ESG Rating Disagreement and Option Market Returns[1]

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December 10, 2025

[1] We appreciate the helpful comments from Vikas Agarwal, John Ampong, George Aragon, Janet Gao, Thang Ho, Anatasios Kagkadis, Weikai Li, Mara Madaleno, Dimitris Petmezas, Chelsea Yao, and Adina Yelekenova, as well as conference and seminar participants at the 4th Conference for Fintech AI and Big Data in Business (poster session), LaMaWa 2025 Joint PhD Workshop on Finance and Econometrics, 13th Portuguese Finance Network Conference, and 2025 FMA annual meeting.

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ESG Rating Disagreement and Option Market Returns

Abstract: This paper examines the relation between the uncertainty emanating from dispersion in ESG ratings (ESG disagreement) and option returns. First, we show that the demand in the options market increases with ESG disagreement in the underlying stock, with option open interest increasing significantly after a spike in ESG disagreement and after ESG-related incidents. Next, we find that ESG disagreement predicts higher implied volatility and lower option returns. The relation between ESG disagreement and option returns is significantly strengthened with the increase in attention to ESG-related matters due to the signing of the Paris climate agreement in 2016. Finally, consistent with central predictions of the demand-based option pricing framework, we show that the relation between ESG disagreement and option returns is modulated by the cost of hedging or replicating the options. The positive (negative) relation between ESG disagreement and implied volatility (option returns) is driven by options that are likely to be costly to hedge for intermediaries in the options market. Exogenous increase in hedging costs due the COVID-19 disruptions, significantly amplify the effect of ESG disagreement on option returns.

Keywords: ESG Rating Disagreement, Options Market, Delta-hedged Return

JEL classification: G12, G14

1 Introduction

The use of Environmental, Social, and Governance (ESG) ratings in the investment industry has grown rapidly over the past decade, with global ESG investing estimated to have surpassed $30 trillion in assets under management (AUM) in 2022 and projected to account for 25% of the total global AUM by the year 2030.[2] At the same time, ESG ratings have been characterized by subjectivity, with ESG rating agencies assigning disparate ratings to the same performance.[3] This disparity in ESG ratings, or disagreement among ESG rating agencies (ESG disagreement), has attracted criticism from investors and regulators alike. So, more than 70% respondents in a survey of institutional investors and fund managers believe that the disparity ratings data, fuelled by methodological inconsistencies, is one of the biggest barriers to ESG investing.[4] Consequently, regulators are developing or have recently introduced regulatory regimes to improve the consistency and reliability of ESG ratings data.[5]

Academic research on the quantum of and the consequences of ESG disagreement on asset markets has also grown over the past decade. Understandably, most studies in this literature have focused on the equity markets (Gibson Brandon et al., 2021; Avramov et al., 2022). We know very little of the impact this uncertainty, stemming from ESG disagreement, has on other asset markets, particularly the options market - the focus of this study.

The options market offers unique advantages in studying ESG disagreement. First, option prices are highly sensitive to systematic and firm-level uncertainty. For example, Kelly et al. (2016) and Ilhan et al. (2021) show that increased political, macroeconomic, or climate policy uncertainty are reflected in option prices. Next, prior studies support that option market investors tend to be more sophisticated (Easley et al., 1998). The option market also exhibits high efficiency and greater sensitivity in information processing and pricing (Bollen and Whaley, 2004; Pan and Poteshman, 2006; Chang et al., 2015). Option markets are better suited to our study from a methodological perspective, too. Option-based measures allow us to examine the effect of ESG disagreement on

[2] https://www.bloomberg.com/
https://www.pwc.com/
https://www.unpri.org/pri
[3] See, for example, Berg, Koelbel, and Rigobon (2022), Gibson Brandon, Krueger, and Schmidt (2021), Berg, Koelbel, Pavlova, and Rigobon (2022).
[4] https://www.ft.com/
[5] https://eur-lex.europa.eu/eli/reg/2024/3005/oj/eng; https://www.fca.org.uk/news/

forward-looking expectations of risk. Finally, through delta-hedged option returns, we are able to precisely focus on the component of option returns likely to be related to ESG disagreement-induced uncertainty, while neutralizing the effect of all other factors that affect the underlying stock.

We provide the first direct evidence that ESG disagreement impacts the options market. Utilizing a comprehensive 14-year panel of options and ESG data from five prominent rating sources, we find that stocks characterized by higher ESG disagreement exhibit increased option demand pressure, elevated implied volatility, and significantly lower returns compared to options on stocks with lower ESG disagreement. Our key results are economically significant, too. For example, a one-standard deviation increase in ESG disagreement reduces (increases) delta-hedged option returns (open interest) by 11% (8%) of its sample average. In addition to the cross-sectional analyses, we employ event-studies based on extreme changes in ESG disagreement and ESG-related incidents, panel regressions, portfolio analyses, and quasi-natural experiments, which utilize market disruptions during COVID-19 and the signing of the Paris climate agreement, to confirm that ESG disagreement does indeed significantly affect demand and returns in the options market.

Our findings are explained by extant literature on the impact of constrained financial intermediation in options markets (Cao and Han, 2013; Bollen and Whalley, 2004; Garleanu, Pedersen, and Poteshman, 2009). We find that demand in the options market increases with ESG disagreement in the underlying stock; and that high ESG disagreement predicts lower option returns when options are costly to hedge.

More specifically, our methodology largely involves a cross-sectional analysis of options on individual equities, conducted monthly. In alignment with established literature, we focus on at-the-money options with a standardized time-to-maturity of approximately fifty days. To isolate the effect of ESG disagreement on option returns from potential confounding factors in stock returns, we primarily analyse the monthly returns of long option positions that are delta-hedged with the underlying stock. We estimate ESG disagreement using data aggregated from five prominent ESG rating sources: MSCI IVA, FTSE Russell, Reprisk, Sustainalytics, and TruValue Lab (TVL).

We employ multiple tests to show that an increase in ESG disagreement is followed by a significant increase in demand for options. First, we show that open interest in the options market increases significantly after the underlying firm experiences an ESG disagreement shock, identified

using the time-series variations in firm-level ESG disagreement. We compare the treatment firm's open interest with that of a control firm - identified through a one-to-one propensity score matching methodology based on pre-shock firm characteristics and disagreement dynamics. We find that spikes in firm-level ESG disagreement increase open interest by almost 25% of its sample average. Next, we use ESG incidents, such as environmental spills and governance scandals, reported by Reprisk as an alternate source of ESG disagreement shocks. We again find that open interest in the options market increases significantly in response to spikes in ESG disagreement – option open interest increases by almost 40% of its sample average in response to ESG incidents.

Next, we examine the relation between ESG disagreement and option open interest using Fama-Macbeth regressions. This cross-sectional analysis shows that firms with greater ESG disagreement are associated with significantly greater open interests in the options markets – a one standard deviation increase in firm-level ESG disagreement increases its option open interest by 8% of its sample average. The results from the event studies and the cross-sectional analysis suggest that an increase in ESG disagreement leads to options markets attracting increased order flow from investors either wanting to hedge the increased uncertainty or speculate on the divergent ESG-related expectations about the company.

We also find that ESG disagreement is positively related to implied volatility, particularly for options that are difficult or costly to hedge. The event studies show that spikes in ESG disagreement and ESG incidents lead to significant increases in implied volatility of options. Additionally, Fama-Macbeth regressions also show that firm-level ESG disagreement is positively associated with option implied volatility, but we find significant cross-sectional variation in this relationship.

Relying on extant literature (for example, Cao and Han, 2013; Gârleanu et al., 2008), we use firm size, idiosyncratic volatility and liquidity to proxy for costs of arbitrage or hedging. While we find that open interest is positively associated with ESG disagreement for all options, the positive relation between ESG disagreement and implied volatility is driven by options that are likely to be costly to hedge or arbitrage for the intermediaries in the options market. The effect of ESG disagreement on implied volatility, as measured by the relevant regression coefficients, is almost twice as large for smaller, less liquid and high idiosyncratic volatility firms than it is for the overall sample.

