Green or Brown: Which Overpriced Stock to Short Sell?

Xintong (Eunice) Zhan
Fudan University
E-mail: xintongzhan@fudan.edu.cn

Weiming (Elaine) Zhang
IE Business School
E-mail: elaine.zhang@ie.edu

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Abstract

We identify a negative causal effect of corporate ESG performance on short selling demand among overpriced stocks. Shorting overpriced stocks with high ESG scores is exposed to higher 1) synchronization risk—the long-side investors are reluctant to sell the overpriced stocks with better ESG performance; 2) short squeeze risks associated with ESG sentiment—high ESG stocks experience sentiment-driven positive price jumps when public attention to ESG spikes; and 3) ESG reputation risk—short sellers who publicly disclose large positions on high ESG stocks may get a bad reputation. The insufficient short demand has important implications for asset prices.

Keywords: ESG performance; mispricing; short sell; market efficiency

JEL Classification: G12; G14; G23; G41

1. Introduction

There is a growing interest in whether corporate environmental, social, and governance (ESG) performance matters for investors' trading behaviors and asset pricing. Anecdotal evidence shows that a number of institutions have broadened their perspectives, and incorporated a firm's ESG (environmental, social, and governance) performance into the investment decision making process. According to a 2020 report by the U.S. SIF (The Forum for Sustainable and Responsible Investment) Foundation, 33% of the professionally managed assets in the U.S. —$17.1 trillion or more in aggregate, are influenced by socially responsible investment principles.

Agents in the financial markets, however, have different preferences towards ESG performance, generating important impacts on asset prices of heterogeneous firms in the equilibrium (Pástor, Stambaugh, and Taylor (2021), and Pedersen, Fitzgibbons, and Pomorski (2021)). In this paper, we investigate whether short sellers have any preference for firms with different ESG performances. Short sellers are known as well-informed and sophisticated investors, and are important for stock market efficiency (e.g., Boehmer, Jones, and Zhang (2008), Christophe, Ferri, and Hsieh (2010), and Boehmer and Wu (2013)). Theoretically, it is unclear whether short sellers have any preferences towards ESG when shorting overpriced stocks. On one hand, short selling does not involve long positions in stocks. The utility (disutility) derivation from holding firms with good (bad) ESG performances in the model of Pástor, Stambaugh, and Taylor (2021) is unlikely an issue for the short sellers.[1] Consequently, short sellers would not distinguish between high and low ESG stocks when these stocks are overpriced to a similar extent. On the other hand, short sellers may face more unconventional risks when they short overpriced high ESG stocks than low ESG stocks. For example, Cao, Titman, Zhan, and Zhang (2022) document that socially responsible institutions are less likely to sell overpriced stocks, especially when these stocks are with higher ESG scores. Such trading behavior of the long-side investors increases the synchronization risk, i.e., the uncertainty about whether and when investors other than short sellers will exploit a common arbitrage opportunity by selling the shorted stocks (Abreu and Brunnermeier (2002)). As a consequence, short sellers would prefer shorting low ESG stocks.

[1] In this paper, "green (brown) firms" refer to those with good (bad) ESG performance in a broad sense, not limited to the environmental performance. We use green (brown) firms and firms good (bad) ESG performance interchangeably.

Whether short sellers have any "preference" for ESG performance is, therefore, a crucial yet under-explored empirical question.

To investigate this important question, we start by examining whether short selling activities vary with corporate ESG performance, among overpriced stocks. To measure the corporate ESG performance, we rely on Thomson Reuters Asset4 database. Based on the score proposed by Stambaugh, Yu, and Yuan (2015) that captures relative mispricing levels, we sort all the stocks with ESG scores available in the Asset4 database into quintiles and classify those in the fifth quintile as the most overpriced stocks. Our panel regressions with a set of control variables show that short selling, i.e., shares on loan and utilization ratio, is significantly lower for firms with higher ESG scores compared to other firms, in the face of similar levels of overpricing. Further analysis shows that lendable shares are higher and lending fees are lower for high ESG firms, compared to low ESG firms. Therefore, it is unlikely that our documented patterns are driven by higher short sale constraints or lower lendable share supply of high ESG firms. Though short sellers are not constrained, they are unwilling to short overpriced stocks with high ESG scores. Our results are not driven by the direct impact of ESG on the mispricing level, and are robust to alternative ESG data (KLD, MSCI ESG, Sustainalytics, and RepRisk) and alternative mispricing measures (standardized unexpected earnings signal (SUE), and mispricing scores in Green, Hand, and Zhang (2017)).

Before further investigating the underlying mechanisms for our documented patterns, we attempt to establish a causal link from corporate ESG performances to short sellers' trading activities. We utilize the bi-annual FTSE4Good index reconstitution as an exogenous shock on perceived corporate ESG performances. FTSE4Good index specializes in corporate ESG issues, and the inclusion enhances the ESG reputation of newly added firms. To mitigate the differences in firm fundamentals, we match the included event firms with control firms according to several important firm characteristics. Then we conduct a difference-in-differences regression analysis for the matched sample. After the inclusion of FTSE4Good index, compared with matched control firms, treated firms have significantly lower short interests and utilization ratios, given the same level of overpricing. The difference-in-differences analysis confirms that corporate ESG performances have a causal and negative impact on short selling activities among overpriced stocks. In addition to bi-annual FTSE4Good index reconstitution events, we provide corroborating

evidence by examining two alternative exogenous shocks, i.e., the passage of close-call ESG shareholder proposals and the announcement of the Paris Agreement.

We further study the underlying mechanisms through which corporate ESG performances affect short selling activities. To summarize, we document that short sellers face a higher synchronization risk, a higher short squeeze risk, and a reputation risk when shorting overpriced stocks with high ESG performances.

Synchronization risk refers to the uncertainty about whether and when investors other than short sellers will exploit a common arbitrage opportunity by selling the shorted stocks (Abreu and Brunnermeier (2002)). Stark, Venkat, and Zhu (2020) document that institutional investors, especially those with longer investment horizons, are more patient to firms with good ESG performances when there are negative earnings announcements. In a similar vein, Cao, Titman, Zhan, and Zhang (2022) find that socially responsible institutions are less sensitive to quantitative mispricing signals.[2] The potential under-reaction from institutions that hold high ESG stocks imposes sizable explicit and implicit costs for short sellers. As it takes longer for the other investors to coordinate and the overpricing to be corrected, short sellers may have to pay a higher borrowing fee, though the daily cost is lower. Consequently, short sellers are less willing to accumulate shorting positions in high ESG stocks even when these stocks are overpriced. By examining the impact of socially responsible institutional ownership and investors' attention on ESG performance, we find corroborating evidence for the synchronic risk channel. Specifically, when the stock is held by more investors caring about ESG performance or paying more attention to ESG performance, long-side investors are less likely to sell it and short sellers have lower demands.

Short squeeze risk, potentially associated with increased ESG awareness, also reduces the short selling activities of overpriced high-ESG stocks. Short squeeze refers to the unexpected rises in the shorted stocks' price. When there are price increases, short sellers have to inject more capital into the margin account, or even close their positions following margin calls. Theoretically, short sellers could face unlimited losses when price rises. Is short squeeze risk a reason why short sellers are unwilling to short high ESG stocks despite the overpricing signal? To test such a possibility, we show that when Google Search Volume Innovation on topic "ESG" elevates, the shorting for overpriced high ESG stocks decreases, possibly because associated short squeeze risk becomes

[2] It is also possible that investors with an above average ESG preference model mispricing in a different way (Pedersen, Fitzgibbons, and Pomorski (2021)).

more prominent. In addition, we construct a stock-level ESG sentiment beta, which captures how the stock return co-moves with the ESG attention by regressing daily returns on the daily Google Search Volume Innovation of the topic "ESG". By definition, stocks with a higher ESG sentiment beta will experience a price jump when the public suddenly pays more attention to ESG issues. Therefore, shorting these stocks is exposed to a higher short squeeze risk associated with ESG attention. We find short sellers indeed shy away from high ESG stocks with a higher ESG sentiment beta even when they are overpriced.[3]

We also test whether shorting high ESG stocks creates any reputation costs for short sellers. Although short sellers help improve market efficiency, they have earned a somewhat negative reputation as they profit while other investors struggle.[4] Taking short positions in high ESG stocks might further deepen the negative reputation of short sellers as they benefit from the stock price drop of green firms that contribute to social welfare. Shorting brown assets, on the other hand, could be reviewed as responsible and may reverse the bad reputation of short sellers.[5] To provide suggestive evidence for this channel, we investigate the reactions from social media to public short selling campaigns by major short sellers. If short sellers indeed perceive a higher reputation risk for shorting stocks with high ESG performances, in equilibrium, there would be fewer public campaigns against high ESG stocks. Moreover, one would expect more negative reactions from social media to public campaigns against high ESG stocks. Following Ljungqvist and Qian (2016), we identify major short sellers, and then collect the data of disclosed short-sale positions on hedge fund websites and the *SeekingAlpha* website. We also collect comments for each campaign from *SeekingAlpha*, and classify each comment into "supportive to" or "against" categories. We find that there are fewer public campaigns against high ESG stocks, and more negative comments

[3] To further corroborate this argument, we use ten speeches of Greta Thunberg as exogenous shocks on public attention to ESG issues, and find that the cumulative abnormal return around Greta Thunberg's speeches of high ESG stocks is 0.57% higher than other stocks. Correspondingly, shares on loan of overpriced high ESG stocks decreases after Greta' speech. This is one example of sudden increased attention to ESG issues, and the results are reported in Internet Appendix IA3.

[4] For example, in certain cases, some have argued that short positions push down companies who otherwise would have prevailed, and thus taking short positions is almost unethical. Some reporters and financial analysts partially attribute the fall of Bear Stearns and Lehman Brothers during the 2008 financial crisis to the intense pressure of short sellers' bear raids. https://mcgillbusinessreview.com/articles/short-sellers-market-traitors-or-balance-keepers

[5] For example, according to the Alternative Investment Management Association (AIMA) and international law firm Simmons & Simmons, alternative investment managers have a long and successful track record of discovering governance failures, as witnessed by the recent Wirecard scandal. They use this same expertise to expose environmental and social failings of issuers, creating more transparent, safer markets for investors around the world. https://www.aima.org/sound-practices/industry-guides/short-selling-and-responsible-investment.html

associated with these campaigns. This evidence suggests that social pressures discourage short sellers from initiating a public short selling position in stocks with high ESG performance.[6]

Finally, we investigate the impact of our findings on asset prices. As short sellers are less willing to short overpriced high ESG stocks, these stocks would have more negative abnormal stock returns afterwards. We find supporting evidence that the return predictability by mispricing signals is concentrated in stocks with high ESG scores. Controlling for the short selling demand in the regressions attenuates the effect of ESG on future stock returns. Therefore, the impacts of ESG performance on short selling activities are likely to drive the return predictability concentration.

To the best of our knowledge, our paper is the first one that investigates the effect of ESG performances on short selling activities despite the fast-growing literature about the impact of ESG performances on investors with different tastes and perspectives. Long-side institutions, especially the ones with stronger ESG preferences or longer investment horizons, derive utility (disutility) from holding green (brown) assets, thus creating non-trivial impacts on asset prices. For example, Starks, Venkat, and Zhu (2020) document that long-term institutional investors tend to be more patient towards high ESG firms, e.g., they are less inclined to sell the stocks even after negative news or poor stock performance. Cao, Titman, Zhan, and Zhang (2022) show socially responsible institutions react less towards quantitative signals. It is, however, unclear whether and through which channels ESG performances influence the short sellers, who are important participants in the stock market and contribute to market efficiency. Our paper fills the gap, and deepens the understanding of ESG preferences or considerations by different market participants.

By identifying the causal effect of corporate ESG performances on short selling demand and the underlying channels, we also contribute to the literature on short selling activities. Exiting literature primarily focuses on the information sources (see for example, Karpoff and Lou (2010), Christophe, Ferri, and Hsieh (2010), Dechow, Hutton, Meulbroek, and Sloan (2021), Hirshleifer, Teoh, and Yu (2011), Drake, Rees, and Swanson (2011), and McLean, Pontiff, and Reilly (2022))

[6] To further explore how the reputation risks affect short sellers' decision in general beyond those large short-sale campaigns, we examine a short selling regulation introduced in European markets on November 1, 2012, which requires public disclosure of short position if it reaches 0.5% of the outstanding amount of share capital. Using UK stocks as our test sample where ESG score is most available, we find after the regulation, short sellers decrease the short position in overpriced high ESG stocks, or accumulate short positions just below the applicable disclosure threshold, to avoid a negative impact on their ESG reputation. The results are reported in Internet Appendix IA4.

and constraints (Reed (2002), and Saffi, and Sigurdsson (2011)) faced by short sellers. Our paper is the first to point out that ESG performances, which are increasingly important given the growing trend of ESG investing, impose sizeable risks on short sellers. Long-side institutions are unwilling to unwind the stocks with high ESG performances and high ESG stocks could experience sudden price jumps driven by ESG sentiment. In addition, short sellers rarely launch public campaigns against firms with good ESG performances because of reputation costs.

More generally, our paper is related to the literature studying how ESG performances affect security prices. Empirical studies document mixed evidence on the relation between corporate social performances and future stock returns. For example, Hong and Kacperczyk (2009) find that "sin" stocks outperform other stocks. Using "100 Best Companies to Work for in America" as a measure of employee satisfaction, Edmans (2011) documents a positive relationship between employee satisfaction and the long-run stock performance. Bolton and Kacperczyk (2021) find stocks of firms with higher total CO_2 emissions earn higher returns, because investors are demanding compensation for their exposures to carbon emission risks. We show that ESG performances could affect short sellers' decisions, which will further affect stock prices and market efficiency.

The rest of the paper proceeds as follows. Section 2 describes our data and measures. We present our main results in Section 3 and explore underlying channels in Section 4. Section 5 investigates the impact on stock returns and Section 6 concludes.

2. Data and key measures

2.1. Data

We collect the data of firms' environmental, social, and corporate governance (ESG) performance from Asset4.[7] These data provide objective, relevant, and systematic environmental, social, and governance (ESG) information based on 250+ key performance indicators (KPIs) and 750+ individual data points, from three pillars.[8] Asset4 covers more than 3,000 firms in major indexes globally. In the U.S., Asset4 covered firms in the S&P 500 index at the beginning of the sample

[7] Asset4 was acquired by Thomson Reuters in 2009 and it now goes by the name Thomson Reuters ESG Scores. However, since the name Asset4 is widely known, we use the old name for simplicity. Note that as of 2018, the ESG ratings data is part of Refinitiv, which is a company co-owned by Thomson Reuters (45%) and Blackstone Group LP (55%).

