effects. Standard errors are double clustered at the firm and year-quarter level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Bid-Ask Spread						
	(1) Aggregate price impact	(2) Aggregate price impact	(3) Aggregate price impact	(4) Aggregate price impact	(5) Aggregate price impact	(6) Aggregate price impact
Susty	0.0411**			-0.0428*		
	(2.11)			(-1.71)		
Envir		0.0529***			-0.0373	
		(3.08)			(-1.60)	
Social			0.0088			-0.0382*
			(0.54)			(-1.73)
post2010 × Susty				0.1405***		
				(4.70)		
post2010 × Envir					0.1396***	
					(5.04)	
post2010 × Social						0.0729***
						(2.77)
Bid-Ask Spread	0.2110***	0.2123***	0.2111***	0.2118***	0.2129***	0.2114***
	(7.55)	(7.57)	(7.55)	(7.60)	(7.61)	(7.58)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry type × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.409	0.410	0.408	0.411	0.413	0.409
Observations	141033	140935	137875	141033	140935	137875

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Panel B: Share turnover						
	(1) Aggregate price impact	(2) Aggregate price impact	(3) Aggregate price impact	(4) Aggregate price impact	(5) Aggregate price impact	(6) Aggregate price impact
Susty	0.0429**			-0.0121		
	(2.38)			(-0.52)		
Envir		0.0487***			-0.0123	
		(3.02)			(-0.57)	
Social			0.0148			-0.0105
			(1.00)			(-0.52)
post2010 × Susty				0.0918***		
				(3.24)		
post201 × Envir					0.0943***	
					(3.60)	
post2010 × Social						0.0390
						(1.64)
Share turnover	0.0407***	0.0407***	0.0408***	0.0403***	0.0403***	0.0406***
	(15.90)	(15.84)	(15.89)	(15.71)	(15.66)	(15.79)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry type × Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.433	0.434	0.432	0.434	0.436	0.432
Observations	143423	143323	140218	143423	143323	140218

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Section IA.2: Sustainability footprints and other portfolio characteristics

In this section of the internet appendix, we examine whether footprints are related to more general portfolio-level characteristics. To do so, we run three pooled cross-sectional regressions in which we relate footprints to measures of investment horizon, size, and portfolio-level factor exposures. We also control for investor, Institution-type×Year-quarter, and Country×Year-quarter fixed effects[1] to account for omitted variables and the fact that institutions of different types (e.g., Bank, insurance company, pension funds) and from different countries might have different preferences and restrictions when it comes to sustainability. The results are reported in Table IA.4.

---Table IA.4 about here----

Table IA.4 shows that portfolio turnover is generally negatively related with the sustainability footprint: this finding suggests that investors with longer investment horizons (i.e., lower turnover) tend to have better footprints. It also appears that investors holding a higher number of stocks tend to have better sustainability, while the size of the institution's equity portfolio tends to correlate negatively with the sustainability footprint. It seems plausible that as the scale of an institution's equity portfolio increases, that institution might be gradually forced to also invest in firms with lower sustainability, rationalizing the negative coefficient estimate for *ln(Assets)*. Institutional investors pursuing industry-oriented investment strategies do not differ significantly from investors diversified over more industries: the coefficient estimates on the dummy variable *# Industries<=2*, which indicates whether the investor's holdings are concentrated in two or fewer SIC2 industries, is not significant. Some of the Fama and French 5 factor exposures turn out to be significantly related to the sustainability footprint. For instance, institutional investors with higher

[1] Note that some even though the portfolio firms are U.S. based, some 13F institutions are international investors. These are typically large institutions with considerable equity holdings in U.S. stocks.

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exposure to high beta *(Beta_mkt)* and small stocks *(Beta_smb)* tend to have significantly worse sustainability footprints. The negative coefficient for the variables *Beta_smb* seems plausible given that smaller firms generally display lower sustainability scores. Interestingly, investors with exposure to quality or gross profitability (see Bouchaud et al. (2019) or Novy-Marx (2013)) tend to generally have better footprints: the coefficient estimate on *Beta_qmrw* is positive and significant.

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Internet Appendix Table IA.4. Sustainability footprint and portfolio characteristics

This table displays results from regressions of the overall sustainability footprint (column (1)), and its environmental and social components (columns (2) and (3)) on several portfolio-level characteristics. Turnover is the four quarter rolling average quarterly portfolio turnover. The variable *ln(# Stocks)* is the natural logarithm of the number of stocks in the investor's portfolio. *# Industries<=2* is a dummy variable indicating if the institutional investor's portfolio holdings are concentrated in two or fewer 2-digit SIC industries. *ln(Assets)* is the natural logarithm of the total value of the investor's stock portfolio. *Beta_mkt*, *Beta_smb*, *Beta_hml*, *Beta_qcma*, and *Beta_qrmw* are the Fama and French (2015) five factor exposures. *Institution type* is based on the classification of 13F institutions in Bushee (2001). Standard errors are clustered at the institutional investor-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Susty_VW	(2) Envir_VW	(3) Social_VW
Turnover	-0.03153**	-0.02809**	-0.03990***
	(-2.32)	(-2.03)	(-3.06)
ln(# Stocks)	0.00762***	0.00807***	0.00411
	(3.22)	(3.44)	(1.59)
# Industries<=2	-0.00553	-0.01125	-0.00111
	(-0.45)	(-0.83)	(-0.09)
ln(Assets)	-0.00382***	-0.00431***	-0.00255*
	(-2.59)	(-2.79)	(-1.81)
Beta_mkt	-0.00519**	-0.00733***	-0.00281
	(-2.23)	(-3.09)	(-1.20)
Beta_smb	-0.00553***	-0.00443***	-0.00694***
	(-4.23)	(-3.30)	(-5.33)
Beta_hml	0.00152	0.00235	0.00049
	(0.94)	(1.48)	(0.29)
Beta_qcma	0.00056	0.00055	-0.00048
	(0.52)	(0.53)	(-0.43)
Beta_qrmw	0.00428***	0.00238**	0.00485***
	(3.51)	(2.02)	(3.77)
Investor FE	Yes	Yes	Yes
Institution type # Year-quarter FE	Yes	Yes	Yes
Country # Year-quarter FE	Yes	Yes	Yes
R-squared	0.721	0.709	0.664
Observations	106980	106980	106884

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