Together, these results indicate that ESG disagreement functions as a demand shock in the options market, and that intermediaries respond to this ESG disagreement-induced demand shock by increasing the price of options as a compensation for the increased risk they are exposed to or for the increased costs they bear from having to hedge options. Consistent with this cost-of-hedging hypothesis, we find that the inverse relation between ESG disagreement and future option returns also emerges from options that are costly or difficult to hedge for the intermediaries.

Finally, we find that the positive alpha generated from an ESG disagreement-based trading strategy supports the cost-of-hedging hypothesis. Results from portfolio sorts show that the monthly spread between low-disagreement and high-disagreement delta-hedged portfolio alphas is 0.15%-0.31% larger in the high arbitrage-friction group than in the low-friction group. The sample mean of delta-hedged returns is -0.71%. So, the role hedging costs play in establishing the effect of ESG disagreement on option returns is economically significant, too. Our results show that when hedging is relatively constrained, increases in option open interest associated with higher ESG disagreement are not easily absorbed by liquidity providers, and hence demand pressure feeds into implied volatility or option prices. ESG disagreement's effect on implied volatility and option returns is modulated by the hedging costs faced by the intermediaries in the options market.

Although the cross-sectional analyses yield clear results, they cannot eliminate the possibility that ESG disagreement correlates with an unobserved variable that may independently influence option returns. We exploit two exogenous events to address such concerns of endogeneity.

First, we find that an exogenous increase in market-wide attention to ESG and climate-related issues strengthens the relation between ESG disagreement and option returns. Previous studies show that the ESG-related attention increases after the Paris Agreement (see Ginglinger and Moreau, 2023; Seltzer et al., 2022; Krueger et al., 2020; Sautner et al., 2023). We find that the cross-sectional relation between ESG disagreement and option open interest, implied volatility, and delta-hedged returns all significantly strengthen in the post-Paris Agreement period. The relevant regression coefficients from the Fama-MacBeth regressions in the post-Paris Agreement period are at least twice as large as they are in the pre-Paris Agreement period. Furthermore, we find that the Paris Agreement period amplifies the alphas from the ESG disagreement-based portfolio strategy precisely in stocks that are likely to experience higher hedging costs.

Next, we find that the inverse relation between ESG disagreement and future option returns strengthens when hedging costs faced by intermediaries increase due to exogenous reasons. Specifically, we use the COVID-19-induced shutdown of NYSE floor trading as a quasi-natural experiment to test the cost-of-hedging hypothesis. Brogaard et al. (2025) show that the suspension of floor trading significantly worsened liquidity and pricing errors in NYSE stocks relative to stocks listed on other exchanges. Thus, the NYSE floor closure provides us with an exogenous and exchange-specific liquidity shock. Using difference-in-difference regressions, we find that when NYSE floor trading is closed during COVID-19, the portfolio alpha from the ESG disagreement-based strategy is significantly higher (around 1.36% monthly) for options written on NYSE stocks than for options on non-NYSE stocks. We further strengthen this evidence using a triple-differences design that exploits cross-sectional variation in ESG disagreement intensity, comparing high-versus-low ESG disagreement firms across NYSE and non-NYSE stocks before (after) and during COVID-19.

Overall, our findings indicate that higher ESG disagreement, reflecting a greater divergence in investor ESG-related expectations, leads to higher uncertainty about future ESG-related outcomes. As a result, investors seeking to either hedge or trade this uncertainty increasingly rely on the options markets. Conversely, intermediaries in the options markets, either because of nontrivial hedging costs or capital constraints, are sensitive to this ESG disagreement-induced incremental demand by end users. Consequently, the intermediaries increase price at which they provide these options, leading to significant negative delta-hedged returns.

To the best of our knowledge, this is the first study to show that firm-level ESG disagreement significantly influences trading and returns in the options market. Most studies in the ESG literature focus on equity markets (see, for example, Cao et al., 2023; Serafeim and Yoon, 2023; Krüger, 2015; Pedersen et al., 2021). There are some exceptions. Ilhan et al. (2021) focus on the options market, too. However, they study the effect of climate policy uncertainty on options market. Unlike their study, we examine the effect of the uncertainty emanating from dispersed ESG ratings on options markets. Most notably, Cao et al. (2024), study perhaps the closest to ours, show that ESG performance (the average ESG score) is inversely related to option returns. In contrast to their study, our focus is on the effect of ESG disagreement (dispersion of ESG scores) on option trading and pricing. Our results show that ESG disagreement has a significant incremental effect on option returns, even after controlling for the effect of average ESG scores in our multivariate analyses.

Furthermore, we find evidence of complementarity between the effect of average ESG score and ESG disagreement on option returns. Results from portfolio double sorts show that returns on high-minus-low ESG score portfolios are particularly high when ESG disagreement is also high and vice versa. The high-minus low ESG score portfolio has a 0.58% larger monthly return in the top ESG disagreement quintile than in the bottom ESG disagreement quintile.

Our study also contributes to the wider literature on option pricing. Our results show that ESG disagreement is a significant determinant of delta-hedged option returns after controlling for variables proposed by previous studies, such as An et al. (2014), Bakshi and Kapadia (2003), Bali and Murray (2013), Cao and Han (2013), Christoffersen et al. (2018), and Zhan et al. (2022). Further, our results that the cost of hedging or replicating options modulates the effect of ESG disagreement on option returns provide additional evidence to the demand-based option pricing framework proposed by Garleanu et al. (2009).

Finally, our study is the first to show that disagreement in ESG scores leads to increased demand in the options markets. Although the effect of disagreement on equity markets has been well researched (see, for example, Banerjee and Kremer (2010), Carlin et al. (2014), and Li and Li (2021)), the literature on the effect of ESG disagreement on equity markets is sparse. Notably, Avramov et al. (2022) argue that ESG uncertainty stemming from the dispersion of ESG scores reduces demand for equities. Our results, however, show that demand for options increases with ESG disagreement. Together, these results, perhaps, indicate that an increase in ESG disagreement leads to a migration in trading demand from the equity to the options markets, underlying the utility of options for hedging and trading during periods of increased ESG uncertainty.

The rest of the paper proceeds as follows. Section 2 describes the data and various measures used in the analyses. Section 3 presents all our results. We discuss exogenous tests in Section 4. Section 5 presents our conclusions.

2 Data

2.1 ESG Data and Sample Coverage

We collect ESG data from five prominent sources: MSCI IVA, FTSE Russell, Reprisk, Sustainalytics, and TruValue Lab (TVL). Four of the above raters (except FTSE Russell) provide monthly or more frequent updated ESG data, ensuring synchronization with the frequency of option data. All five raters provide a clear data publication date. The updating frequency of ESG data and the corresponding time of the ratings are crucial for our analysis. Suppose an institution updates the ESG scores for the previous fiscal year only several months after its conclusion, even if the scores are continuously rewritten. In that case, they are unlikely to accurately reflect a company's current ESG performance in the context of monthly trading in the options market. Moreover, we need to ensure that all ESG data is available at the time of portfolio formation. Therefore, we ultimately opted for ESG data with a higher update frequency, ratings that are not strictly based on fiscal years, or strictly disclosure-oriented, and datasets that provide a clearly defined publication date.

Specifically, Sustainalytics and MSCI IVA have provided weekly and monthly updated ESG overall scores, and their data can be traced back to 2009 and 2007, respectively. After 2018, Sustainalytics transitioned to using ESG risk ratings rather than overall ESG scores to represent ESG performance, where a lower risk rating indicates better performance. Reprisk has offered the Reputation Risk Index (RRI) to gauge ESG risk exposure since 2007, with higher RRI values indicating greater ESG risk exposure. We choose TVL momentum scores since 2008, which measure weighted ESG performance over the past year. We use the IVA Company Rating[6] as the MSCI IVA ESG score, which ranges from "AAA" to "CCC" (seven-tier). ESG scores from Reprisk, TVL, and Sustainalytics range from 0 to 100. We also collect the ESG incident data from Reprisk. For Sustainalytics' risk rating and RRI, we invert the scale (i.e., 100 minus the risk rating) to derive the ESG score, thus aligning it with the performance measure. FTSE Russell has provided semi-annually updated ESG scores since 2017.