[8] Raw Asset4 score ranges from 0 to 100. To interpret regression coefficients more conveniently, we divide the raw Asset4 score by 100.

period and expanded to firms in the Russell 1000 index in the later period.

Equity lending characteristics, including shares on loan, lendable supply, and lending fee, are taken from Markit and available at the stock-day level. Markit Securities Finance collects stock loan trading information from over 100 participants and approximately 85% of the OTC securities lending market. The analyst coverage and forecast data are from I/B/E/S. Stock returns, prices, and trading volumes are obtained from the Center for Research on Security Prices (CRSP). The accounting data are collected from COMPUSTAT. We obtain institutional holdings (13F) data from Thomson Reuters. We obtain the data on U.S. individual stock options from OptionMetrics and high-frequency trading data from TAQ. The monthly Fama-French factors and risk-free rates are from Kenneth French's data library. The sample period is from January 2006 to December 2019.

2.2. Key measures

2.2.1. Mispricing signals

We follow Stambaugh, Yu, and Yuan (2015), and consider a monthly updated composite quantitative signal (SYY score), constructed by combining each stock's rankings on 11 anomaly variables. The anomalies are *Net Stock Issues*, *Composite Equity Issues*, *Accruals*, *Net Operating Assets*, *Asset Growth*, *Investment-to-Assets*, *Distress*, *O-score*, *Momentum*, *Gross Profitability Premium,* and *Return on Assets*. For each anomaly, the stocks are sorted into 100 groups and assigned a rank from 1 to 100; the highest rank is assigned to the stocks associated with the lowest average abnormal future return, as documented in the literature. The composite quantitative signal of a stock is the arithmetic average of its rankings on the 11 anomalies, ranging between 1 and 100. According to this measure, stocks with the highest SYY score are the most overpriced and their expected future returns are the most negative. Those with the lowest values are the most underpriced and are expected to have the highest future returns.

In addition, we construct two alternative mispricing measures. First, we follow Foster, Olsen, and Shevlin (1984) and Bernard and Thomas (1989) and use firms' standardized unexpected earnings (SUE) as the first alternative mispricing signal. We calculate the difference between the current quarter's earnings and the earnings four quarters ago, scaled by the standard deviation of unexpected earnings over the last eight quarters. Second, following Green, Hand, and

Zhang (2017), we construct the second alternative mispricing measure based on 94 firm characteristics.

2.2.2. Short selling variables

The main dependent variables in our study are the following: loan quantity (*On loan*) is the daily average of shares on loan relative to the total shares outstanding; lendable supply (*Lendable shares*) is the daily average of shares available for lending relative to a firm's total shares outstanding; utilization rate (*Utilization ratio*) is the daily average of utilization ratio (short interest divided by lendable shares); and borrowing fee (*Lending fee*) is the average transaction-weighted rate reported by Markit and expressed in percentage per annum. To measure short selling activities at the stock-month level, for each short selling variable, we take the daily average of five trading days before the month-end and the first five trading days of the next month.

2.3. Sample summary

Table 1 Panel A reports the descriptive statistics for the shorting activities in the equity lending market. On average, 26.52% of a firm's outstanding shares are available for lending, with 3.88% being on loan and a utilization ratio of 12.09%. The value of *On loan* and *Lendable shares* has quite a sizeable cross-sectional variation, with a standard deviation of 4.95% and 6.91%, respectively. The 10-percentile and 90-percentile value of *Utilization ratio* is 0.86% and 32.26%, indicating some firms are more heavily borrowed while some are barely borrowed. The average annualized fee is 0.53%, implying that it is very cheap, on average, to borrow shares in our sample with ESG scores available.

[Insert Table 1 about here]

We report the summary statistics of ESG performance, short selling activities, and other related variables in Panel B of Table 1. *Ln*(*ME*) is the logarithm of market capitalization and *Ln*(*BM*) is the logarithm of book-to-market ratio (Fama and French (1992)). *Institutional Ownership* is the aggregated shares held by 13F institutions at the end of the most recent quarter. *Analyst* is the number of analysts following at the end of last month. *Leverage* is the total liabilities scaled by the total asset at the most recent fiscal year-end. *Loss* is a dummy variable indicating a

negative income. Idiosyncratic volatility (*IVOL*), as in Ang, Hodrick, Xing, and Zhang (2006), is computed as the standard deviation of the residuals of the Fama and French (1993) three-factor model estimated using the daily stock returns over the previous month. *ESG score* has a mean of 0.63 and its standard deviation is 0.25. Such a large cross-sectional variation of ESG score is useful to better estimate the effect of social performance on short selling activities in the equity lending market.[9] *SYY* score is 45.02 on average, indicating the stocks in our sample are slightly underpriced compared to the original sample covered by Stambaugh, Yu, and Yuan (2015). In each month, we divide our sample stocks into quintiles based on the SYY score, and those in the fifth quintile are classified as "overpriced" stocks and we assign one to their *Overprice* dummy variable. The other stocks have an *Overprice* dummy equal to zero. By construction, *Overprice* has a mean of 0.2. In addition, our sample stocks are quite large, with 79% shares held by institutions and followed by 15.26 analysts on average.

We report the time-series average of cross-sectional Pearson and Spearman correlations among short-selling related variables, *ESG score*, *SYY score*, *Overprice,* and other variables in Panel C of Table 1. The Pearson correlation between *ESG score* and *SYY score* is only -0.09, and the correlation between *ESG score* and *Overprice* is -0.1. These low correlations show that ESG performances do not affect the ex-ante mispricing levels in our sample. We observe that *ESG score* tends to have high correlations with *Ln*(*ME*) and *Analyst*, which we further control in the multivariate regression analyses.

3. Empirical results

3.1. Overpricing, ESG performance, and short selling activities

We start our analysis by examining how the firm-level ESG performance affects short selling activities conditional on mispricing.[10] Specifically, we sort all the stocks into quintiles using SYY mispricing scores at the month end, and focus on those most overpriced stocks (those with the highest SYY mispricing scores) because short selling activities are concentrated on these stocks.

[9] Another popular ESG database used in the literature is MSCI KLD, which has a larger sample coverage. However, the MSCI KLD ESG score is updated annually, sticky over time, and has a smaller cross-sectional deviation as the distribution is clustered around zero.

[10] We conjecture that investors use mispricing score as their primary identification variable and overpriced stocks will have higher short demand from short sellers. In Appendix Table A1, we find shares on loan, utilization ratio and lending fees are significantly higher for stocks with higher SYY scores, or overpriced stocks, all significant at the 1% level.

We use the full sample rather than overpriced stocks only, because including "fairly priced" stocks in our sample helps to control for the direct effect of ESG performance on the stock valuation. We run the following panel regression:

$$Short\ Selling\ Demand_{it} = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} + \beta_2 ESG_{it-1} + \beta_3 Overprice_{it-1} + \beta_4' X_{it-1} + \gamma_t + \theta_i + e_{it}, \quad (1)$$

where $Overprice_{it-1}$ is a dummy that equals one for overpriced stocks identified at the end of month $t-1$. $Short\ Selling\ Demand_{it}$ is the average of daily short selling activities during (-5, +5) days around the end of month t, including shares on loan and utilization ratio.[11] $ESG_{it-1}$is the ESG performance at the end of last month. X_{it-1} are the control variables including market capitalization, book-to-market ratio, institutional ownership, analyst coverage, firm leverage, loss dummy, and idiosyncratic volatility. γ_t is the time fixed effects, and θ_i is the firm fixed effects.

The results are tabulated in Panel A, Table 2. In Column (1), the coefficient on $Overprice_{it-1}$ is statistically positive, which demonstrates that short sellers do utilize the information contained in the SYY scores and make short selling decisions accordingly. The coefficient (β_1) on the interaction term captures the incremental effect of ESG performance on short selling demand, for overpriced stocks compared to the other stocks, and is significantly negative. Therefore, among overpriced stocks, a higher ESG performance is associated with a lower short selling demand compared to the other stocks. After controlling for a set of firm characteristics, we find that a one-standard-deviation (0.25) increase in ESG scores is associated with a 0.40% decrease in shares on loan, equivalent to 10.4% of the mean loan and 8.2% of the standard deviation. Consistent with the results of fewer shares on loan for overpriced high-ESG stocks, we find utilization ratio is lower with a negative coefficient significant at the 1% level.

[Insert Table 2 about here]

We then investigate whether the results are driven by the common short-sale constraints. Four measures are used to proxy for the short-sale constraints, including lendable shares, lending

[11] We include five trading days before the monthly SYY mispricing score becomes available to capture the potential information leakage captured by short sellers. The results are similar using different calculation windows and are discussed in Section 4.4.

fees, ERR short selling risk (Engelberg, Reed, and Ringgenberg (2018), hereafter ERR), and put-call implied volatility ratio. The results are presented in Panel B of Table 2. Columns (1) and (2) report the results for lendable shares, which measure the willingness of long investors to lend out the shares. The coefficient on the interaction term is not significantly different from zero, suggesting the fewer shares on loan for overpriced high-ESG stocks are not due to the lower supply of shares available to borrow. We further find that the lending fee and ERR short selling risk are in fact lower for overpriced high-ESG stocks, showing borrowing costs and uncertainty of borrowing costs are not concerns for short sellers. In addition, the put-call implied volatility ratio is lower for overpriced stocks with high ESG performance, indicating investors are not buying more put options due to higher short-sale constraints. Taken together, the lower short selling demands for overpriced high-ESG stocks are not due to common short sale constraints such as fewer lendable shares or higher lending fees.

3.2. Alternative mispricing measures

There is a vast literature investigating the relationship between ESG performance and stock returns (Hong and Kacperczyk (2009), Edmans (2011), and Chava (2014)). One may concern that ESG is related to the ex-ante mispricing level, which directly affects short sellers' trading decisions. As we show earlier, the correlation between ESG score and mispricing score (*Overprice*) is very low, thus it is unlikely that the ESG scores affect ex-ante mispricing levels in our sample. In the unreported test, we also find that ESG scores do not predict the cross-section of stock returns.

It is however possible that short sellers perceive ESG scores as a source of mispricing and react accordingly. To rule out such a possibility, we examine the unconditional relation between ESG scores and short selling activities, and report the results in Appendix Table A1. The short demand is lower for high ESG stocks, but statistically insignificant after controlling for firm characteristics. Therefore, ESG scores do not directly affect short selling demand.

[Insert Table 3 about here]

We also show that the documented results are robust to alternative mispricing measures. First, we consider the standardized unexpected earnings signal (SUE) explored in the accounting

literature.[12] Second, following Green, Hand, and Zhang (2017), we construct another composite mispricing measure based on 94 firm characteristics. Utilizing these two alternative mispricing measures, we repeat our analysis and report the results in Table 3 Panel A and Panel B, respectively. ESG scores again have low correlations with these two alternative mispricing measures, and our results hold for the alternative mispricing measures.

3.3. Alternative ESG data providers

Given the complexity of measuring ESG information, academics have stressed that ESG ratings from different providers disagree substantially, and the validity of these ratings has been debated critically (see Eccles and Stroehle (2020), Christensen, Serafeim, and Sikochi (2022), Gibson, Krueger, Riand, and Schmidt (2021), Berg, Koelbel, and Rigobon (2022), and Berg, Koelbel, Pavlova, and Rigobon (2021)). For example, Berg, Koelbel, and Rigobon (2022) find the correlations among ESG ratings from six rating providers are low. They decompose the divergence into contributions of scope, measurement, and weights, and find measurement drives most of the divergence. The results raise the concern that research conclusions potentially depend on the choice of rating providers.

To address the concern that our empirical results are only significant to a particular ESG data provider, we test the validity of our results using alternative ESG data from four alternative ESG rating providers: KLD[13], MSCI[14], Sustainalytics[15], and RepRisk[16]. All ratings are organized in a way that the higher the scores, the better the ESG performances, i.e., we flip the signs of the

[12] See for example, Foster, Olsen, and Shevlin (1984) and Bernard and Thomas (1989).
[13] KLD, formerly known as Kinder, Lydenberg, Domini & Co., was acquired by RiskMetrics in 2009. MSCI bought RiskMetrics in 2010. The data set was subsequently renamed to MSCI KLD Stats as a legacy database. We keep the original name of the data set to distinguish it from the MSCI data set. The KLD scores measure the firm-level social performance, including community relations, product characteristics, environmental impact, employee relations, workforce diversity, and corporate governance. The data covers both the social benefits and harms of a firm.
[14] MSCI ESG rating identifies both ESG risks and opportunities that are the most material to an industry. Within each industry, MSCI identifies industry leaders and laggards according to the exposure to ESG risks and how well the focal firm manages those risks relative to peers, and then assign ratings accordingly.
[15] Sustainalytics identifies key ESG issues for different industry peer groups, based on an analysis of the peer group and its broader value chain, a review of companies' business models, and key activities associated with environmental and/or social impacts. It collects data via its own disclosure, media and NGO reporting to analyse ESG information according to key ESG issues, and assign scores accordingly.
[16] RepRisk is a news-based data provider. It screens over 90,000 public sources each day, including print and online media, government bodies, regulators, and other online sources. When there are material ESG risks such as violations of international standards that can have reputational, compliance, and financial impacts on the company, RepRisk index increases.

RepRisk scores, which are designed to measure risks. We include KLD because it is the most frequently used dataset in academic studies. We include RepRisk because it relies mainly on the news and media reporting, which has markedly different information compared to other raters that rely on a blend of data sources (Berg, Koelbel, Pavlova, and Rigobon (2021)). Asset4, MSCI, and Sustainalytics are widely recognized and used by sustainable finance professionals.[17]

We rely on two empirical strategies to validate our results. First, we construct a combined ESG score using a simple average of available ESG scores for a particular stock. Specifically, for each ESG data provider, we sort all the stocks into deciles according to the corresponding ESG score, and assign the decile rank to the stocks. Afterwards, we calculate the average ranking by a firm's available ESG scores. We require that at least three ESG ratings are available for a particular stock to calculate the combined ESG score.[18] This approach allows us to integrate different ESG information from various data providers, while maintaining a reasonably large sample. Using this combined ESG score, we again confirm that among overpriced stocks, firms with better ESG performances have lower shares on loan and lower utilization ratios. The results are shown in Panel A, Table 4.