We then calculate ESG disagreement based on this data and match it with the options portfolio of the following month. Following Avramov et al. (2022), we rank all stocks covered by any available raters according to their ESG scores from each data provider, compute the percentile rank (normalized between zero and one) for each rater, and fill in missing values using the last

[6] We follow Avramov et al. (2022) to use the IVA Company Rating. Berg et al. (2022) use the IVA Industry Weighted score as the MSCI IVA rating. We get the same result in this study when using the IVA Industry Weighted score.

available value. We compute the "ESG Score" as the average percentile across available raters. Additionally, for each stock and each month, we calculate the pairwise rating uncertainty as the standard deviation of the ranks provided by the two raters in the pair and define "ESG disagreement" as the average of these pairwise standard deviations. ESG disagreement is given by

$$ESG\ Disagreement_t = \frac{1}{n}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{\left|s_{i,f,t} - s_{j,f,t}\right|}{\sqrt{2}} \tag{1}$$

and ESG score is given by

$$ESG\ Score_t = \frac{1}{N}\sum_{i=1}^{N} s_{i,f,t} \tag{2}$$

where n is equal to C_N^2, and N represents the total number of ESG raters; $s_{i,f,t}$ is the percentile of the ESG score in holding month t, for firm f, rated by rater i.

The final sample spans from January 2008 to December 2021. Unlike Gibson Brandon et al. (2021) and Avramov et al. (2022), our dataset extends to early 2022, as it is significant to use post-2018 data as a sample. In 2018, Sustainalytics rewrote its data: Sustainalytics discontinued its overall rating in favour of a risk rating. These reforms in ESG data could potentially impact the pricing of ESG disagreement. We follow Avramov et al. (2022) and pick firms with ratings from at least two raters each month. Table 1 shows the pairwise ESG disagreement and correlation. In Panel A, we show that mostly the pairwise disagreements (standard deviation) range from 0.1 to 0.2. For example, in our sample, the standard deviation of FTSE Russell's average rating percentile and Reprisk's average percentile across all firms and holding months is 0.201, which is the highest pairwise ESG rating disagreement in our sample. Unlike other raters, Reprisk RRI and TVL momentum are incident-oriented and based on big data methods. Their rating methodology differs substantially from that of the other three rating agencies. Panel B in Table 1 shows a -0.184 correlation between Reprisk and Sustainalytics, and -0.239 between Reprisk and FTSE Russell[7],

[7] The negative correlation between Refinitiv and Reprisk is also found in Berg et al. (2022), which equals -0.45 for the North America sample.

indicating a different rating methodology among them. For TVL, the rating correlations are nearly zero with the other five raters[8].

[Insert Table 1 here]

Table A1 details the number of rated stocks over time after merging ESG data and all available option data in our sample period. Panel A in Table 1.1 shows that the range of ratings by most agencies expands over time. Panel B in Table 1.1 shows the number of raters for a certain firm over time. We show that our final sample with available ESG disagreement measurements is representative due to the values in column N≥2 (%): the proportions range from 64% to 99% in our sample after merging option data and ESG data. Additionally, we observe that our sample covers more than 80% SP500 stocks in all years from 2008 to 2021. Along with the increasing number of covered firms, the result indicates that our sample covers most of the big firms and more small firms over time.

We provide the number of companies rated each month in Figure 1. There are three points of a sudden increase in 2012, 2016, and 2018, corresponding to the expansions of ESG rating scope by MSCI IVA, Sustainalytics, and the inclusion of FTSE Russell data. We also provide the average number of rating agencies rating each company per month in Figure 2. There are several points of a sudden increase in 2009, 2012, 2016, and 2018, corresponding to the inclusion of Sustainalytics, the expansions of ESG rating scope by MSCI IVA, Sustainalytics, and the inclusion of FTSE Russell, respectively.

[Insert Figure 1 here]

Figure 2 shows the trend of overall ESG disagreement. For every holding month, we take the average ESG disagreement across all firms. The horizontal axis is the sample date from 2008 to 2021. Within our sample period, a sharp fluctuation of ESG disagreement is observed from the fourth quarter of 2008 to the first quarter of 2009, corresponding to the most severe phase of the

[8] According to Berg et al. (2022), Reprisk RRI shows a negative correlation with Vigeo-Eiris, S&P Global, and Refinitiv, while its correlation coefficient with Sustainalytics is 0.06. Some of the correlations are slightly different from the results in Berg et al. (2022) because our results show the pairwise ESG rating disagreement and rating correlations after merging ESG data and option data, and because of the sample period and scope. Berg et al. (2022) use the sample between 2014 to 2020, while our sample is from 2008 to 2021. For TruValue Labs (TVL) ESG data, Berg et al. (2022) use the Insight Score, while we use the Momentum Score. For Sustainalytics, Berg et al. (2022a) use the ESG Risk Rating backward from 2018, while we use their dataset since 2009.

2008 financial crisis, particularly after the bankruptcy of Lehman Brothers. From 2008 to 2021, the ESG disagreement level shows an increasing trend.

[Insert Figure 2 here]

Our findings differ from Avramov et al. (2022), mostly due to the following reasons. First, we used data from different rating agencies. Avramov's study primarily relied on traditional ESG performance-based ratings (e.g., MSCI KLD, IVA, Asset4), which are typically grounded in long-term ESG strategies, disclosures, and policies. In contrast, our study incorporates RepRisk and TruValue Labs, which, as noted earlier and in Table 1, differ fundamentally from traditional ESG ratings. RepRisk and TruValue Labs rely on real-time data from media and controversial events, making their ratings more volatile and potentially inconsistent with traditional ESG ratings. These agencies adopt big data methodologies, with RepRisk placing a stronger emphasis on short-term and dynamic ESG-related events. Risk event-oriented ratings are more sensitive to external shocks (e.g., environmental disasters, social controversies), leading to greater discrepancies compared to traditional disclosure-based ratings. Over time, traditional ESG rating agencies may converge due to market expectations and regulatory pressures, reducing rating disagreement. For instance, Avramov highlights a gradual consensus among traditional rating agencies on ESG standards. In contrast, risk event-oriented agencies like RepRisk and TruValue Labs, due to their methodological differences, may not exhibit this convergence effect. Second, we used data from a different period: our analysis covers the years 2008 to 2021, while Avramov's study spans 2002 to 2019. Since 2020, ESG issues have garnered increased global attention, and the availability of media coverage and data has grown significantly. Dynamic risk events, such as the COVID-19 pandemic, climate crises, and social unrest, have become more frequent, amplifying the influence of RepRisk and TruValue Labs. This likely explains the significantly higher levels of ESG disagreement observed in our post-2019 data.

We provide several figures to illustrate the distribution of ESG-related data. Figure 1 shows the ESG disagreement level across different industries, using the Fama-French 12-industry distribution. For each industry, the ESG disagreement level is averaged monthly across all firms.

The three highest disagreement industries are Consumer Nondurables and Utilities, while the lowest is Energy[9].

[Insert Figure 3 here]

2.2 Delta-hedged Option Return

We collect daily option data from OptionMetrics Ivy DB US and follow Bakshi and Kapadia (2003) and Cao et al. (2024) to construct delta-hedged option portfolios, with daily rebalancing or a buy-and-hold strategy for one month. To better evaluate the delta-hedged return, our hedging strategy involves buying a call (or put) option and then hedging with the corresponding position in the underlying stock. In this scenario, higher demand for options leads to increased option premiums and lower delta-hedged returns. For the delta-hedged call option, for example, we long one unit of the call option and short delta units of its underlying stock. The chosen options have around 50 days to maturity and expire on the third Friday or Saturday of the month. We hold the portfolio for one month, starting from the end of the month before the last. For example, for options that expired on December 21, 2013, we held the delta-hedged portfolio from October 31, 2013, to November 30, 2013. We apply several filters to the options. First, we only retain options without dividends paid during their remaining life. Second, we only keep options with positive trading volume in the holding month, and where the midpoint is at least \$0.125. Third, we drop options if the bid price is greater than or equal to the offer price. We also exclude options that violate no-arbitrage conditions (for instance, $S \geq C \geq \max(0, S - Ke^{-rt})$ for call options). Finally, we exclude options with unavailable implied volatility and retain only the monthly observations for each firm with both available call and put options. We apply these filters at the end of each month.