[Insert Table 4 about here]

Second, following Berg, Koelbel, Pavlova, and Rigobon (2021), we utilize a noise-correction procedure as an additional robustness test, in which we instrument Asset4 ESG scores by ratings of other ESG rating agencies. Specifically, we use a two-stage least squares regression to tackle the measurement error problem in ESG scores. The first stage regression uses the ESG scores of four alternative data providers as instruments for the Asset4 ESG score and includes the same controls as in Equation (1):

$$Asset4_{it} = \alpha + \beta_1 KLD_{it} + \beta_2 MSCI_{it} + \beta_3 Sus_{it} + \beta_4 Reprisk_{it} + \beta_5' X_{it} + e_{it}, \quad t = 1,2,3 \ldots T \tag{2}$$

We run the above regression each month, where $Asset4_{it}$ is the Asset4 ESG score for stock i in month t. Denote $\widehat{Asset4}_{it}$ as the fitted value from estimating equation (2). Then we run the

[17] These ESG data are featured in the 2019 and 2020 investor survey "Rate the Raters" by SustainAbility Institute (see https://www.sustainability.com/globalassets/sustainability.com/thinking/pdfs/sustainability-ratetheraters2020-report.pdf).

[18] The results are similar if we require at least two ESG ratings available for a particular stock.

second stage regression according to Equation (1) while replacing ESG scores with instrumented Asset4. Table 4 Panel B shows the 2SLS regression results.[19] We still observe that short sellers are less willing to short overpriced high ESG stocks. Therefore, our results are not driven by a particular ESG data provider, and are robust to alternative ESG data sources, though they may be noisy and contain different ESG information.

3.4. Causality from ESG performance to short sellers' demand

To establish a causal link from firms' ESG performances to short sellers' trading activities among overpriced stocks, we consider a shock that changes a firm's ESG reputation perceived by market participants. Specifically, we examine the effects of FTSE4Good Index biannual reconstitution on our documented patterns. Launched in 2001, the FTSE4Good Index Series is a series of benchmark and tradable indexes for ESG (Environmental, Social, and Governance) investors. Criteria are developed using an extensive market consultation process and are approved by an independent committee of experts.[20] Since FTSE4Good is an established index that specializes in corporate ESG issues, we expect the inclusion events carry information concerning firms' ESG reputation perceived by the market participants. Will short sellers treat the stocks differently after the inclusion? To answer the question, we find one control firm for each treated firm according to ESG score, firm size, book to market value, number of analysts following and institutional ownership. The event window is (-6, +6) months, excluding the event month for the following regression:

$$Short\ Selling\ Demand_{it} = \alpha + \beta_1 Treat_{it} \times Post_{it} \times Overprice_{it-1} + \beta_2 Treat_{it} \times Post_{it} + \beta_3 Post_{it} \times Overprice_{it-1} + \beta_4 Treat_{it} \times Overprice_{it-1} + \beta_5 Overprice_{it-1} + \beta_6 Post_{it} + \beta_7 Treat_{it} + \beta_8' X_{it-1} + \gamma_t + \theta_i + e_{it}, \quad (3)$$

where $Treat_{it}$ is a dummy equal to one for stocks included in the FTSE4Good index, and zero otherwise. $Post_{it}$ is a dummy equal to one for the 6 months after the event, and zero otherwise. β_1 captures how short selling demands change after the stock is included in the FTSE4Good index, compared to its matched control firms.

[19] We also show the results for industry and time fixed effects, to address the concern that we do not have enough within-firm variation to support the firm fixed effects estimation, as some ESG scores are updated annually.

[20] More information about the index could be found on the FTSE4Good Index Factsheet: https://research.ftserussell.com/Analytics/FactSheets/temp/506aa4aa-8612-4ec6-ac2f-3f6c4c721141.pdf

[Insert Table 5 about here]

We present the regression results in Table 5. After the stocks are included in an index specialized in ESG issues, shares on loan decrease by 0.91% if the stocks are overpriced. Correspondingly, the utilization ratio decreases. Though the number of events is limited, the difference-in-differences analysis suggests a negative causal impact of ESG performances on the short selling demand, among overpriced stocks.

We also notice that the trading associated with index-linked products, such as index futures, index options, and ETFs, could potentially affect the price discovery for the underlying stocks. For example, Hasbrouck (2003) documents that ETFs help to improve intraday price discovery using index futures. Glosten, Nallareddy, and Zou (2021) show that ETF activity increases short-run informational efficiency for stocks with weak information environments. In contrast, Israeli, Lee, and Sridharan (2017) show that pricing efficiency decreases after an increase in ETF ownership. One may concern that our finding is due to increased passive ownership or ETF ownership when a stock is included in an index, thus short sellers are less willing to short them. To mitigate this concern, we perform a placebo test using reconstruction of the Russell 1000 index.

A stock's index assignment has an important impact on its portfolio weight in that index, as each Russell Index is value-weighted such that firms at the top of either index receive the highest weight. Therefore, the 1000th largest stock at the end of May, which is just included in the Russell 1000, has a trivial portfolio weight, whereas the 1001st largest stock just included in Russell 2000 will be given a considerable index weight. Therefore, the largest firms in the Russell 2000 index are likely to be widely held by any funds or ETFs tracking the Russell 2000, whereas funds tracking the Russell 1000 would hold almost none of the smallest firms in the Russell 1000. Following Appel, Gormley, and Keim (2016) and Chen, Dong, and Lin (2020), we use the inclusion of Russell 2000 as an exogenous shock on the ETF ownership and institutional ownership. If short selling demands for the largest 100 stocks that are included in the Russell 2000 index are lower than that for the smallest 100 stocks included in Russell 1000 index, given a similar level of overpricing, our aforementioned evidence from the FTSE4Good Index Series inclusion would be less convincing.

The results are tabulated in Appendix Table A2. Consistent with Glosten, Nallareddy, and

Zou (2021), we find there is more short selling demand for the 100 largest stocks in Russell 2000 index when they are overpriced, compared to the 100 smallest stocks in Russell 1000 index, which should lead to higher price efficiency. This placebo test helps to rule out the alternative that our results are driven by the inclusion of a general index.

In addition, we also examine another two alternative shocks to provide further evidence of the causality. Specifically, we use the passage of ESG related close-call shareholder proposals as a shock to firms' policy that would change firms' future ESG performance, and the announcement of the Paris Agreement as a shock that strengthens investors' ESG awareness. We provide related analysis and results in the Internet Appendix IA1 and IA2.

4. Channels: ESG performance and short selling risks

4.1. Synchronization risk

Abreu and Brunnermeier (2002) argue that arbitrage is limited if rational traders face uncertainty about when their peers will exploit a common arbitrage opportunity, i.e., synchronization risk. If the mispricing correction process by their peers is delayed, arbitragers will face both explicit and implicit holding costs. For example, short sellers must hold the short-sale proceeds in a margin account that pays minimal or no interest. They cannot fully hedge their arbitrage strategy in a world where a perfect substitute for the mispriced asset does not exist, leading to sizable implicit costs. Starks, Venkat, and Zhu (2020) document that investors are more patient towards high ESG firms and sell less after negative earnings surprises. Hartzmark and Sussman (2019) document that mutual fund managers could attract more fund inflows by holding high ESG stocks. Therefore, better ESG profiles may increase the synchronization risks as the long-side investors delay the selling decision despite the overpricing signals. As a consequence, short sellers are less willing to accumulate short positions in high ESG stocks even when they are overpriced to avoid holding costs. To investigate this possibility, we examine whether the aforementioned results are stronger when the long-side investors are less willing to cooperate with short sellers, for instance, when there are more socially responsible investors, or when the investors' attention on ESG performance is higher.

Socially responsible investors are more patient towards "good citizens"; thus, they may be less willing to sell overpriced high ESG stocks, increasing the synchronization risks and lowering the short selling demands. We follow Cao, Titman, Zhan, and Zhang (2022) and sort all the

financial institutions into three groups, based on the average ESG score of firms in their portfolio holdings. Institutions in the top tercile have the highest average portfolio ESG score and are labeled as socially responsible institutions. For each firm, we calculate the fraction of socially responsible institutions (SRIO) as the number of shares held by socially responsible institutions, divided by the total number of shares held by all the institutions. We test whether the negative relationship between ESG and short selling demand is stronger for the stocks held by more socially responsible institutions, by running the following regression:

$$
\begin{aligned}
&Short\ Selling\ Demands_{it} \\
&\quad = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} \times High\_SRIO_{it-1} \\
&\quad + \beta_2 ESG_{it-1} \times High\_SRIO_{it-1} + \beta_3 Overprice_{it-1} \times High\_SRIO_{it-1} \\
&\quad + \beta_4\ ESG_{it-1} \times Overprice_{it-1} + \beta_5 Overprice_{it-1} + \beta_6 High\_SRIO_{it-1} \\
&\quad + \ \beta_7 ESG_{it-1} + \beta_8' X_{it-1} + \gamma_t + \theta_i + e_{it}\ , \qquad (4)
\end{aligned}
$$

we divide all the stocks into two groups based on $SRIO$ at the end of the last quarter, and $High\_SRIO_{it-1}$ is a dummy representing stocks with SRIO above the median. All the regressions include firm fixed effects and time fixed effects.

[Insert Table 6 about here]

Panel A of Table 6 reports the results. β_1 is significantly negative for both shares on loan and utilization ratio, indicating when the stocks are more held by the socially responsible institutions, the documented relationship between ESG scores and short selling demand gets intensified.

In addition, we expect the importance of ESG performance would vary with investors' attention to ESG issues. When there is more attention to a firm's ESG performance, long-side investors derive higher utility from holding these assets and create a larger synchronization risk. As a result, the relation between ESG performance and short selling demand should be magnified. To capture investors' attention on individual firms, we employ a text-based measure, Climate Change Exposure (*CC_Expo*), constructed by Sautner, Van Lent, Vilkov, and Zhang (2022) that extracts information from quarterly earnings conference calls. The method adopts a machine learning keywords discovery algorithm to count the frequency of climate change related bigrams

in a transcript, scaled by the total number of bigrams. It captures overall attention on climate change exposure of the firms, including both risks and opportunities. We conjecture that when the analysts and managers talk more about climate related topics during the conference call, investors pay more attention to firms' ESG performance, therefore its impact on short sellers' trading activities would be more substantial. We divide the whole sample into two groups based on the *CC_Expo* of the firm last quarter, and test whether the results are more significant among firms with higher *CC_Expo*.

The results are reported in Panel B, Table 6. The coefficients on the triple interaction term are all significantly negative. The effect of ESG performance on short selling demand in the high *CC_Expo* group is much stronger compared to that in the low *CC_Expo* group, while ESG score is still negatively related to short selling demand among overpriced stocks in the low *CC_Expo* group. The results indicate that when the attention to a firm's climate exposures is higher, ESG performance becomes a more relevant factor that short sellers would take into consideration.

As a robustness check, we directly investigate the long-side investors' trading behaviors for overpriced stocks with different ESG performances. Specifically, we regress the change in the quarterly holdings of the mutual funds and all the 13F institutions at the end of a given quarter on the interaction term between *Overprice* and the ESG score. We measure the change in holdings in two different ways, for both mutual funds and 13F institutions. First, we calculate the log change in the number of institutions holding the shares, since previous research suggests that the number of institutions holding a stock, rather than the amount that they hold, is more informative (Sias, Starks, and Titman (2006), Khan, Kogan, and Serafeim (2012), and Edelen, Ince, and Kadlec (2016)). In addition, we calculate the change in the percentage of shares held by mutual funds and 13F institutions. Then we run the following firm-quarter panel regression:

$$Holding\ Changes_{it} = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} + \beta_2 ESG_{it-1} + \beta_3 Overprice_{it-1} + \beta_4' X_{it-1} + \gamma_t + \theta_i + e_{it}, \quad (5)$$

where $Holding\ Changes_{it}$ is measured by four variables: log change of mutual funds number, change of mutual fund ownership, log change of 13F institution number, and change of institutional ownership. X_{it-1} are the control variables measured at the end of last quarter, including market capitalization, book-to-market ratio, institutional ownership, analyst coverage,

firm leverage, loss dummy, and idiosyncratic volatility. We include quarter fixed effects and firm fixed effects.

The results are tabulated in Appendix Table A3. We find mutual funds decrease their holdings after the stock is identified as overpriced. Among overpriced stocks, fewer mutual funds dump the stocks with higher ESG scores. For overpriced stocks, when ESG score increases from Q1 to Q3 (0.46), the decrease in mutual funds ownership is mitigated by 0.23%. The results of the 13F institution number change and institutional ownership change reveal the same pattern, suggesting that investors who hold high ESG stocks delay the selling decision when the stocks are overpriced. Therefore, short sellers are more likely to avoid stocks with high ESG performances despite the overpricing signal because of higher synchronization risk.

4.2. Short squeeze risks and ESG sentiment

Short squeeze is another type of risk that is essential for short sellers. The activity of behavioral noise traders might lead to temporary price movements, which will reduce the value of the arbitrage portfolio if the price moves even further away from the fundamental value. For short sellers, a temporary price increase instead of a price drop could trigger margin calls and short sellers will have to liquidate their positions before making profits. De Long, Shleifer, Summers, and Waldmann (1990) describe such uncertainty about price movement as *noise trader risk* and Xu and Zheng (2016) model it as *short squeeze risks*.

Given the popularity of ESG investing, stocks that are "Good Citizens" might experience sudden and large buying pressures when the public collectively pays attention to ESG issues, leading to a surge in the stock price. To avoid the "short squeeze", short sellers would shy away from the overpriced high ESG stocks even more when ESG related attention/sentiment is high. We measure the public attention to ESG by using Google Search Volume Index. Specifically, we calculate the logarithm of monthly change in the Google Search Volume Index (DGSVI) on the topic "Environmental, social and corporate governance",[21] and investigate whether the results are stronger when the DGSVI is higher. The results are reported in Panel A, Table 7. We find when there is an increase in Google Search Volume on ESG related topics, short sellers are less willing

[21] We find consistent results when using other topics such as "Global Warming" and "Socially Responsible Investing".

to short overpriced high ESG stocks to a greater extent, since the upside jump probability of these stocks is higher. [22]

[Insert Table 7 about here]

There are also substantial variations among the reaction of stock prices to the ESG attention. When the attention to ESG spikes, the stocks with positive price reactions carry more severe short squeeze risks for short sellers. To capture such variations in price jumps driven by ESG attention, we construct an ESG sentiment beta following a similar procedure in Huynh and Xia (2021). For each stock in each month, we estimate an ESG sentiment beta (β_{ESG}) from a monthly rolling regression of stock excess returns on innovations in the daily Google Search Index Volume (DGSVI) of ESG related topics over a 252-day window with a minimum of 120 valid daily return observations. In addition, we use 60 days of daily return to estimate a short-term ESG sentiment beta, requiring a minimum of 24 valid observations. We control for Fama-French three factors as follows.

$$RET_{it} = \alpha + \beta_{ESG} DGSVI_{it} + \beta_2 Mkt\_rf_{it} + \beta_3 SMB_{it} + \beta_4 HML_{it} + e_{it}, \quad (6)$$

where $DGSVI_{it}$ is the innovation of Google Search Volume of topic "Environmental, Social, and Corporate Governance". RET_{it} is the daily excess return of the stocks. $Mkt\_rf_{it}, SMB_{it}, HML_{it}$ are daily factors obtained from Kenneth French's data library. β_{ESG} captures a stock's covariance with innovation in the investors' attention towards ESG related topics on a daily basis. By construction, a greater β_{ESG} indicates an increase in the stock price when innovation in the public's ESG attention/sentiment increases.