Then we calculate the delta-hedged return with daily rebalance. The delta-hedged call returns are computed as

$$\Pi(t, t+\tau) = C_{t+\tau} - C_t - \sum_{n=0}^{N-1} \Delta_{C,\,t_n} [S(t_{n+1}) - S(t_n)] - \sum_{n=0}^{N-1} \frac{a_n r_n}{365} \left[C(t_n) - \Delta_{C,t_n} S(t_n)\right]$$

[9] Our results here differ from Gibson Brandon et al. (2021), as we use a different sample with Gibson Brandon et al. (2021): We collect data from all companies rated by more than two ESG rating agencies between 2008 and 2021, extending beyond just S&P 500 firms. Additionally, the ESG raters we select are also different.

(3)

which means each option is discretely hedged N times over the period t to $t + \tau$; where C is the call price, S is the underlying stock price; Δ is the value of delta for the call option, with $n = 0,1,..., N - 1$, $t_0 = t$, and $t_N = t + \tau$. For put options, the delta-hedged returns are the same as the equation above. To make the returns comparable, we use $\Pi(t, t + \tau) / (\Delta_t S_t - C_t)$ for calls and $\Pi(t, t + \tau) / (P_t - \Delta_t S_t)$ for puts, as final delta-hedged returns with daily rebalance. We also use the buy-and-hold option return (Goyal and Saretto, 2009), which means we hold the delta-hedged portfolio at the end of a month and hold it for one month without daily hedging. The returns of buy-and-hold call returns are given by

$$HPR_{t+1} = \frac{H_{t+1}}{H_t} - 1 = \frac{(C_{t+1} - \Delta_c S_{t+1}) - (C_t - \Delta_c S_t)}{H_t}$$

(4)

and similar to put returns, where the initial cost H_t is equal to $(\Delta_t S_t - C_t)$ for calls and $(P_t - \Delta_t S_t)$ for puts.

2.3 Delta-hedged Option Return

After merging option data and ESG data, our final sample includes 194,914 observations (97,457 for call options and 97,457 for put options) across 168 months. The average days to maturity are 49.42, and all the chosen options have relatively high liquidity, low bid-ask spread, and their moneyness is close to 1. Panels A and B in Table 2 show the related statistical summary for call and put options, respectively. The mean and standard deviation of delta-hedged gain for call options are -0.78% and 5.16% (-0.72% and 4.13%) monthly. We also collect stock data from CRSP, accounting data from Compustat, and analyst coverage data from I/B/E/S. We also collect institutional ownership data from the Thomson Reuters 13F Filings and compute the institutional ownership ratio (IOR) following Chen et al. (2002). The stock statistics summary is shown in Panel C of Table 2, where LnME and LnBM are the logarithms of the market equity and book-to-market ratio, respectively; RET1 and RET212 are cumulative returns in month t − 1 and t − 12 to t − 2; IDVOL is the idiosyncratic volatility following Ang et al. (2006); ILLIQ is the log of the illiquidity

measure, which is from Amihud (2002); Market Beta is the market beta of rolling 60-month FF-3 monthly return regressions. Panel D in Table 2 lists the correlations among control variables.

[Insert Table 2 here]

Because of the limited scope of firms in ESG rating and the screening in options, as Panel A in Table A2 shows, our final sample only covers 7.9% of stocks in the stock universe on average over 168 months. However, our sample covers 32% of the market capitalization instead, which means the in-sample stocks are relatively representative[10]. 54% of stocks in our sample are traded at the NYSE on average; we cover 40% of S&P500 stocks, and 36% of stocks in our sample belong to the S&P500 index, on a monthly average. Accordingly, the average percentile of firm size is 82% of the CRSP percentile, which means large companies are the major components of our sample. The average institutional ownership ratio is 82%. The detail of sample coverage for the time-series average is shown in Panel B of Table A2.

3 Result and Discussion

3.1 Baseline Results

Our core hypothesis is that higher ESG disagreement is associated with lower delta-hedged gains. If ESG disagreement means difficulty in assessing firms' ESG performance and causes volatile sentiment and different opinions, investors' discrete expectation leads to higher volatility or uncertainty. This could prompt investors to hedge the ESG-related risk, causing a higher hedging demand. In this case, the option is likely to be more expensive, and the delta-hedged gain will be lower.

We use monthly Fama-Macbeth regressions (Fama and MacBeth, 1973) to get our baseline result of ESG disagreement. We perform the following cross-sectional regression:

$$DepVar_{i,t+1} = \beta_0 + \beta_1 ESGDisagreement_{it} + \boldsymbol{\gamma}' \boldsymbol{Z_{i,t}} + \epsilon_{i,t}$$

[10] Our sample covered more stocks than Cao et al. (2023a) in monthly average.

(5)

where $DepVar_{i,t+1}$ is the value of the dependent variable of firm i and month $t+1$. Z is a vector of control variables. Results are shown in Table 3: we examine the impact of ESG disagreement on delta-hedged gains with daily rebalancing across different option types. We have a 4-tier control variable set. The basic controls include ESG score, firm size, book-to-market ratio, the return in the previous month, the return from 12 months ago to 2 months ago, and the market beta, which is the coefficient of the market factor based on Fama-French 3-factor (Fama and French, 1995). The arbitrage conditions include idiosyncratic volatility following Ang et al. (2006), the Amihud illiquidity (Amihud, 2002), the option open interest, and the option bid-ask spread on the date we construct the delta-hedged portfolio. We also control the volatility risk by using the variance risk premium (Carr and Wu, 2009; Bollerslev et al., 2020), and the jump risk by using risk-neutral skewness and risk-neutral kurtosis (Bakshi et al., 2003; Rehman and Vilkov, 2012; Cao and Han, 2013).

Given that the 4-tier variables are controlled tier by tier, ESG disagreement coefficients in columns (1) to (4) of Table 3 are all negatively significant at 1% level: -0.849 (t = -6.18), -0.523 (t = -4.22), -0.366 (t = -3.45), and -0.371 (t = -3.57), respectively. After introducing arbitrage condition controls and the variance risk premium (VRP), the magnitude of the ESG disagreement coefficients declines substantially, whereas adding risk-neutral moments produces only marginal changes. The coefficient shows that moving from the 25th to the 75th percentile of ESG disagreement (an increase of 0.13) lowers next-month delta-hedged option returns by about 0.05-0.11%. Our results remain robust when using call or put options only or considering the trading costs. Table A3 shows the robustness test result, and all coefficients of ESG disagreement are significantly negative at 1% level.

[Insert Table 3 here]

Our results suggest that higher ESG disagreement correlates with lower returns in the following month. This confirms our prior hypothesis: ESG disagreement in the previous month is associated with lower delta-hedged returns in the following month. If ESG disagreement reflects divergent ratings on a firm's ESG performance at a given point in time, it likely signals challenges in evaluating the firm's ESG attributes. This disparity can drive volatile sentiment and conflicting opinions among investors, leading to divergent expectations and higher volatility or uncertainty.

As a result, investors may seek to hedge against ESG-related risks, increasing the demand for hedging. Consequently, options on firms with high ESG disagreement are likely to be priced higher, leading to lower delta-hedged gains.

If ESG disagreement affects delta-hedged returns by influencing hedging demand, we should observe lower delta-hedged returns corresponding to high ESG disagreement levels, along with higher implied volatility and increased open interest for options. We use option open interest (proxied by the Option OI: the total number of option contracts that are open at the end of the previous month and scaled by the stock trading volume of the last month, multiplied by 1000, following Cao et al., 2023) and implied volatility as dependent variables and conduct Fama-MacBeth regressions on ESG disagreement, controlling for 4-tier variables. When the option open interest is the dependent variable, we exclude the option open interest and the option bid-ask spread in the arbitrage condition variable tier.

ESG disagreement loads positively and significantly (at 1% level) on both option open interest and implied volatility across all 8-column specifications, indicating that options market systematically price disagreement as a salient source of uncertainty. Specifically, in columns (5) and (9), the coefficients on ESG disagreement imply that moving from the first quartile to the third quartile of disagreement raises implied volatility and option open interest by approximately 0.01 and 0.002. From a behavioural finance perspective, ESG disagreement may reflect behavioural biases arising from information asymmetry or differing investor views on a firm's long-term sustainability. The tests in Panel B further confirm that ESG disagreement drives an increase in implied option volatility and influences options market pricing by amplifying market uncertainty and investors' hedging demand. Our results remain robust for only call/put options using FE panel regressions. Table A4 shows the panel regression results with time FE and Industry FE, for only call (put) options. All coefficients of ESG disagreement are significant at 1% level.

3.2 The ESG Disagreement Shocks and ESG Risk-related Incidents

To examine whether any sharp increase in ESG disagreement is transmitted into options market outcomes, we construct firm-level ESG disagreement shocks based solely on within-firm time-series variation. For each firm and each month, we compute the percentage change in ESG disagreement as the month-to-month difference scaled by the previous month's level. Using the

time-series distribution of this percentage change, we define a disagreement shock as an observation where the firm's monthly change exceeds its own long-run mean by more than three standard deviations. We have a total of 344 shocks in our sample.

For each identified shock, we define a six-month event window spanning months -3 to +2, where the shock occurs in month 0. A treatment indicator (TREAT) is then assigned to all months within the event window of any firm that experiences such a shock, with the month immediately preceding the shock serving as the benchmark. To obtain a valid counterfactual, we perform one-to-one propensity score matching (PSM) for each treated firm-month. The matching covariates include all baseline control variables in Tier 1, idiosyncratic volatility, and the levels of ESG disagreement in the two months prior to the shock (t - 1 and t - 2). This matching procedure yields a control group closely aligned with treated observations in pre-shock firm characteristics and disagreement dynamics.

We calculate the time-series average of the differences of delta-hedged return, option open interest, and implied volatility between the benchmark (the month prior to the event month) and the event month. Figure 4 reveals a clear sequence (after one-to-one PSM) in the market response to the sharp increases in ESG disagreement (for any reason). In the event month, the option open interest rises significantly, indicating an immediate surge in hedging and trading needs when ESG-related uncertainty spikes. This demand shock is also accompanied by a pronounced jump in implied volatility, consistent with investors requiring greater compensation for a suddenly more uncertain risk-neutral distribution. Delta-hedged returns turn significantly negative in the event month, reflecting the transmission of the demand shock into option prices under heightened uncertainty. The pattern across all four panels aligns tightly with the mechanism proposed in the paper: sudden increases in ESG disagreement first manifest in option open interest, feed into volatility, and ultimately compress delta-hedged returns.

[Insert Figure 4 here]

Firm-level ESG-related risk incidents, such as environmental spills, labor disputes, or governance scandals, may significantly increase ESG-related uncertainty and weaken investors' confidence in the reliability of ESG ratings. For example, in September 2016, Wells Fargo faced a fake accounts scandal, where employees, driven by sales targets, opened millions of bank and credit card accounts without customer consent. This misconduct resulted in customers being charged

unauthorized fees and caused negative impacts on their credit histories. As a result of this scandal, Wells Fargo was recorded by Reprisk with a series of risk incidents in September 2016, which were classified as governance-related.

[Insert Figure 5 here]

Figure 5 shows the changes in ESG disagreement surrounding the occurrence of ESG incidents, indicating that ESG disagreement is likely to increase when ESG incidents happen, and gradually decrease in the following 12 months. Following Derrien et al. (2021) and Cao et al. (2024), we also examine whether ESG risk-related incidents generate similar options market responses. We define a treatment month as any holding month in which RepRisk records at least one ESG risk-related incident for the underlying firm, and apply the same event study and DID framework used for the ESG disagreement shock. Figure 5 shows that the options market response (after one-to-one PSM) to ESG incidents is noticeably weaker than the reaction to sharp increases in ESG disagreement. However, focusing narrowly on the event window (months -1 to 0), we still observe statistically significant movements for most variables except the delta-hedged return without daily rebalancing. Option OI and implied volatility rise significantly around the incident month, while delta-hedged returns exhibit a modest decline.

[Insert Figure 6 here]

3.3 Arbitrage Conditions

Across the twelve specifications, a clear pattern emerges: once the arbitrage-condition controls are included (in columns (2), (6), and (10)), the coefficient on ESG disagreement declines sharply for delta-hedged returns and implied volatility, whereas the effect on Option OI remains largely unchanged. This divergence is informative. We are inspired by Gârleanu et al. (2008) and Cao and Han (2013): the pattern suggests that arbitrage constraints play a central role in determining whether the incremental option demand (proxied by option open interest) induced by ESG disagreement is ultimately reflected in option prices.

To examine whether arbitrage constraints shape the pricing of ESG disagreement in the options market, we partition the sample each month into high- and low-arbitrage-constraint groups using several standard proxies. Firms with market equity above the NYSE 50th percentile,

idiosyncratic volatility (or stock/option bid-ask spreads) below the sample median are classified as having low arbitrage constraints, and firms failing these criteria are assigned to the high-constraint group. Within each arbitrage-constraint group, we sort stocks into quintiles based on their ESG disagreement and calculate the long-minus-high (LMH) portfolio returns by subtracting the monthly average delta-hedged return of the top-quintile disagreement portfolio from that of the bottom-quintile portfolio. We then compare the monthly average LMH returns between the high- and low-constraint groups. We further compute the seven-factor alpha of the delta-hedged return by using the Fama-French six-factor (Fama and French, 2018) augmented with the options market factor from Coval and Shumway (2001). We then form an analogous seven-factor LMH return.

In Table 4, the cross-group differences in LMH spreads show that the disagreement effect is significantly stronger in the high-arbitrage-constraint portfolios: the LMH monthly return in the high-constraint group exceeds that in the low-constraint group by 0.22% (t = 2.50), 0.15% (t=1.87), and 0.31% (t=3.95) across the firm size, idiosyncratic volatility, and option bid-ask spread measures, respectively. For the 7-factor alpha monthly LMH returns, the differences between the high-constraint group and the low-constraint group are 0.18% (t = 2.25), 0.12% (t=1.69), and 0.22% (t=3.03), respectively. This pattern indicates that the effect of ESG disagreement on option-based returns strengthens precisely where hedging is more costly and arbitrage activity is more restricted. Our results remain robust when using the buy-and-hold (without daily rebalance) delta-hedged portfolio. Table A5 shows the robustness tests. The differences in monthly LMH return between the high arbitrage limit group and the low arbitrage limit group are 0.55% (t = 5.08), 0.42% (t = 4.74), and 0.55% (t = 6.13), categorised by firm size, idiosyncratic volatility, and option bid-ask spread, respectively. For the LMH 7-factor alphas, they are 0.57% (t = 5.70), 0.46% (t = 5.16), and 0.48% (t = 6.34), respectively.

[Insert Table 4 here]

Specifically, when both the underlying stock and its options exhibit high liquidity or low arbitrage frictions, the disagreement-related uncertainty can be hedged away relatively easily. Therefore, even though disagreement elevates option demand, this demand does not translate into higher implied volatility, nor does it meaningfully alter delta-hedged option returns. In contrast, when arbitrage or hedging is costly or constrained, the disagreement-induced uncertainty becomes difficult to offset, allowing heightened option demand to pass through to option prices.

Consequently, implied volatility rises and delta-hedged returns decline, consistent with the mechanisms highlighted in Gârleanu et al. (2008) and Cao and Han (2013).

Table 5 reports the Fama-MacBeth regressions across subsamples formed by different levels of arbitrage constraints, with all specifications controlling for the full set of four control tiers. We use the same dependent variables as in Table 3: RET (delta-hedged return with daily rebalance), IV (implied volatility of the option on the day of constructing the delta-hedged position), and OI (the option open interest, proxied by Option OI). Across all eight groups (four high-arbitrage-constraint subsamples in Panel A, and four low-constraint subsamples in Panel B), the coefficient on ESG disagreement is uniformly positive and statistically significant in the OI regressions. This result is consistent with our expectation that higher ESG disagreement elevates option demand.