Then we investigate how aforementioned results are affected by ESG sentiment beta. Panel B of Table 7 shows that when the ESG sentiment beta and potential upside jump probability are higher, the demand from short sellers for overpriced high ESG stocks further decreases, lending support to the short squeeze risks channel.

[22] To further strengthen the relationship between sudden surge of ESG sentiment and price increases of high ESG stocks, we utilize ten speeches of Greta Thunberg as exogenous shocks on public attention to ESG related issues, and find the cumulative abnormal return (CAR) is higher for high ESG stocks and short selling demand decreases for overpriced high-ESG stocks after her speeches. The results are reported in Internet Appendix IA3.

As a robustness test, we use four measures to proxy for the upside jump probabilities and directly examine the relationship between ESG and upside jump probabilities. First, we calculate realized skewness using daily stock returns in a month. Second, following Bollerslev, Li, and Zhao (2020), we use high-frequency intraday data, and construct relative signed jump variation, which is defined as the difference between the up and down semi-variance measures divided by the total return variance. Third, motivated by Xing, Zhang, and Zhao (2010), we calculate implied skewness from option prices, which is the difference between the implied volatilities of out-of-the-money (OTM) call options and the implied volatilities of at-the-money (ATM) call options. Following Kelly, Pástor, and Veronesi (2016), we use upside slope as the fourth measure, calculated as the slope of a function that relates right-tail implied volatility to moneyness (with moneyness being measured by the option's delta) of call options.[23] The last two measures capture the positive jump possibility perceived by investors based on the forward-looking information contained in the option prices. The results are reported in Appendix Table A4. Consistent with the hypothesis, we find high ESG stocks have both a higher realized upside jump probability and a perceived upside jump probability.

4.3. Potential ESG reputation risk

Although short sellers help improve price efficiency, they have earned a relatively more negative reputation since they tend to profit while other investors struggle. In certain cases, some have argued that short positions push down companies who otherwise would have prevailed, and thus taking short positions is almost unethical. It is concerned that short sellers may often attempt to illegally manipulate stock prices.[24] Such concern would be particularly severe when short sellers attempt to short the "Good Citizens", as a growing number of long-side institutions and individuals[25] have a preference for high ESG stocks. To fully test the ESG reputation risk channel,

[23] A lower upside slope is associated with higher positive jump probability perceived by the investors, meaning a more expensive OTM call options relative to ATM call options, since OTM call options has lower delta. To make it easier to interpret and consistent with other three measures, we take the negative value of upside slope.

[24] See generally the Commission's 2010 release adopting the short-sale circuit breaker price test, Exchange Act Release No. 61595 (Feb. 26, 2010), 75 FR 11232, 11235-37 (Mar. 10, 2010) (discussing past and present concerns of market participants about manipulative short sale activity). A number of commenters noted concerns with potential trade manipulation, see, e.g., letter from Judith Scott, General Counsel, Portfolio Recovery Associates (Jun. 24, 2011) ("Portfolio Recovery Associates").

[25] In Capgemini's World Wealth Report 2020, more than a quarter (27%) of high net worth individuals (HNWIs) — those with investible assets of $1 million or more — said they were interested in sustainable products. Detailed report could be found: https://worldwealthreport.com/

one needs the identification of short sellers shorting a certain stock. This is impossible given that short sellers in the U.S. are not required to disclose any short position to the public. However, some short sellers do disclose their shorting intention through public campaigns so that the long-side investors will join and sell the shorted stocks (see for example, Ljungqvist and Qian (2016)). If reputation risk is another channel through which ESG performances affect short sellers' trading decisions on overpriced stocks, we would expect 1) there are fewer short sale campaigns against high ESG stocks; 2) the public reaction to the short sale campaigns against high ESG stocks is more negative.

Using data provided by Ljungqvist and Qian (2016) along with the information we collected about the publicly disclosed short-sale position/report from hedge funds' websites and *SeekingAlpha* over a period from 2006 to 2019,[26] we identified 205 publicly disclosed short-sale campaigns. These targets are generally mid-cap stocks, with an average market capitalization of $9,124 million, which is in the 69th percentile of the distribution of CRSP firms.[27] Only several stocks have non-missing ESG scores from the Asset4 database, which mainly covers large stocks in major indexes. To supplement the ESG performance information for these short-sale targets, we utilize ESG scores from two other alternative databases in this test, KLD and MSCI IVA databases.[28] Following Brandon, Krueger, and Mitali (2021), we calculate the ESG score as follows:

$$ESG\_combined_{it} = \frac{1_{KLD,it} \times z_t(KLD) + 1_{IVA,it} \times z_t(IVA)}{1_{KLD,it} + 1_{IVA,it}}, \quad (7)$$

where $1_{KLD,it}$ ($1_{IVA,it}$) is a dummy variable indicating if the KLD (IVA) score is available for stock i in period t, $z_t(KLD)$ and $z_t(IVA)$ is the standardized ESG score with a mean of zero and a standard deviation of one. This approach uses an average standardized score whenever both KLD and IVA scores are available, and uses only the available standardized score whenever a stock is

[26] There are 31 arbitrageurs in Ljungqvist and Qian (2016). Among them, 17 arbitrageurs release multiple reports and 14 arbitrageurs release one report. We focus on the 17 arbitrageurs, which include Citron Research, Bronte Capital, GeoInvesting, Ian Bezek, ShareholderWatchdog, Alfred Little, MuddyWaters, Kerrisdale Capital, Asensio & Co., Spruce Point, Chimin Sang, Prescience Investment, Absaroka Capital Management, Chinese Company Analyst, The Forensic Factor, Glaucus Research, and OLP Global.

[27] The average market capitalization of short-sale targets in Ljungqvist and Qian (2016) is $969.3 million, 54th percentile of the distribution of CRSP firms, from 2006 to 2011. The targets are larger in terms of CRSP distribution and much larger in absolute market value, because firms are growing over time and short-sellers seem to target some large firms recently.

[28] These two databases have larger coverage compared to Asset4.

covered by one data provider only.[29] By doing so, we have identified 110 events with ESG scores available.

To investigate whether the short sellers are less willing to disclose their short position publicly if the firm has good ESG performance, we run a logit regression and examine the probability of being targeted. Column (1) in Panel A, Table 8 shows that after controlling for the short selling demand (proxied by shares on loan and utilization ratio), high ESG firms are less likely to be the targets of the public short-sale campaigns. One step further, we perform a one-to-one propensity score matching based on shares on loan, utilization ratio, and other firm characteristics. In Column (2) of Table 8 Panel A, we compare two stocks that have been shorted to a similar extent and have similar firm characteristics, and find short sellers are less willing to reveal to the public about their short position if they are going to violate social norms, i.e., short selling firms with good ESG performances.

[Insert Table 8 about here]

The next question is when short sellers take positions that effectively bet against high ESG stocks publicly, do they indeed suffer from social pressures? We use the tone of online comments to infer investors' attitudes towards public short-sale campaigns. For each campaign, we search the related reports in *SeekingAlpha* and collect comments under the reports, summing up to 5,277 comments. We choose *SeekingAlpha* because the users are more sophisticated in terms of investment knowledge than users of general social media such as *Twitter*. We read all the comments, and for each comment, we assign an *Agreement Score* and an *ESG dummy*. Specifically, the *Agreement Score* of a comment is equal to -1 if the comment is against the short-sale activity,

[29] This approach has two advantages. First, even though ESG ratings can disagree, taking average could be a better estimation of true ESG performance. Second, this allows us to obtain the largest possible sample with non-missing ESG performance, as targets of short-sale campaigns are usually midcap stocks.

+1 if the comment is supportive to the short-sale activity, and 0 if it is neutral.[30] The *ESG dummy* equals 1 if the comment mentions ESG related topics, and 0 otherwise.[31]

Then we run comment-level panel regressions with year fixed effects and the results are reported in Table 8 Panel B. We examine the following two questions: 1) whether the tone from the public is more negative towards short-sale campaigns if the stock has a higher ESG score; 2) whether there are more ESG related comments if the stock has a higher ESG score. We find the *Agreement Score* is lower for high ESG stocks, indicating there is more pressure from social media if short sellers publicly disclose their short position in high ESG stocks. Moreover, it is likely that such adverse reactions are related to the ESG performance of the firms, indicated by a positive relationship between ESG score and ESG dummy.

Publicly disclosed short-sale activities are rare in numbers, special in nature, and could be quite different from general short sellers. To investigate the ESG reputation risk channel in general, we further examine a short selling regulation introduced in European markets on November 1, 2012, which requires a certain level of public disclosure of short positions. We find that after the regulation came into force, short selling demand of high ESG firms decreases among overpriced stocks, which suggests short sellers care about their ESG reputations and try to hide some short positions on high ESG stocks. Detailed descriptions and test results are reported in Internet Appendix IA4.

Nevertheless, we admit that the evidence for the ESG reputation risk channel is only suggestive so far. There could be more future studies along this line, given the growing demand for higher transparency of funds' short selling activities. For example, SEC has adopted new rules and forms to modernize the reporting and disclosure of information by registered investment

[30] For example, when Citron Research disclosed a bearish view on Monster Beverage (Ticker: MNST) in 2016, there is one comment saying, "We happen to be a retailer of many retail products, Monster happens to be one of them. Just happen to look at an invoice for a delivery this week, Monster energy was over half the bill. Monster has added a number of items, and entered new categories, and all of them sell. This is quite rare. Over the years, all we hear is how health-conscious people are and they want to point to the dropping consumption of cola and carbonated. Its down has been more than replaced by Energy, fully sweet teas, and item extensions like Mountain Dew kick start...Does any of this matter to the valuation, maybe not, but if it drops all the way to $80 We will be buying all the way there." We assign an agreement score of -1 and ESG score of 1 for this particular comment.

[31] We rely on the 28 important ESG issues identified by RepRisk, one news-based ESG data vendor, to classify whether a comment is related to ESG issues. Environmental issues include climate change, local pollution, waste issues etc. Social issues include discrimination in employment, local participation issues, occupational health and safety issues etc. Governance issues include executive compensation issues, fraud, tax optimizations etc.

companies.[32] Under the new rule, the holding information related to derivatives, including options, futures, swaps and others will be disclosed in the financial reports. Put options are often viewed as a substitute for short selling. One could therefore study the short selling activities from put options holding and trading, and examine the role of ESG performances.

5. The impact on stock returns

In this section, we investigate the implication of the documented trading behavior of short sellers on asset prices. When stocks are overpriced and there is not enough short selling to correct the mispricing for high ESG stocks, we expect the future returns of these stocks to be more negative, as the mispricing gets corrected gradually. To test this hypothesis, we calculate the cumulative daily return from the sixth trading day to the end of the month and then run the following Fama and MacBeth (1973) regression.

$$R_{it} = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} + \beta_2 ESG_{it-1} + \beta_3 Overprice_{it-1} + \beta_4' X_{it-1} + e_{it} \quad (8)$$

where $R_{it}$is the cumulative daily return from the sixth trading day to the end of the month. We include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility, as control variables. The results are reported in Table 9.

[Insert Table 9 about here]

Columns (1) and (2) of Table 9 Panel A show that among overpriced stocks, an increase in one standard deviation of ESG score is associated with a 0.26% lower cumulative daily return. To further show that more negative return associated with overpriced high-ESG stock is due to limited short selling demand, we examine whether the return predictability is concentrated in stocks with a lower short selling demand. Specifically, within each SYY mispricing quintile, we divide stocks into two groups based on shares on loan and utilization ratio, and we expect the return predictability of ESG performance among overpriced stocks to be stronger for the low short selling demand group. Columns (3) and (4) in Panel A, Table 9 report the results for stocks with low

[32] More details about amendments and new rules could be found: https://www.sec.gov/divisions/investment/guidance/secg-investment-company-reporting-modernization-rules.htm

shares on loan and stocks with high shares on loan, respectively. We find that the return predictability only exists among stocks with a lower short selling demand.

The aforementioned results are consistent with the story that short sellers are less willing to short overpriced high-ESG stocks, leading to a more negative return afterwards. To lend more support to this argument, we next examine the impact of short selling demand on the return predictability by controlling for the short selling demand in the regression. If overpriced high-ESG stocks have more negative returns because of insufficient short demand, then the impact of the ESG score on the returns should be weakened when short selling demand is controlled for. The results are reported in Panel B Table 9. Among overpriced stocks, lower shares on loan are associated with more negative stock returns, showing insufficient short demand delays the process of mispricing correction. Short selling demand indeed plays a key role in explaining the negative relation between overpriced high ESG stocks and stock returns. After controlling for the short selling demand proxies, the magnitude of the coefficient is reduced by 30%, from -0.924 (Column (2)) to -0.652 (Column (6)) and *t*-statistic drops. However, the impact of ESG score is still marginally significant, showing that insufficient short selling demand may not be the only reason for the return predictability documented.