[Insert Table 5 here]

However, the transmission of this open interest into prices differs sharply across arbitrage environments. In the high-constraint portfolios, where liquidity is lower, and hedging and arbitrage are costlier, ESG disagreement loads significantly in both the implied volatility (IV) and delta-hedged return (RET) regressions. By contrast, in the low-constraint portfolios, the coefficients in the IV and RET columns are economically small and generally insignificant, with the only exception being the low option bid-ask spread group (even in that case, the magnitudes are markedly weaker than those observed in the corresponding high option bid-ask spread group). Overall, the results indicate that disagreement-induced option demand affects option prices and hedging returns primarily when arbitrage constraints bind.

3.4 ESG Disagreement and ESG Score

Prior research shows that ESG disagreement influences the pricing of ESG scores by altering the degree of ESG-related uncertainty faced by investors (Avramov et al., 2022). A similar interaction is likely to operate in the options market. If we view ESG uncertainty as consisting of two components (the score-level uncertainty emphasized in Cao et al. (2024) and the disagreement-based uncertainty documented in this study), then low ESG scores may amplify the options market impact of ESG disagreement. Firms with weak ESG performance already exhibit elevated

uncertainty and downside risk; combining this with high disagreement further erodes the credibility of the available ESG information, magnifying investors' sensitivity to disagreement-related signals.

Specifically, when ESG disagreement becomes exceptionally high, markets may demand a higher "ESG-score premium" to offset the aggregate ESG uncertainty. Firms with extremely high disagreement are likely to face a stronger marginal information effect: when the underlying ESG environment is already opaque, any additional ESG-related information, whether positive or negative, carries greater informational weight. For these firms, shifts in ESG sentiment can trigger especially strong reactions in the options market, as investors become acutely sensitive to any signals that may help resolve the heightened uncertainty surrounding the firm's ESG profile.

To further check the effect of ESG disagreement in different overall ESG Score levels, we use a 5x5 sorted portfolio (double-sorted by ESG score and ESG disagreement) in Table 6. We calculate the (high-minus-low) HML portfolio return for each group with different overall ESG levels, and the results show an upward trend in HML returns from the low disagreement rank group to the high disagreement rank group. We then get the LMH column result by using the high-disagreement group's return minus the low-disagreement group's return for each row. We finally get an HML-LMH return of 0.58% (t = 3.16), a monthly return (0.42% for 7-factor alpha, with t-statistics = 2.53, in the HML row and LMH column. Our result shows that if we buy the delta-hedged portfolio in the top quintile of ESG score and sell that in the bottom quintile of ESG score to have an HML return, the HML return in the top ESG disagreement quintile is monthly 0.58% higher than that of the bottom ESG disagreement quintile. Unlike the equity market, the options market ESG premium arises primarily in options written on stocks with high ESG disagreement. This pattern supports our hypothesis that option traders demand a higher ESG premium when the underlying asset exhibits greater disagreement-induced uncertainty.

[Insert Table 6 here]

We then report the 5x5 portfolio results for call options and put options, respectively. In Panel C, we show the HML-LMH returns of call options equal 0.47% (t = 1.71) (0.34% for 7-factor alpha, with t = 1.45). In Panel D for put options, the original HML-LMH return and 7-factor alpha are 0.70% (t = 3.93) and 0.50% (t =2.85), respectively. We have a more significant result on the put option than the call option. Our FM regressions in Table A6 show the same result. The coefficients

of the interaction term between the high ESG disagreement dummy and ESG score (Low ESG dummy) are only positively (negatively) significant for put options.

Compared with call option delta-hedged returns, the short-sale constraints are more directly linked to the delta-hedged returns of put options (see Ramachandran and Tayal, 2021). When high ESG disagreement releases a negative signal, investors who cannot short the underlying stock are more likely to express their downside views through put options. As a result, put prices react more strongly, while call options exhibit a weaker response. This pattern is consistent with the arbitrage-constraint mechanism discussed earlier.

Our conclusion is not inconsistent with prior research. Although Cao et al. (2024) have shown that the role of ESG scores in the options market is bidirectional, investors may place particular emphasis on the ability of high ESG scores to mitigate downside risks (see Jagannathan et al., 2017; Gibson et al., 2020; Ilhan et al., 2021) when ESG disagreement levels are exceptionally high. The downside tail risk is mainly reflected in the put option premiums. Our test focuses on the effect of ESG scores within the group with high ESG disagreement. In such a group, compared to expectations of price increases in the underlying asset, the options market is likely to have more pronounced expectations of price declines for the underlying assets with low ESG scores. Thus, low ESG scores are primarily associated with increased demand for put options, leading to a decline in delta-hedged returns for puts, while the impact on call options is less significant.

4 Exogenous Tests

4.1 The COVID-19

We exploit the COVID-19-induced closure of the NYSE trading floor as an exogenous liquidity shock to further test whether arbitrage constraints are the key channel through which ESG disagreement is priced in the options market. As documented by Brogaard et al. (2025), the suspension of floor trading on March 23, 2020, sharply reduced price efficiency, lowered liquidity, and increased pricing noise for NYSE-listed stocks, while leaving securities on other exchanges

unaffected. These disruptions gradually dissipated only after the main reopening[11] of floor trading on June 17, 2020.

[Insert Figure 7 here]

Figure 7 plots monthly LMH 7-factor alphas for NYSE (treated) and non-NYSE (control) stocks around the COVID-19 floor-trading closure of NYSE. We label the event period as March 2020 to May 2021. March 2020 is treated as the event month, when the NYSE suspended floor trading, and May 2021 marks the full reopening of floor trading. The vertical dashed line marks the closure of NYSE floor trading. In subgraph A (B), we show the LMH delta-hedged returns (LMH 7-factor alphas) over time for the underlying stocks in both NYSE and non-NYSE, before and after the NYSE floor trading closure because of COVID-19. We show that LMH delta-hedged option returns (7-factor alphas) written on NYSE-listed stocks are significantly higher during the NYSE floor trading closure than those written on non-NYSE-listed stocks, compared with non-event periods. Subgraph C (D) shows the differences in LMH delta-hedged returns (7-factor alphas) between NYSE and non-NYSE groups. The differences are significantly higher during the NYSE floor trading closure. The figure illustrates that the NYSE-specific liquidity disruption materially heightened the sensitivity of option returns to ESG disagreement.

Building on this setting, we examine whether this NYSE-specific liquidity shock heightened the sensitivity of the options of NYSE-listed stocks to ESG disagreement relative to options written on non-NYSE stocks. We construct a COVID-19 period dummy (CV), equal to one from March through May 2020 (3M), and match with the month we construct the delta-hedged position (the month before the holding month), and an NYSE dummy indicating whether the underlying stock is listed on the NYSE. Under this difference-in-differences (DID) design, our dependent variable must capture the power of ESG disagreement pricing in the options market. To this end, for each month, we sort firms into quintiles based on ESG disagreement, form a low minus high disagreement (LMH) portfolio, compute its monthly average return, and obtain the corresponding 7-factor alpha. This LMH 7-factor alpha serves as our measure of the power of the ESG disagreement being priced.

[11] According to Brogaard et al. (2025), there are in total 3 reopenings of the NYSE floor trading: May 26, 2020, June 17, 2020, and May 10, 2021. The effect of liquidity recovery of the first reopening is relatively weak, according to Brogaard et al. (2025), so we only use the latter two reopenings in our tests.

Our coefficient of interest is therefore the interaction term CV × NYSE. A positive and significant estimate indicates that, during the COVID-19 NYSE floor-trading shutdown, options on NYSE stocks became more sensitive to ESG disagreement, consistent with a tightening of arbitrage constraints. We conduct this test in the full sample as well as in the high- and low-IDVOL (as well as Stock BA and Option BA) subsamples to keep baseline arbitrage conditions comparable. Based on our mechanism, we expect the interaction effect to be strongest and most statistically significant in the high-IDVOL (or Stock BA, Option BA) subsample. As robustness checks, we also consider alternative definitions of the COVID period, including a one-month window (1M, March 2020 only) and an extended window (15M) from March 2020 through May 2021, ending with the full reopening of the NYSE trading floor.

Table 7 reports the time-series difference-in-differences estimates of LMH delta-hedged returns during the COVID-19 liquidity shock. Across all specifications, the coefficient on the interaction term CV × NYSE is positive and statistically significant, indicating that the sensitivity of delta-hedged LMH returns to ESG disagreement increased for options on NYSE stocks during the floor-trading shutdown relative to options on non-NYSE stocks. The 7-factor alpha on the LMH portfolio return for options on NYSE stock during COVID-19 is 1.36% (monthly) higher than that of the control group.