6. Conclusion

With the increasing awareness of ESG issues in recent years, more and more investors take ESG information into consideration. Do the short sellers, who are the natural arbitragers, consider the ESG performance when making short selling decisions? Our analysis suggests that when a stock is overpriced, short sellers will shy away from it if the stock has a good ESG performance. We use the inclusion of FTSE4Good Index inclusion (as well as the passage of close-call ESG proposals and the Paris Agreement) to establish the causal relationship between ESG performances and short selling demand, conditional on the mispricing level. We further find the lower demand for overpriced high-ESG stock is not due to common short-sale constraints such as fewer lendable shares or higher borrowing costs. Three potential explanations include synchronization risks, short squeeze risks, and ESG reputation risks. First, short sellers face higher uncertainty about whether and when the "long-side" investors will sell the overpriced high-ESG stocks. Second, high ESG stocks have a higher probability of upside price jump, and may experience a sudden price increase when the attention to ESG spikes. Third, short sellers who care about their ESG reputations may

be reluctant to short overpriced high-ESG stocks. Finally, the negative relationship between ESG performance and short selling demand among overpriced stocks has a considerable implication on stock returns. Overpriced stocks with high ESG scores have more negative stock returns afterwards. Controlling for short selling demand weakens the return patterns, but does not fully eliminate them.

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Table 1. Summary statistics

This table presents descriptive statistics of short selling activities, stock characteristics, and the correlation matrix. Panel A reports the stock-month summary statistics of short selling activities variables. Panel B reports summary statistics of ESG score, logarithm of market capitalization, the logarithm of book to market value, institutional ownership of most recent quarter-end, analyst coverage, firm leverage, loss dummy indicating negative earnings last year, and idiosyncratic risk (IVOL) of last month. We present the time-series average of cross-sectional distributions. *On loan* is the daily average of shares on loan relative to the total shares outstanding. *Lendable shares* is the daily average of shares available for lending on a given day relative to a firm's total shares outstanding. *Utilization ratio* is *on loan* divided by *Lendable shares*. *Lending Fee* is the daily average of transaction-weighted rate reported by Markit and expressed in percentage per annum. *ESG score* is the monthly updated raw score from the Asset4 database and scaled by 100. *SYY* score for a stock is the mispricing score in Stambaugh, Yu, and Yuan (2015). Each month, we divide stocks into five quintiles based on the SYY score, and *Overprice* is a dummy equal to one for stocks in quintile 5. *Ln(ME)* is the logarithm of market capitalization. *Ln(BM)* is the logarithm of book to market ratio. *Institutional ownership* is the percentage of common stocks owned by institutions in the previous quarter. *Analyst* is the number of analysts following the firm in the previous month. *Leverage* is the total liabilities scaled by the total asset at the most recent fiscal year end. *Loss* is a dummy variable indicating a negative income. *IVOL* is the annualized idiosyncratic volatility computed as in Ang, Hodrick, Xing, and Zhang (2006). Panel C reports the time-series average of cross-sectional correlations among different short selling variables, ESG scores, and other firm characteristics. The Pearson correlations are shown below the diagonal together with Spearman correlations above the diagonal. The sample period is from January 2006 to December 2019.

Panel A: Short selling activities

Jan 2006 – Dec 2019	Mean	Std	10-Pctl	Q1	Med	Q3	90-Pctl
On loan (%)	3.88	4.95	0.36	0.77	1.99	4.97	10.12
Lendable shares (%)	26.52	6.91	18.51	22.48	26.82	30.86	34.57
Utilization ratio (%)	12.09	14.96	0.86	2.13	6.19	16.20	32.26
Lending fee (%)	0.53	1.53	0.35	0.36	0.37	0.38	0.43

Panel B: Stock characteristics

Jan 2006 – Dec 2019	Mean	Std	10-Pctl	Q1	Med	Q3	90-Pctl
ESG score	0.63	0.25	0.28	0.41	0.64	0.87	0.94
SYY	45.02	11.82	30.46	36.54	44.10	52.60	60.77
Overprice	0.20	0.40	0.00	0.00	0.00	0.00	1.00
Ln(ME)	8.97	1.20	7.62	8.12	8.81	9.68	10.61
Ln(BM)	-0.90	0.79	-1.84	-1.35	-0.85	-0.34	0.02
Institutional ownership	0.79	0.16	0.59	0.70	0.81	0.90	0.96
Analyst	15.26	7.51	5.84	9.66	14.65	20.11	25.51
Leverage	0.26	0.20	0.03	0.13	0.24	0.36	0.50
Loss	0.12	0.32	0.00	0.00	0.00	0.01	0.61
IVOL	0.07	0.04	0.03	0.04	0.06	0.08	0.11

Panel C. Correlations among short selling activities and stock characteristics

Spearman / Pearson	Var1	Var2	Var3	Var4	Var5	Var6	Var7	Var8	Var9	Var10	Var11	Var12	Var13	Var14
On loan	1.00	0.17	0.95	0.17	-0.28	0.17	0.16	-0.42	0.02	0.32	-0.10	0.07	0.18	0.28
Lendable shares	0.21	1.00	-0.01	-0.10	-0.03	-0.05	-0.04	-0.23	0.08	0.59	0.00	-0.12	0.00	0.13
Utilization ratio	0.89	-0.08	1.00	0.19	-0.30	0.18	0.17	-0.41	0.01	0.20	-0.13	0.09	0.18	0.27
Lending fee	0.28	-0.12	0.41	1.00	-0.09	0.07	0.08	-0.08	0.02	0.02	-0.03	0.06	0.10	0.12
ESG	-0.24	0.03	-0.27	-0.08	1.00	-0.10	-0.11	0.51	-0.09	-0.22	0.26	0.06	-0.14	-0.21
SYY	0.15	-0.07	0.18	0.06	-0.09	1.00	0.69	-0.17	0.31	0.01	-0.12	0.25	0.23	0.19
Overprice	0.15	-0.04	0.17	0.06	-0.10	0.74	1.00	-0.12	0.19	0.02	-0.06	0.20	0.22	0.17
Ln(ME)	-0.36	-0.21	-0.35	-0.10	0.50	-0.19	-0.12	1.00	-0.21	-0.31	0.58	0.03	-0.18	-0.28
Ln(BM)	0.02	0.07	0.00	0.02	-0.07	0.27	0.17	-0.20	1.00	-0.01	-0.19	-0.02	0.14	0.04
Institutional ownership	0.34	0.64	0.13	0.01	-0.13	0.00	0.01	-0.27	-0.01	1.00	-0.02	-0.03	0.10	0.25
Analyst	-0.08	0.02	-0.10	-0.07	0.25	-0.12	-0.05	0.56	-0.18	0.01	1.00	-0.11	-0.08	0.00
Leverage	0.09	-0.12	0.13	0.07	-0.02	0.22	0.18	0.01	-0.08	0.00	-0.12	1.00	0.10	0.00
Loss	0.19	-0.01	0.20	0.11	-0.13	0.25	0.22	-0.18	0.12	0.08	-0.07	0.10	1.00	0.24
IVOL	0.28	0.05	0.30	0.18	-0.19	0.20	0.17	-0.27	0.04	0.16	-0.01	0.04	0.26	1.00

Table 2. Overpricing, ESG performance, and short selling activities

Panel A presents the results from panel regressions of short selling demand as a function of the ESG performance and an overpriced dummy. Short selling demand is proxied by shares on loan and utilization ratio. Panel B presents the results from panel regressions of short sale constraints as a function of the ESG performance and an overpriced dummy. Short sale constraints are measured by lendable shares, lending fee, ERR short selling risks (Engelberg, Reed, and Ringgenberg (2018)), and put-call implied volatility ratio. At the end of each month, all sample stocks are sorted into five quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

Panel A. Short selling demand

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG	-1.144**	-1.615***	-5.523***	-6.382***
	(-2.18)	(-3.69)	(-3.45)	(-4.59)
Overprice	1.745***	1.677***	6.554***	5.945***
	(5.16)	(5.86)	(6.09)	(6.39)
ESG	-0.663	0.099	-2.507**	-0.546
	(-1.37)	(0.25)	(-1.97)	(-0.47)
Ln(ME)		-2.212***		-6.303***
		(-11.65)		(-11.58)
Ln(BM)		0.010		-0.712
		(0.07)		(-1.51)
Institutional ownership		19.504***		43.577***
		(14.48)		(11.75)
Analyst		0.045***		0.147***
		(3.51)		(3.39)
Leverage		4.694***		12.890***
		(6.31)		(5.44)
Loss		0.731***		2.403***
		(7.14)		(7.30)
IVOL		9.248***		31.770***
		(11.51)		(12.56)
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.495	0.628	0.547	0.630
Observations	106,665	95,658	106,665	95,658

Panel B. Short-sale constraints

	Lendable shares		Lending fee		ERR Short selling risk		Put-call implied volatility ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overprice x ESG	0.874*	0.617	-0.273***	-0.226***	-0.042***	-0.034***	-1.297**	-0.864*
	(1.84)	(1.41)	(-2.88)	(-2.79)	(-2.94)	(-2.60)	(-2.49)	(-1.75)
Overprice	-0.924***	-0.751***	0.280***	0.211***	0.041***	0.029***	0.913**	0.592*
	(-2.99)	(-2.67)	(3.88)	(3.50)	(3.82)	(3.10)	(2.38)	(1.65)
ESG	0.394	0.515	-0.025	0.054	-0.008	0.004	-0.467	-0.145
	(0.68)	(0.94)	(-0.54)	(1.17)	(-1.12)	(0.57)	(-1.21)	(-0.38)
Ln(ME)		-0.651***		-0.187***		-0.028***		-0.775***
		(-3.46)		(-3.84)		(-4.39)		(-4.11)
Ln(BM)		0.375**		-0.017		-0.006		0.098
		(2.06)		(-0.64)		(-1.48)		(0.79)
Institutional ownership		15.774***		0.849***		0.160***		1.338
		(16.52)		(3.64)		(4.61)		(1.30)
Analyst		0.045***		0.003		0.001		-0.038**
		(3.10)		(1.06)		(1.24)		(-2.53)
Leverage		-0.900		0.103		0.001		0.377
		(-1.14)		(0.59)		(0.04)		(0.43)
Loss		-0.492***		0.049**		0.008**		0.047
		(-4.48)		(2.02)		(2.04)		(0.37)
IVOL		-2.599***		1.754***		0.392***		-3.553*
		(-2.89)		(6.36)		(6.40)		(-1.78)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R-squared	0.771	0.796	0.334	0.335	0.244	0.245	0.114	0.114
Observations	106,665	95,658	106,665	95,658	106,658	95,653	98,222	88,437

Table 3. Alternative mispricing measures

The table presents the results from panel regressions of short selling demand as a function of the ESG performance and alternative mispricing measures. Short selling demand is proxied by shares on loan and utilization ratio. We use standardized unexpected earnings (SUE) in the most recent quarter in Panel A and Green, Hand, and Zhang (2017) mispricing score in Panel B as two alternative mispricing measures. At the end of each month, all sample stocks are sorted into five quintiles based on two alternative mispricing measures. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

Panel A: SUE as mispricing measure

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG	-1.209***	-0.766***	-3.445***	-2.406***
	(-3.56)	(-2.69)	(-3.65)	(-2.97)
Overprice	1.798***	1.079***	5.153***	3.325***
	(7.29)	(5.36)	(7.60)	(5.85)
ESG	-0.643	-0.048	-2.799**	-1.197
	(-1.35)	(-0.12)	(-2.19)	(-1.03)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.496	0.627	0.548	0.629
Observations	106,665	95,658	106,665	95,658

Panel B: Green, Hand, and Zhang (2017) mispricing score as mispricing measure

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG	-1.061**	-1.245***	-5.573***	-5.709***
	(-2.55)	(-3.45)	(-4.08)	(-4.71)
Overprice	1.259***	1.362***	5.677***	5.639***
	(4.04)	(5.10)	(5.48)	(6.10)
ESG	-0.803	-0.027	-2.849**	-0.801
	(-1.63)	(-0.07)	(-2.18)	(-0.69)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.490	0.627	0.544	0.629
Observations	106,151	95,000	106,151	95,000

Table 4. Alternative ESG scores

Panel A presents the panel regression results of short selling demand as a function of ESG performance and an overpriced dummy. The dependent variables include *On loan* and *Utilization ratio*. At the end of each month, all available stocks are sorted into five quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is a combined ESG score from Asset4, KLD, MSCI, Sustainalytics, and Reprisk. For each ESG data provider, we sort stocks into quintiles and assign the rank to the stocks. A combined ESG score is the average of ranks according to different ESG data providers, when at least three ESG data providers are available. In Panel B, we first instrument Asset4 ESG score by ESG scores from KLD, MSCI, Sustainalytics, and Reprisk. Then we report the effects of the instrumented ESG score on short selling activities. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

Panel A. Combined ESG score

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG	-0.254***	-0.263***	-0.891***	-0.860***
	(-3.77)	(-4.66)	(-4.30)	(-4.67)
Overprice	2.466***	2.159***	8.181***	6.849***
	(6.32)	(6.52)	(6.64)	(6.25)
ESG	0.036	0.104**	0.208	0.367**
	(0.64)	(2.19)	(1.25)	(2.47)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.512	0.653	0.562	0.652
Observations	95,918	86,238	95,918	86,238

Panel B. Instrumented ESG score

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG	-2.589**	-3.012***	-6.975**	-9.816***
	(-2.33)	(-3.94)	(-1.98)	(-3.81)
Overprice	2.081***	2.395***	5.899**	7.710***
	(2.68)	(4.52)	(2.32)	(4.18)
ESG	0.414	5.471	-1.096	17.734
	(0.43)	(1.27)	(-0.36)	(1.51)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.225	0.237	0.199	0.165
Observations	47,095	47,088	47,095	47,088

Table 5. Short selling activities around FTSE4Good US Index inclusion events

This table reports panel regression results of short selling demand around the FTSE4Good US Index inclusion events, conditional on overpricing. The dependent variables include *On loan* and *Utilization ratio*. The event window is (-6, +6) months excluding the event month. We match firms that are included in the index with firms that are not included using a propensity score matching approach. Our matching variables include ESG score, size, book to market ratio, stock return, momentum, and idiosyncratic volatility before the event. *Treat* is a dummy equal to one for stocks included in FTSE4Good US Index in that quarter, and zero otherwise. *Post* is a dummy equal to one for the period after index inclusion, and zero otherwise. *Overprice* is a dummy equal to one for stocks in the fifth quintile according to the Stambaugh, Yu, and Yuan (2015) mispricing score, and zero otherwise. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Post x Treat x Overprice	-1.047***	-0.905**	-2.579**	-2.226**
	(-2.87)	(-2.10)	(-2.48)	(-1.99)
Post x Treat	0.017	0.037	-0.099	-0.058
	(0.29)	(0.68)	(-0.48)	(-0.29)
Post x Overprice	0.282**	0.208*	0.759	0.507
	(2.12)	(1.76)	(1.14)	(0.81)
Treat x Overprice	0.396	0.307	1.286	1.143
	(1.02)	(0.77)	(1.31)	(1.16)
Overprice	0.044	0.136	-0.052	0.180
	(0.16)	(0.61)	(-0.07)	(0.30)
Post	0.067	0.058	0.230	0.249
	(1.43)	(1.23)	(1.35)	(1.42)
Treat	-0.091	-0.104	-0.173	-0.210
	(-0.63)	(-0.71)	(-0.41)	(-0.50)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.728	0.745	0.758	0.768
Observations	5,040	4,864	5,042	4,866

Table 6. The impacts of socially responsible investors and ESG attention

This table investigates the relationship between ESG performances and short selling demand conditional on socially responsible institutional ownership (SR_IO) and climate change exposure, in Panel A and B, respectively. At the end of each month, all available stocks are sorted into five quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. In Panel A, in each quarter, we divide all the stocks into two groups based on socially responsible institutional ownership (SR_IO). Following Cao, Titman, Zhan, and Zhang (2022), we first calculate a value-weighted size-adjusted ESG score as the socially responsible score for all the institutions. Then we define socially responsible (SR) institutions (one-third of all) based on their scores. SR_IO is the number of shares held by SR institutions divided by the total number of shares held by all the institutions. *High SR_IO* is a dummy equal to one for firms with SR_IO above the median last quarter, and zero otherwise. In Panel B, each quarter, we divide all the stocks into two groups based on Climate Change Exposure (CC_Expo), constructed by Sautner, Van Lent, Vilkov, and Zhang (2022), which captures overall attention on climate change exposure of the firms from earnings conference calls. *High CC_Expo* is a dummy equal to one for firms with CC_Expo above the median last quarter, and zero otherwise. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

Panel A: The impact of socially responsible institutional ownership (SR_IO)

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x High SRIO	-2.404***	-1.739**	-5.968**	-3.703**
	(-2.80)	(-2.34)	(-2.37)	(-2.27)
Overprice x ESG	0.533	-0.284	-1.220	-3.651*
	(0.66)	(-0.41)	(-0.52)	(-1.76)
Overprice x High SRIO	1.463***	1.232***	3.224**	2.382*
	(2.92)	(2.77)	(2.07)	(1.68)
ESG x High SRIO	0.547	0.791	1.210	1.519
	(0.90)	(1.58)	(0.74)	(1.06)
High SRIO	-0.305	-0.180	-0.264	0.251
	(-0.80)	(-0.55)	(-0.25)	(0.26)
Overprice	0.842*	0.825**	4.473***	4.340***
	(1.85)	(2.02)	(3.15)	(3.35)
ESG	-2.463***	-1.363**	-9.983***	-6.680***
	(-3.62)	(-2.48)	(-5.22)	(-4.04)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.499	0.629	0.552	0.633
Observations	105,528	95,415	105,528	95,415

Panel B: The impact of climate change exposure

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x High CC_Expo	-2.301***	-1.917***	-6.302***	-5.878***
	(-3.14)	(-3.30)	(-2.76)	(-3.06)
Overprice x ESG	-0.454	-0.955**	-3.467**	-4.456***
	(-0.79)	(-2.07)	(-1.97)	(-3.16)
Overprice x High CC_Expo	1.302**	1.269***	3.928**	4.235***
	(2.57)	(3.09)	(2.38)	(2.92)
ESG x High CC_Expo	-0.026	-0.350	-0.546	-1.348
	(-0.07)	(-1.20)	(-0.52)	(-1.46)
High CC_Expo	-0.167	0.030	-0.280	0.187
	(-0.62)	(0.14)	(-0.35)	(0.26)
Overprice	1.460***	1.327***	5.363***	4.643***
	(3.95)	(4.34)	(4.50)	(4.75)
ESG	-1.892***	-0.461	-8.517***	-4.643***
	(-3.77)	(-1.12)	(-5.53)	(-3.45)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.500	0.631	0.553	0.635
Observations	101,005	91,467	101,005	91,467

Table 7. The impacts of public attention and ESG sentiment beta

This table investigates the relationship between ESG performances and short selling demand conditional on Google Search Volume and ESG sentiment beta, in Panel A and B, respectively. At the end of each month, all available stocks are sorted into five quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. In Panel A, DGSVI is the monthly innovation on the Google Search Volume of topic "Environmental, social and corporate governance". In Panel B, for each stock, we estimate ESG sentiment beta by running the regression of daily return on the daily Google Search Volume on the topic "ESG", based on the 252-day rolling window. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

Panel A: The impact of Google Search Volume

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x DGSVI	-1.084***	-0.706**	-3.607***	-3.478***
	(-2.86)	(-2.39)	(-2.91)	(-2.58)
Overprice x ESG	-0.554	-1.233***	-3.914**	-5.360***
	(-1.00)	(-2.72)	(-2.37)	(-3.75)
Overprice x DGSVI	0.561**	0.211	2.398***	2.030**
	(2.42)	(0.80)	(3.09)	(2.37)
ESG x DGSVI	0.293**	0.235*	-0.225	-0.201
	(2.15)	(1.68)	(-0.58)	(-0.48)
Overprice	1.483***	1.506***	5.807***	5.455***
	(4.29)	(5.23)	(5.36)	(5.84)
ESG	-0.718	0.065	-2.659**	-0.638
	(-1.49)	(0.16)	(-2.09)	(-0.55)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.495	0.628	0.548	0.630
Observations	106,665	95,658	106,665	95,658

Panel B: The impact of ESG sentiment beta

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x $Beta_{ESG}$	-14.535*	-24.860***	-35.792*	-49.282***
	(-1.69)	(-2.84)	(-1.86)	(-2.72)
Overprice x ESG	-0.535	-1.212***	-3.872**	-5.310***
	(-0.96)	(-2.67)	(-2.34)	(-3.71)
Overprice x $Beta_{ESG}$	5.981	11.770**	24.406	30.454*
	(0.99)	(2.30)	(1.18)	(1.70)
ESG x $Beta_{ESG}$	-3.374	-1.442	-5.612	-3.831
	(-0.77)	(-0.35)	(-0.45)	(-0.33)
Overprice	1.470***	1.493***	5.775***	5.421***
	(4.24)	(5.19)	(5.33)	(5.80)
ESG	-0.723	0.060	-2.658**	-0.636
	(-1.50)	(0.15)	(-2.09)	(-0.55)
$Beta_{ESG}$	3.003	-0.077	3.946	-2.592
	(1.05)	(-0.03)	(0.47)	(-0.32)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.495	0.628	0.548	0.630
Observations	106,665	95,658	106,665	95,658

Table 8. ESG performances and short-sale campaigns

This table presents the effects of corporate ESG performances on the short-sale campaigns. In Panel A, we present the logit regression results with the short-sale campaign dummy as the dependent variable for the full sample and for a matched sample. We match short-sale campaign targeted firms with non-target firms according to shares on loan, utilization ratio, logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility using a propensity score matching approach. In Panel B, we investigate the attitude of the public to short-campaigns conditional on the ESG performances of the targeted firms. In Columns (1) and (2), the dependent variable is the agreement score of each comment. The agreement score takes the value of -1 if the comment is against the short-sale campaign, +1 if the comment is supportive of the short-sale campaign, and 0 if the comment is neutral. In Columns (3) and (4), the dependent variable is the ESG dummy, which equals one if the comment mentions ESG related topics, and zero otherwise. As Thomson Reuters Asset4 coverage is not sufficient for the analyses in this table, we rely on a combined score (ESG score) for the analyses related to short-sale campaigns. Specifically, ESG score is a combined score, whenever possible, using the average of standardized scores obtained from the KLD database and IVA database. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All the regressions control for year fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the event. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

Panel A. Probability of being targeted by short-sale campaigns

	(1)	(2)
	Full sample	Matched sample
ESG score	-0.489***	-0.398**
	(-3.22)	(-1.99)
Controls	Yes	Yes
Year fixed effects	Yes	Yes
Adj R-squared	0.126	0.040
Observations	25,156	208

Panel B. Comment-level analysis

	(1)	(2)	(3)	(4)
	Agreement Score		ESG Dummy	
ESG score	-0.147***	-0.120***	0.020*	0.044***
	(-3.99)	(-3.14)	(1.66)	(2.89)
Controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.041	0.058	0.032	0.032
Observations	5,277	4,634	5,277	4,634

Table 9. ESG performances, short selling activities, and future stock returns

Panel A reports the Fama-MacBeth regression results of future stock returns on the overpriced dummy, ESG performances, and other controls, for the full sample (Columns (1) and (2)), stocks with low and high shares on loan (Columns (3) and (4)), and stocks with low and high utilization ratio (Columns (5) and (6)), respectively. Panel B reports the Fama-MacBeth regression results of future stock returns on the overpriced dummy, ESG performances, and shares on loan and utilization ratio as additional control variables. At the end of each month, all available stocks are sorted into five quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. Within each SYY mispricing quintile, we further divide stocks into two groups based on shares on loan or utilization ratio. *ESG* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. We report Newey-West (1987) *t*-statistics in parentheses below the coefficients. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels. The sample period is from January 2006 and December 2019.

Panel A. ESG, mispricing, short demand, and stock returns

	Full sample		Subsample: On loan		Subsample: Utilization	
			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
Overprice x ESG	-0.586**	-0.924***	-0.975**	-0.440	-1.010**	-0.444
	(-1.98)	(-2.86)	(-2.49)	(-0.70)	(-2.50)	(-0.77)
Overprice	-0.055	0.243	0.067	0.136	0.106	0.151
	(-0.27)	(1.15)	(0.23)	(0.38)	(0.36)	(0.48)
ESG	-0.122	0.433*	0.278	0.435*	0.316	0.459*
	(-0.71)	(1.85)	(1.17)	(1.70)	(1.14)	(1.97)
Controls	No	Yes	Yes	Yes	Yes	Yes
Adj R-squared	0.012	0.060	0.065	0.066	0.065	0.064
Observations	105,986	95,104	47,783	47,321	48,006	47,098

Panel B. Controlling for short selling demand

	(1)	(2)	(3)	(4)	(5)	(6)
Overprice x ESG	-0.586**	-0.924***	-0.447	-0.757*	-0.466	-0.652*
	(-1.98)	(-2.86)	(-1.14)	(-1.93)	(-1.09)	(-1.70)
Overprice	-0.055	0.243	-0.202	0.037	-0.180	0.006
	(-0.27)	(1.15)	(-0.93)	(0.15)	(-0.78)	(0.02)
ESG	-0.122	0.433*	-0.170	0.393*	-0.176	0.381*
	(-0.71)	(1.85)	(-1.08)	(1.82)	(-1.09)	(1.72)
Overprice x On loan			0.021	0.036**		
			(1.23)	(2.22)		
On loan			-0.014	-0.025**		
			(-1.07)	(-2.19)		
Overprice x UT					0.008	0.014**
					(1.35)	(2.31)
UT					-0.006	-0.007**
					(-1.33)	(-1.99)
Controls	No	Yes	No	Yes	No	Yes
Adj R-squared	0.012	0.060	0.025	0.070	0.024	0.070
Observations	105,986	95,104	105,986	95,104	105,986	95,104

Supplementary Appendix for
"Green or Brown: Which Overpriced Stock to Short Sell?"

Variable Definitions

Short Selling Activity Measures	
On loan	Daily average of shares on loan relative to the total shares outstanding from five trading days before the month-end and the first five trading days of the next month.
Lendable shares	Daily average of shares available for lending on a given day relative to a firm's total shares outstanding from five trading days before the month-end and the first five trading days of the next month.
Utilization ratio	Each day, we use shares on loan scale by lendable shares to get daily utilization ratio, then take average from five trading days before the month-end and the first five trading days of the next month.
Lending fee	Daily average of transaction-weighted rate reported by Markit and expressed in percentage per annum.
Mispricing Measures	
SYY score	SYY score, ranging between 1 and 100, is the composite mispricing measure in Stambaugh, Yu, and Yuan (2015). Stocks with the highest SYY values are most "overpriced" and those with the lowest values are most "underpriced". Updated monthly.
SUE score	Standardized unexpected earnings score is computed as the difference between current quarter's earnings and the earnings four quarters ago, then divided by the standard deviation of unexpected earnings over the last eight quarters.
Overprice	At the end of each month, all available stocks are sorted into five mispricing quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. Overprice is a dummy that equals one for stocks in the fifth quintile, i.e., the most "overpriced" stocks, and zero otherwise.
Corporate Social Performance (ESG) measures	
ESG score	ESG score is monthly updated from the Asset4 database, based on 250+ key performance indicators (KPIs) and 750+ individual data points, from three pillars. The range of ESG score is between 0 and 1 after scaling by 100.
Institution Holding Change Measures	
Mutual funds number change	Difference between logarithm of mutual funds holding the stock this quarter and last quarter.
Mutual fund ownership change	Difference between total mutual fund ownership this quarter and last quarter.
Institution number change	Difference between logarithm of 13f institutions holding the stock this quarter and last quarter.
Institutional ownership change	Difference between total 13f institutional ownership this quarter and last quarter

Stock Characteristics	
Ln(ME)	The natural logarithm of the market value of the firm's equity at the end of last year.
Ln(BM)	The natural logarithm of book equity for the fiscal year-end in a calendar year divided by market equity at the end of December of that year, as in Fama and French (1992).
Institutional ownership	The percentage of common stocks owned by institutions in the previous quarter.
Analyst	The number of analysts following the firm in the previous month.
Leverage	Total liabilities scaled by the total asset at the end of the most recent fiscal year.
Loss	A dummy variable equal to one if the net income at the end of the most recent fiscal year is negative, and zero otherwise.
IVOL	Idiosyncratic volatility, as in Ang, Hodrick, Xing, and Zhang (2006), computed as the standard deviation of the regression residual of individual stock returns on the Fama and French (1993) three factors using daily data in the previous month.
ESG sentiment beta	ESG sentiment beta is estimated from daily rolling regressions of individual stock excess returns on the innovation in the Google Search Index of the topic "ESG", after controlling for daily Fama-French three-factor. It is based on a 60-day rolling window with a minimum requirement of 24 days, or 252-day rolling window with a minimum requirement of 120 days.
Socially responsible institutional ownership	We first calculate value-weighted size-adjusted ESG score as socially responsible score for all the institutions. Then we define socially responsible (SR) institutions (one-third of all) based on their score. SR_IO is the number of shares held by SR institutions divided by the total number of shares held by all the institutions.
Climate change exposure	Constructed by Sautner, Van Lent, Vilkov, and Zhang (2022), this measure counts the frequency of certain climate change bigrams in a transcript, scaled by the total number of bigrams in that transcript, and captures overall attention on climate change exposure of the firms from earnings conference calls.