[Insert Table 7 here]

In the whole sample (columns 1-3), the interaction coefficients range from 1.04 to 1.54 and are consistently significant at the 1% level, regardless of whether the COVID period is defined as March to May 2020 (3M), March 2020 only (1M), or March 2020 to May 2021 (15M). The magnitudes are even larger in the high-IDVOL (as well as the high Option BA and high Stock BA) subsample, where the coefficients range from 1.43% to 3.58%, again all highly significant. By contrast, the low-IDVOL (Option BA, Stock BA) subsample shows weaker and mostly insignificant interaction effects. Taken together, these results show that the COVID-19-induced NYSE-specific liquidity shock strengthened the pricing of ESG disagreement in delta-hedged option returns, particularly among stocks with high idiosyncratic volatility. The result is consistent with the view that heightened arbitrage constraints amplify disagreement-driven options market effects.

To accommodate firm-level and option-level controls and to sharpen identification, we extend the baseline DID framework to a triple-differences (DDD) design by exploiting heterogeneity in ESG disagreement intensity. Relative to the DID setting, the third difference is introduced by comparing firms with high versus low ESG disagreement. Specifically, we construct a dummy variable H that equals one if a firm's ESG disagreement in a given month falls above the sample median, and zero otherwise. The DDD specification, therefore, estimates differential changes in delta-hedged option returns across NYSE versus non-NYSE stocks, before and during COVID, between high ESG disagreement and low ESG disagreement firms.

The model includes the full set of two-way interaction terms and the triple interaction H × NYSE × CV[12]. Due to the inclusion of time fixed effects, the COVID dummy (CV) is omitted because it is collinear with the time effects. Firm and time fixed effects are included throughout. To avoid mechanical contamination from exchange switching, the exchange listing status is locked based on each firm's listing exchange as of February 2020, immediately prior to the onset of the COVID shock. We further remove option observations for firms that change listing venue during the COVID period. As a result, we also omit the NYSE dummy due to multicollinearity[13]. This procedure ensures that the treatment assignment is predetermined relative to the shock and eliminates potential endogeneity arising from endogenous exchange code switching during the crisis.

Table A7 reports the corresponding DDD estimates. The coefficients on the triple interaction term H × NYSE × CV are negative and statistically significant in the pooled sample and in both the call and put subsamples. For example, in Column (1), the estimate implies that, during the NYSE floor trading closure period, delta-hedged option returns for high-disagreement firms listed on the NYSE are on average 1.24% lower per month than those for low-disagreement firms and non-NYSE stocks, highlighting a large and economically meaningful impact of the NYSE-specific liquidity shock on the pricing of ESG disagreement. This evidence reinforces our DID findings by showing that the COVID-induced NYSE liquidity shock disproportionately amplified the pricing

[12] We set the COVID period as March to May 2020 in our DDD design, which is exactly the DMM closure period of the NYSE.

[13] Around 110 firms, which account for 3% of our sample, experienced the switch of exchange code. Most firms have only 1 exchange code across our sample period.

of ESG disagreement. The result supports the view that when arbitrage and hedging are costly, ESG rating disagreement exerts a stronger impact on delta-hedged option returns.

4.2 The Paris Agreement

A large literature shows that the Paris Agreement materially increased market attention to ESG and carbon-related risks. Bolton and Kacperczyk (2021) document that carbon premia strengthened after the Agreement, consistent with investors reassessing climate-related exposures. Similarly, Cao et al. (2025) identify January 2016 to June 2017 as a period of unusually elevated ESG attention and show that the ESG score premium is substantially larger during this 18-month window than before or after. Motivated by these findings, we examine whether the Paris Agreement also amplifies the pricing of ESG disagreement by increasing market focus on ESG considerations in the options market.

We follow Cao et al. (2025) and define the Paris Agreement period (PA) as Jan 2016 to Jun 2017. For each month, we sort options into quintiles based on ESG disagreement and construct the LMH (low-minus-high disagreement) delta-hedged return. We then regress the time series of LMH returns on the seven risk factors together with the PA period dummy. To ensure comparability with our earlier results, we run this specification separately for the high arbitrage constraint and low arbitrage constraint groups, defined exactly as in Table 6 (by IDVOL, stock bid-ask spread, and option bid-ask spread). In addition, to assess structural changes in disagreement pricing around the Agreement, we split the full sample into the pre-PA period (2008–2015) and post-PA period (2016–2021) and re-estimate the baseline Fama–Macbeth regressions from Table 3 within each subperiod. Panel A and Panel B of Table 8 report the time-series factor regressions for the high and low arbitrage constraint groups, respectively, and Panel C reports the pre-/post-PA FM regression cross-sectional estimates.

[Insert Table 8 here]

In Panel A, the PA dummy is consistently positive and statistically significant across all three high-arbitrage-constraint subsamples (high IDVOL, high stock bid-ask spread, and high option bid-ask spread). The estimated coefficients indicate a positive LMH return during the Paris Agreement, ranging from 0.35% to 0.48% per month, higher than the non-PA periods, and remain

significant after including the full set of equity and options market factors. This pattern implies that when market-wide ESG attention rises, disagreement-induced uncertainty commands a larger return premium precisely in environments where arbitrage is most restricted and hedging ESG-related uncertainty (or arbitrage) is most costly. In contrast, Panel B shows that among low-arbitrage-constraint stocks, the PA coefficients are small and statistically insignificant across all specifications. This asymmetry reinforces the mechanism: higher ESG attention alone is insufficient to strengthen disagreement pricing; the effect emerges only when arbitrage frictions impede traders' ability to neutralize disagreement-related uncertainty.

Panel C further corroborates this interpretation. Before the Paris Agreement, the cross-sectional pricing of ESG disagreement is weak or mixed (we see an insignificant result in column 2 for implied volatility). After the Paris Agreement, however, ESG disagreement becomes strongly priced across delta-hedged returns, implied volatility, and Option OI, with consistent signs and significant t-statistics (all significant at 1% level). Given the ESG disagreement level moving from the first quartile to the third quartile, the delta-hedged return will decrease by 0.05% (monthly) more after the Paris Agreement, compared with pre-PA periods. The shift from pre-PA null effects to post-PA strong effects is consistent with the view that the Agreement elevated the salience of ESG-related risks and strengthened markets' response to disagreement specifically.

5 Conclusion

This study systematically examines the impact of ESG (Environmental, Social, Governance) rating disagreement on the options market, highlighting how rating divergence influences option hedging demand and expected returns. Our findings indicate that higher levels of ESG disagreement are related to lower expected returns in delta-hedged option portfolios, driven by increased hedging demand and implied volatility. This effect is pronounced in both call and put options markets, demonstrating that investors pay a premium to hedge against the uncertainty associated with disparate ESG ratings.

Moreover, our cross-sectional and time-series evidence shows that this pricing effect is fundamentally shaped by arbitrage conditions. When liquidity is high and hedging frictions are low, the rise in option demand induced by ESG disagreement does not fully transmit into implied

volatility or delta-hedged returns. In contrast, under costly hedging or arbitrage (captured through firm size, idiosyncratic volatility, and both stock and option bid-ask spreads), the same disagreement-driven uncertainty is amplified and becomes strongly reflected in option prices. A series of portfolio sorts and subsample Fama-MacBeth regressions consistently confirm that the disagreement premium is concentrated precisely where hedging and arbitrage costs are high. In addition, our results show that the pricing of ESG information reflects a meaningful interaction between ESG scores and ESG disagreement, indicating that the ESG premium is shaped by both the level and the reliability of a firm's ESG performance.

Taken together, these results demonstrate that ESG disagreement constitutes a distinct and systematically priced source of uncertainty in the options market. Its impact operates primarily through hedging demand, is magnified when arbitrage or hedging is costly, and strengthens in periods of heightened ESG attention. Our findings highlight that options markets serve as an important channel through which investors hedge ESG-related uncertainty, and they underscore the need to account for rating disagreement when assessing the asset-pricing implications of ESG information.