Table A1. Mispricing and short selling activities

The table presents the panel regression results of short selling activities as a function of ESG and the overpriced dummy. The dependent variables include *On loan* and *Utilization ratio*. SYY is Stambaugh, Yu, and Yuan (2015) mispricing score at the end of last month. At the end of each month, all available stocks are sorted into five quintiles based on the Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice	1.170***	0.797***	3.578***	2.361***
	(9.07)	(7.42)	(9.71)	(7.46)
ESG	-0.804*	-0.122	-3.242**	-1.438
	(-1.67)	(-0.31)	(-2.53)	(-1.25)
Ln(ME)		-2.211***		-6.297***
		(-11.65)		(-11.58)
Ln(BM)		-0.004		-0.766
		(-0.03)		(-1.64)
Institutional ownership		19.481***		43.501***
		(14.43)		(11.68)
Analyst		0.045***		0.146***
		(3.49)		(3.36)
Leverage		4.664***		12.829***
		(6.27)		(5.41)
Loss		0.722***		2.382***
		(7.08)		(7.23)
IVOL		9.166***		31.550***
		(11.40)		(12.38)
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.495	0.628	0.547	0.629
Observations	106,665	95,658	106,665	95,658

Table A2. Short selling activities around Russell 2000 inclusion events

This table reports panel regression results of short selling activities around the Russell 2000 Index inclusion events. The event window is (-6, +6) months excluding the event month. The dependent variables include *On loan* and *Utilization ratio*. The treated group contains the 1001st to 1100th stocks in terms of market capitalization at the end of May, which will be included in the Russell 2000 index. The control group contains the 901st to 1000th stocks in terms of market capitalization at the end of May, which will be included in Russell 1000 index. At the end of each month, all available stocks are sorted into five quintiles based on the Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. We match treated and control firms via a propensity score matching based on ESG score, size, book to market ratio, and stock return in the prior month. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Post x Treat x Overprice	1.097**	0.797*	3.564**	2.368*
	(2.47)	(1.78)	(2.26)	(1.70)
Post x Treat	-0.235	-0.134	-0.919*	-0.847*
	(-1.55)	(-0.91)	(-1.96)	(-1.82)
Post x Overprice	-0.184	-0.274	-0.236	-0.368
	(-0.57)	(-0.81)	(-0.23)	(-0.37)
Treat x Overprice	-1.159**	-0.757	-3.879**	-2.108
	(-2.37)	(-1.52)	(-2.41)	(-1.45)
Overprice	1.110***	0.901**	4.064***	2.461**
	(2.80)	(2.18)	(3.05)	(1.99)
Post	0.054	0.072	0.095	0.237
	(0.44)	(0.57)	(0.25)	(0.62)
Treat	-0.437**	-0.263	-1.239*	-0.556
	(-2.05)	(-1.27)	(-1.86)	(-0.84)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.663	0.709	0.683	0.711
Observations	20,561	17,680	20,561	17,680

Table A3. Overpricing, ESG performances, and long-side institutions' trading behavior

This table reports the panel regression results of quarterly trading behavior of mutual funds and institutions towards overpriced stocks with different ESG scores. In Columns (1) and (2), *mutual funds number change* is defined as the difference between the logarithm of mutual funds holding the stock this quarter and last quarter. In Columns (3) and (4), *mutual funds ownership change* is defined as the difference between total mutual fund ownership this quarter and last quarter. In Columns (5) and (6), *institution number change* is defined as the difference between logarithm of institution numbers holding the stock this quarter and last quarter. In Columns (7) and (8), *institutional ownership change* is defined as the difference between total institutional ownership this quarter and last quarter. One month before the end of each quarter, we calculate the average Stambaugh, Yu, and Yuan (2015) mispricing score of the preceding three months for each stock. Then all the available stocks are sorted into five SYY quintiles. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last quarter. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	Mutual funds number change		Mutual fund ownership change		Institution number change		Institutional ownership change	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overprice x ESG	1.361**	1.115*	0.513***	0.502***	3.421***	2.902**	0.905***	0.979***
	(2.27)	(1.76)	(3.95)	(3.62)	(2.96)	(2.36)	(2.87)	(2.82)
Overprice	-1.988***	-1.545***	-0.164*	-0.172*	-3.140***	-2.520***	-0.371*	-0.383*
	(-5.13)	(-3.56)	(-1.69)	(-1.65)	(-5.00)	(-3.64)	(-1.92)	(-1.79)
ESG	0.577	0.714	-0.205**	-0.162	4.777***	5.122***	0.137	0.106
	(1.09)	(1.29)	(-2.09)	(-1.60)	(4.47)	(4.62)	(0.57)	(0.38)
Ln(ME)		-2.241***		-0.004		-2.248***		-0.084
		(-8.27)		(-0.10)		(-4.63)		(-0.69)
Ln(BM)		-0.272		0.042		0.817*		0.240**
		(-1.17)		(1.14)		(1.84)		(2.19)
Institutional ownership		11.842***		-1.955***		-1.617		-13.388***
		(7.51)		(-9.55)		(-0.80)		(-17.46)
Analyst		-0.053**		0.004		0.005		0.027***
		(-2.55)		(0.99)		(0.13)		(2.73)
Leverage		0.417		0.504***		-0.245		0.561
		(0.41)		(3.03)		(-0.11)		(1.03)
Loss		-1.610***		0.013		-0.935**		0.098
		(-7.61)		(0.27)		(-2.42)		(0.81)
IVOL		-18.156***		0.157		-14.688***		-2.024
		(-5.37)		(0.26)		(-3.15)		(-1.39)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R-squared	0.398	0.419	0.826	0.833	0.457	0.469	0.271	0.301
Observations	35,184	31,906	35,184	31,906	34,652	31,443	34,649	31,441

Table A4. ESG performances and upside jump risk

The table presents the results from panel regressions of upside jump risks measures, which proxy for the short squeeze risks, as a function of ESG performance and other control variables. The dependent variable is realized skewness, relative signed jump variation, option implied skewness, and upside slope in Columns (1) to (4), respectively. Realized skewness is the skewness calculated using the previous month's daily stock returns. Following Bollerslev, Li, and Zhao (2019) and using high-frequency intraday data, relative signed jump variation is defined as the difference between the up and down semi-variance measures divided by the total return variation. Option implied skewness is the difference between the implied volatilities of out-of-the-money (OTM) call options and at-the-money (ATM) call options. Upside slope is calculated as the slope of a function that relates right-tail implied volatility to moneyness (with moneyness measured by the option's delta) of call options. To make it easier to interpret, we take the negative value of the upside slope. *ESG* score is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by the firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	Realized skewness	Relative signed jump variation	Option implied skewness	Upside slope
	(1)	(2)	(3)	(4)
ESG	8.302***	0.357**	0.212**	1.391***
	(2.88)	(2.28)	(2.06)	(2.88)
Ln(ME)	-11.932***	-0.692***	-0.125***	-1.595***
	(-11.44)	(-10.65)	(-2.70)	(-6.96)
Ln(BM)	-0.851	-0.049	-0.084**	0.329*
	(-0.87)	(-0.87)	(-2.31)	(1.70)
Institutional ownership	-3.264	-0.126	-0.390*	-1.061
	(-0.74)	(-0.48)	(-1.67)	(-0.93)
Analyst	-0.058	-0.008	0.005	0.046**
	(-0.58)	(-1.47)	(1.26)	(2.50)
Leverage	0.380	0.150	0.089	-0.438
	(0.08)	(0.60)	(0.45)	(-0.45)
Loss	-3.334***	-0.308***	-0.094**	0.321
	(-2.85)	(-4.52)	(-2.15)	(1.53)
IVOL	47.146***	-0.663	-0.799*	8.590***
	(5.04)	(-1.29)	(-1.79)	(3.31)
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.048	0.160	0.307	0.337
Observations	95,644	95,284	84,710	72,885

Internet Appendix for
Green or Brown: Which Overpriced Stock to Short Sell?

IA1. Short selling activities around the passage of ESG proposal

We rely on a difference-in-differences approach to study the causal effect of the close-call passage of a firm's ESG proposal on its short selling demand. We obtain the data on shareholder proposal voting results from ISS. Proposals related to "social/environmental issues" or "corporate governance issues" are classified as ESG proposals. Following Flammer (2015) and Cao, Liang, and Zhan (2019), we use a voting firm's random passage of ESG proposals around 50% as identification, assuming the passage of an ESG proposal to be a randomly assigned variable with regard to firms' other characteristics. Intuitively, there is no reason to expect any systematic difference between a company for which an ESG proposal passes with 50.1% of the votes and a company for which a similar proposal fails with 49.9% of the votes. However, if a company passes an ESG proposal, it will have a better ESG performance in the future compared to its peers that fail with a similar voting rate (Cao, Liang, and Zhan (2019)). As a result, we conjecture that among overpriced stocks, the short selling demand would be lower after a firm passes a close-call ESG proposal compared to another firm that just fails an ESG proposal. To test this hypothesis, we run the following regression for the event window of (-6, +6) months:

$$\begin{aligned} Short\ Selling\ Demand_{it} &= \alpha + \beta_1 Treat_{it} \times Post_{it} \times Overprice_{it-1} + \beta_2 Treat_{it} \times Post_{it} + \\ \beta_3 Post_{it} \times Overprice_{it-1} &+ \beta_4 Treat_{it} \times Overprice_{it-1} + \beta_5 Overprice_{it-1} + \beta_6 Post_{it} \\ &+ \beta_7 Treat_{it} + \beta_8' X_{it-1} + \gamma_t + \theta_i + e_{it}, \end{aligned} \quad \text{(IA1)}$$

where $Treat_{it}$ represents the firms passing an ESG proposal with a supporting rate lower than 55%. The control group includes firms that reject an ESG proposal with a supporting rate higher than 45%. $Post_{it}$ is the dummy for the 6 months after the event.[33]

Results in Appendix Table IA1 are consistent with the hypothesis. If a firm passes a close-call ESG proposal, its ESG performance is expected to be improved compared to its peers that just reject an ESG proposal. Shares on loan and utilization ratio decrease significantly. It

[33] We exclude the month when ESG proposal is passed, because Flammer (2015) and Cao, Liang, and Zhan (2019) document a positive CAR associated with close-call pass of ESG proposal, which might also affect short sellers' decision.

indicates when the ESG score of a firm is expected to increase after the passage of an ESG proposal, short sellers are less willing to short it, especially for overpriced stocks.

IA2. Short selling activities around the Paris Agreement

Another shock we utilize is the Paris Agreement. On December 12, 2015, the Paris Agreement was announced at the 21st Conference of the Parties (or COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris. The PA is broadly considered as a landmark step for global climate change mitigation and adaptation action, and more importantly, it came as a surprise. For the first time, most UN countries agreed on the need to limit global temperature increase "well below 2°C" above pre-industrial levels (Art 2.1(a)), to strengthen the ability of countries to deal with the impacts of climate change (Art 2.1(b)), and to commit to "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" (Art 2.1(c)).[34] After the announcement of Paris Agreement, investors' ESG awareness and their attention on ESG related issues would increase. Climate risks, including regulatory risks and litigation risks would also increase, through the adoption of a carbon tax for instance. As a result, after the PA was announced, investors become more aware of ESG issues, and climate risk has a higher probability to be materialized, and we expect the effect of ESG performance on short selling activities of overpriced stocks to be magnified.

Specifically, we look at a short window of (-6, +6) months around the announcement of Paris Agreement, excluding the event month (2015 December). In particular, we hypothesize that after Paris Agreement, investors' ESG awareness will be magnified, and the effect of ESG performance on short selling demand will become stronger as a result. We run the following regression and report the results in Table IA2.

$$Short\ Selling\ Demand_{it} = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} \times Post_t + \beta_2 ESG_{it-1} \times Post_t + \beta_3 Overprice_{it-1} \times Post_t + \beta_4\ ESG_{it-1} \times Overprice_{it-1} + \beta_5 Overprice_{it-1} + \beta_6 ESG_{it-1} + \beta_7 Post_t + \beta_8' X_{it-1} + \gamma_t + \theta_i + e_{it}, \quad \text{(IA2)}$$

where $Post_t$ is a dummy representing six months after Paris Agreement. Consistent with our conjecture, there are even fewer shares on loan for overpriced high-ESG stocks after Paris

[34] Complete texts of the Paris Agreement can be found at https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement.

Agreement, together with a lower utilization ratio.

IA3. The impact of Greta's speeches

To further elaborate the relationship between a sudden surge of ESG sentiment and price increases of high ESG stocks, we utilize ten speeches of Greta Thunberg as exogenous shocks on public attention to ESG related issues, and investigate whether there is a difference in returns between stocks with high ESG and other stocks around her speeches. We divide our sample firms into ESG quintiles and investigate how the cumulative abnormal return (CAR) of high ESG stocks differs from other stocks. Figure IA1 provides an informal view of the impact of Greta's speeches by plotting the CAR for low ESG stocks, medium ESG stocks, and high ESG stocks in a window of twenty days. Visual inspection shows that high (low) ESG stocks have a positive (negative) return drift after Greta's speeches, yet the reaction is quite a short term. For a more formal analysis, we run the following panel regression using an event window of (-5, +5) days and (-10, +10) days around her speeches:

$$CAR_{it} = \beta_1 High\_ESG_{\ it} + \beta_2 X_{it} + \gamma_t + \theta_i + e_{it}, \quad \text{(IA3)}$$

where CAR_{it} is estimated based on FF-3 factor model, and $High\_ESG_{\ it}$ is a dummy variable equal to one for firms with high ESG scores, and zero for other firms. We include industry and event fixed effects.[35]

The results are shown in Panel A, Table IA3. We find that during the event window of (-5, +5) days, cumulative abnormal return for high ESG stocks is 0.57% higher compared to other stocks in the same industry, and it is less significant if we look at the event window of (-10, +10) day, which indicates the effect is short-lived and reverse a little bit afterwards. Using Greta's speeches as an exogenous shock on ESG awareness/sentiment of ESG, the results imply that stocks with better social performance do have higher ESG sentiment risks for short sellers. This will make short selling activities rather risky when the attention on ESG issues increases rapidly. Next, we investigate the short-term impact of Greta's speeches on short sellers' activity using the following specification.

$$Short\ Selling\ Demand_{it} = \alpha + \beta_1 High\_ESG_{it} \times Post_t +$$

[35] As nine of the ten speeches are in 2019 and we use the ESG scores in December 2018 to classify sample firms, adding firm fixed effects will absorb most variation in ESG performance. In addition, industry fixed effect makes the magnitude of coefficient align with Figure IA1. In unreported result, we use firm fixed effect and find consistent results.

$$\beta_2 High\_ESG_{it} + \beta_3 Post_t + \beta_4' X_{it-1} + \gamma_t + \theta_i + e_{it}, \quad \text{(IA4)}$$

where $Short\ Selling\ Demand_{it}$ is the daily short selling activities in the event window of (-5, +5) days or (-10, +10) days, including shares on loan and utilization ratio. $Post_t$ is a dummy equaling to one after the Greta's speech day. Results are reported in Panel B, Table IA3. For stocks with high ESG scores, there is a lower short selling demand after Greta's speeches, together with a lower utilization ratio and lower lending fee.

IA4. Short selling activities around the European Union (EU) regulation on short selling

The European Union (EU) regulation on short selling (No 236/2012) came into force on November 1, 2012. All investors, except dealers, that trade in EU venues must disclose any short positions when reaching 0.5% of the outstanding amount of share capital, and for each subsequent 0.1% increment. Moreover, notifications have to be updated when values fall below the relevant thresholds.[36] The disclosure rules apply as long as the principal trading venue is located in the EU, irrespective of the investor's domicile, and cover both shares and derivatives positions (on a delta-adjusted basis). This means that each regulated entity must report net short positions calculated by summing up long, short, and delta-adjusted derivatives positions of the reference stock. The disclosure must take place by the next business day (before 3:30 pm local time), and contain the name of the investor, the date when the short position crossed the disclosure threshold, the International Securities Identification Number (ISIN), the name of the shorted stock, and the size of the net short position as a percentage of the issued share capital.

By examining how the short interest on overpriced high ESG stocks changes after the regulation of public disclosure, we provide suggestive evidence for the role of ESG reputation risks on short selling decisions. We focus on stocks in the United Kingdom, because Asset4 has the most extensive coverage for UK stocks, yet does not cover many stocks in other EU countries.[37] We get short-selling related variables from Markit Europe, and firm fundamentals from Worldscope. Following Stambaugh, Yu, and Yuan (2015), we construct a similar mispricing measure (SYY score) for UK stocks, by combining 11 anomalies to get a composite score. Those with higher SYY scores are relatively overpriced compared to stocks with lower SYY scores. We look at a short window of (-12, +12) months around the effective day of EU regulation on short selling disclosure. If short sellers do care about their ESG reputation, they

[36] In addition, a short position must be confidentially disclosed only to the regulator when it reaches 0.2% of the outstanding amount of share capital. This requirement is also required for each additional 0.1% above the 0.2% threshold.

[37] With limited stocks in other countries, we could barely identify enough overpriced stocks.

would be less willing to short overpriced stocks with high ESG performances after the regulation comes into force, when all the investors are aware of institutions' shorting positions by the next business day. To test this hypothesis, we run the following regression.

$$Short\ Selling\ Demand_{it} = \alpha + \beta_1 ESG_{it-1} \times Overprice_{it-1} \times Post_t +$$
$$\beta_2 ESG_{it-1} \times Post_t + \beta_3 Overprice_{it-1} \times Post_t + \beta_4\ ESG_{it-1} \times Overprice_{it-1}$$
$$+\beta_5 Overprice_{it-1} + \beta_6 ESG_{it-1} + \beta_7 Post_t + \beta_8' X_{it-1} + \gamma_t + \theta_i + e_{it}, \qquad \text{(IA5)}$$

where $Post_t$ is a dummy representing "post" period after the enforcement of short selling regulation. We include both firm and time fixed effects, and the control variables are the same as those in Table 2.

Results in Table IA4 show that there is a drastic decrease in short interest and utilization ratio for overpriced high ESG stocks when investors are required to disclose the short position publicly. We also find a similar but weaker effect for lending fees. These results indicate at least, investors, who trade UK stocks do care about their ESG reputation, and avoid publicly disclosing their shorting position on high ESG stocks.

Figure IA1. Cumulative return around Greta Thunberg's speeches

This figure plots the cumulative abnormal return for low, medium, and high ESG stocks around Greta Thunberg's speeches in a window of (−10, +10) days. All the stocks are sorted into five quintiles based on ESG scores at the end of last month. Low, medium, and high ESG group contains stocks in the first quintile, second to the fourth quintile, and fifth quintiles of stocks, respectively. Cumulative abnormal return is calculated based on the FF-3 factor model.

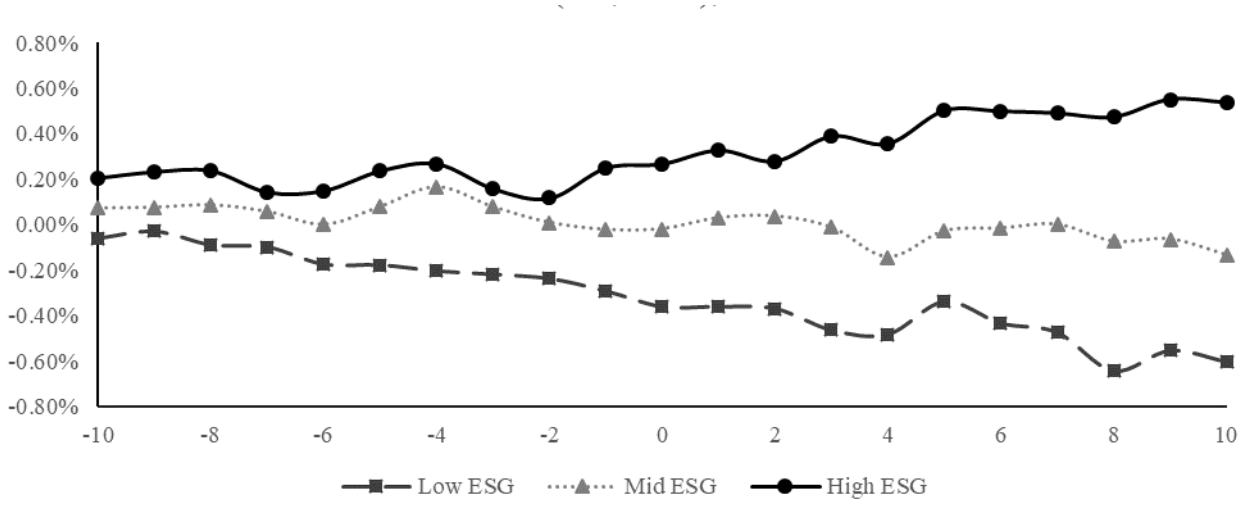

Table IA1. Short selling activities around the passage of ESG proposals

This table reports panel regression results of short selling demands around the FTSE4Good US Index inclusion events, including *On loan* and *Utilization ratio*. Event window is (-6, +6) months excluding the event month. The treated group is the firms that have passed a close-call ESG proposal, with supporting rates lower than 55%. The control group is the firms that have rejected a close-call ESG proposal, with supporting rates higher than 45%. At the end of each month, all available stocks are sorted into five quintiles based on the Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. The control group is identified via a propensity score matching based on ESG score, size, book to market ratio, stock return in the prior month, momentum, and idiosyncratic volatility. *Post* equals one after the stocks are included in the Index, and zero otherwise. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test. The sample period is from January 2006 to December 2019.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Post x Treat x Overprice	-0.852**	-0.783*	-3.025***	-2.852**
	(-2.21)	(-1.80)	(-2.67)	(-2.30)
Post x Treat	0.246**	0.196**	0.543**	0.399*
	(2.46)	(2.38)	(2.04)	(1.91)
Post x Overprice	0.251*	0.271*	1.102***	1.191***
	(1.82)	(1.85)	(2.80)	(3.10)
Treat x Overprice	0.573	0.458	2.241	1.848*
	(1.08)	(1.42)	(1.33)	(1.80)
Overprice	0.067	0.059	0.085	0.050
	(0.38)	(0.32)	(0.19)	(0.12)
Post	-0.159***	-0.185***	-0.417***	-0.499***
	(-2.73)	(-3.27)	(-2.91)	(-3.57)
Treat	-0.011	-0.054	0.012	-0.106
	(-0.10)	(-0.51)	(0.04)	(-0.33)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.798	0.827	0.812	0.843
Observations	3,289	2,952	3,290	2,952

Table IA2. Short selling activities around the Paris Agreement

This table reports panel regression results of short selling demands as a function of ESG performances and the overpriced dummy around the Paris Agreement. The event window is (-6, +6) months, excluding the event month (December 2015). The dependent variable is *On loan* and *Utilization ratio* in the next month in Columns (1) and (2), and Columns (3) and (4), respectively. At the end of each month, all available stocks are sorted into five mispricing quintiles based on the Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. *Post* equals one after December, 2015. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x Post	-3.173***	-2.526**	-9.892***	-6.920*
	(-2.64)	(-2.42)	(-2.62)	(-1.87)
Overprice x ESG	-1.080	-1.120	-2.966	-3.282
	(-0.98)	(-1.33)	(-1.01)	(-1.24)
Overprice x Post	2.982***	2.315***	9.218***	6.570**
	(3.34)	(2.94)	(3.30)	(2.35)
ESG x Post	-0.207	-0.813*	-0.951	-2.537
	(-0.36)	(-1.73)	(-0.53)	(-1.52)
Overprice	1.106	1.097*	3.347	3.284*
	(1.31)	(1.71)	(1.57)	(1.70)
ESG	-1.854	-1.649*	-5.440*	-5.024**
	(-1.60)	(-1.86)	(-1.91)	(-2.14)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.853	0.891	0.876	0.894
Observations	8,278	7,488	8,278	7,488

Table IA3. The impact of Greta Thunberg's speeches

This table examines the impacts of Greta Thunberg's speeches on cumulative abnormal returns and short selling activities for the event windows of (-5, +5) days and (-10, +10) days. Panel A presents results from panel regressions of cumulative abnormal return around Greta Thunberg's speeches on ESG performance. We divide the sample firms into quintiles based on the ESG performance. Cumulative abnormal return is estimated based on the FF-3 factor model. *High_ESG* is a dummy equal to one for firms with the highest ESG score, and zero otherwise. *Post* is a dummy equal to one after Greta Thunberg's speeches, and zero otherwise. Control variables include the logarithm of market capitalization, the logarithm of book to market value, reversal, momentum, and idiosyncratic volatility. All regressions include industry fixed effects and event fixed effects. Panel B presents results from panel regressions of short selling activities around Greta Thunberg's speeches on ESG performance and mispricing. At the end of each month, all available stocks are sorted into five mispricing quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and idiosyncratic volatility. All regressions include firm fixed effects and day fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

Panel A: CAR around Greta's speeches

	Event window: (-5, +5) days		Event window: (-10, +10) days	
	(1)	(2)	(3)	(4)
High_ESG	0.788***	0.566**	0.817***	0.386**
	(3.75)	(2.28)	(4.33)	(2.06)
Ln(ME)		-1.949**		-2.091*
		(-2.43)		(-1.82)
Ln(BM)		-0.461***		-0.807***
		(-4.78)		(-6.35)
MOM_1		3.223**		-2.390***
		(2.08)		(-11.40)
MOM_{12_2}		0.550		-8.202***
		(0.88)		(-12.24)
IVOL		-13.584***		-32.538***
		(-2.59)		(-6.40)
Industry fixed effects	Yes	Yes	Yes	Yes
Event fixed effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.091	0.119	0.026	0.005
Observations	7,308	6,809	7,308	6,809

Panel B: Short selling activities around Greta's speeches

	Event window: (-5, +5) days		Event window: (-10, +10) days	
	On loan	Utilization ratio	On loan	Utilization ratio
	(1)	(2)	(3)	(4)
Overprice x ESG x Post	-1.539**	-2.972**	-1.466*	-2.681**
	(-2.09)	(-2.36)	(-1.95)	(-2.22)
Overprice x ESG	1.623	3.240	1.665	3.495
	(0.95)	(0.78)	(1.02)	(0.87)
Overprice x Post	0.919**	1.986**	0.805*	1.714**
	(2.12)	(2.42)	(1.75)	(2.14)
ESG x Post	0.041	0.067	0.023	-0.046
	(1.09)	(0.67)	(0.46)	(-0.36)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.908	0.910	0.912	0.914
Observations	54,075	54,075	103,277	103,277

Table IA4. Short selling activities around effective day of European Union (EU) regulation on short selling

This table reports panel regression results of short selling demands as a function of ESG performance and the overpriced dummy around the effective day (November 1st 2012) of European Union (EU) regulation on short selling (No 236/2012), for stocks traded in the United Kingdom. The event window is (-12, +12) months around the effective day of EU regulation on short selling disclosure, excluding event month. The dependent variable is *On loan* and *Utilization ratio* in the next month in Columns (1) and (2), and Columns (3) and (4), respectively. At the end of each month, all available stocks are sorted into five mispricing quintiles based on Stambaugh, Yu, and Yuan (2015) mispricing score, constructed accordingly for stocks traded in the United Kingdom. *Overprice* is a dummy equal to one for stocks in the fifth quintile, and zero otherwise. *ESG score* is the monthly updated raw score from Asset4 database and scaled by 100 at the end of last month. *Post* equals one after November 2012, and zero otherwise. Control variables include the logarithm of market capitalization, the logarithm of book to market value, institutional ownership, analyst coverage, firm leverage, loss dummy indicating negative earnings, and price volatility. All regressions include firm fixed effects and time fixed effects. The *t*-statistics in the brackets are calculated from robust clustered standard errors by firm. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

	On loan		Utilization ratio	
	(1)	(2)	(3)	(4)
Overprice x ESG x Post	-1.120**	-1.371**	-5.068*	-7.913**
	(-2.46)	(-2.24)	(-1.94)	(-2.45)
Overprice x ESG	0.659**	0.906**	1.600	3.940**
	(2.43)	(2.59)	(0.99)	(2.25)
Overprice x Post	0.530*	0.774*	3.310	6.049**
	(1.75)	(1.91)	(1.55)	(2.39)
ESG x Post	0.266	0.340	2.241**	1.664
	(1.25)	(1.44)	(2.33)	(1.64)
Overprice	0.084	-0.097	0.727	-1.440
	(0.43)	(-0.37)	(0.54)	(-1.06)
ESG	-0.024	-0.039	-1.153	-1.539
	(-0.10)	(-0.16)	(-1.23)	(-1.55)
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Adj R-squared	0.747	0.749	0.738	0.745
Observations	6,274	4,954	6,299	4,969