Appendix: Variable Definitions

Variable Name	Definition
ESG Data (Source: FTSE Russell, MSCI IVA, Reprisk, Sustainalytics, TruValue Labs)	
ESG Disagreement	Following Avramov et al. (2022), for each rater pair-month, we rank all stocks covered by both raters according to the original rating scale of the respective data provider and calculate the percentile rank. And for each stock, we calculate the average of the standard deviations of pairwise rankings as ESG Disagreement
ESG Score	Following Avramove et al. (2022), ESG Score is the average ranking of the ESG Score from rating agencies. For each month, we rank the firms' ESG performance based on the ESG Score from rating agencies one by one. The number of ranks we get is equal to the number of available raters for each firm. Then we calculate the percentile ranks for each rank. ESG Score is equal to the mean value of percentile rankings.
#Incidents	The number of incidents reported in Reprisk Incident Data in the previous month for a certain firm.
Firm-level data (Source: CRSP, Compustat)	
LnME	The logarithm of the market equity in the previous December.
LnBM	The logarithm of the book-to-market ratio: using the book equity of the fiscal year end in a certain calendar year, divided by the market equity at the end of the previous December, following Fama and French (1992).
RET1	The stock return in the previous month
RET212	The cumulative stock return from the prior second through the twelfth months.
Market Beta	The beta of the market factor, using the FF-3 (Fama and French, 1995) factor with a 60-month rolling regression.
IDVOL	The idiosyncratic volatility, which is the standard deviation of the residuals of the FF-3 factor (Fama and French, 1995) regression over the past one month, with a requirement of at least 15 non-missing daily stock returns.
ILLIQ	The logarithm of the Amihud Illiquidity measure (Amihud, 2002), the average of daily absolute returns divided by the stock dollar volume within the previous one month, multiplied by 100 million, with a requirement of at least 15 non-missing daily stock returns.

Institutional Ownership Ratio	The percentage of shares owned by institutional investors, divided by the number of shares outstanding. Data are from Thomson Reuters Institutional (13f) Holdings.
ANLST	The number of analysts following the firm in the previous month.

Option data (Source: OptionMetrics Ivy DB US)

Delta-hedged Return with Daily Rebalance	The change (in the following month) in the value of a portfolio consisting of buying one contract of the option position and using delta shares of the underlying stock to hedge the value of delta, and re-hedged daily. Delta is the Black-Scholes option delta. The call option delta-hedged gain is scaled by $\Delta S - C$, where S is the underlying stock close price, and C is the call option premium. The put option delta-hedged return is scaled by $P - \Delta S$.
Delta-hedged Return without Daily Rebalance	The change (in the following month) in the value of a portfolio consisting of buying one contract of the option position and using delta shares of the underlying stock to hedge the value of the delta. The portfolio is constructed at the end of the month and held for one month until the end of the month before the expiration month of the option, without daily rebalance.
Option OI	The open interest of the option at the last trading day of the month that is two months prior to the expiration date, divided by the stock trading volume of the month.
Option BA	The absolute value of the difference between the option bid price and offer price, divided by the mean value of the bid price and the offer price.
VRP	The variance risk premium, calculated by the 30-day model-free implied variance from Britten-Jones and Neuberger (2000), minus the realized volatility (The realized variance is computed from daily log returns over a one-month future window)
RN SKEW/RN KURT	The model-free implied risk-neutral variance/skewness, calculated for options with expiration of around 50 days at the end of each month, using the implied volatility of 30 days and from the Volatility Surface to perform the PchipInterpolator (following Rehman and Vilkov, 2012).

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Figure 1. Number of Rated Stocks and Raters Over Time

This figure presents the number of rated companies and the number of raters across different months, from 2008 to 2021.

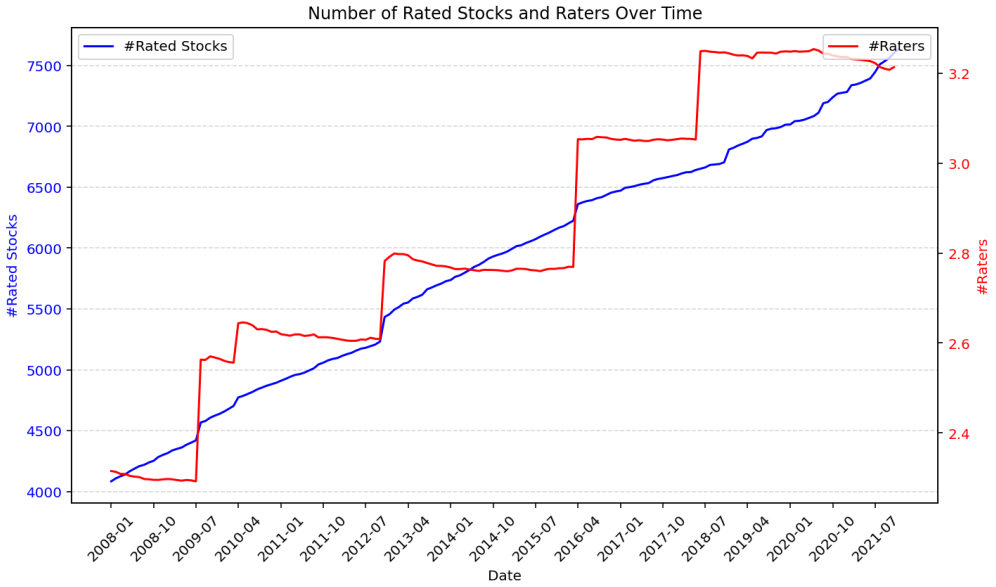


Figure 2. Number of Rated Stocks and Raters Over Time

This figure presents the number of rated companies and the number of raters across different months, from 2008 to 2021.

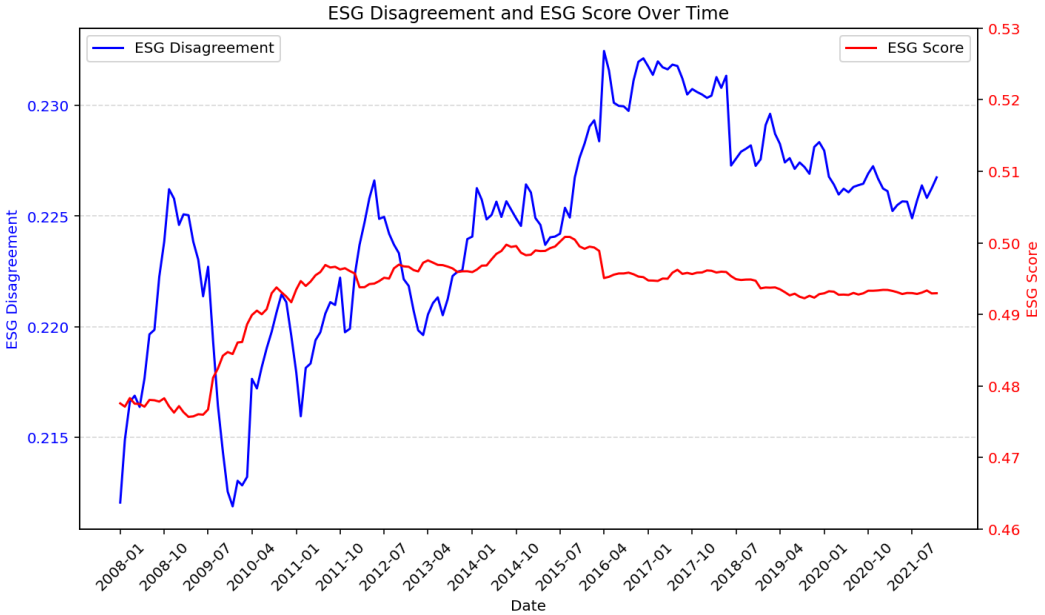


Figure 3. ESG Disagreement Level by the FF 12-Industry

This figure presents the ESG disagreement levels across different industries. We use the Fama-French 12 industry distribution. For each industry category, the ESG disagreement level is averaged monthly across all companies. ESG Disagreement follows Avramov et al. (2022): the standardized average of ESG ranges, where each range is the difference between two ESG rating percentiles from two raters.

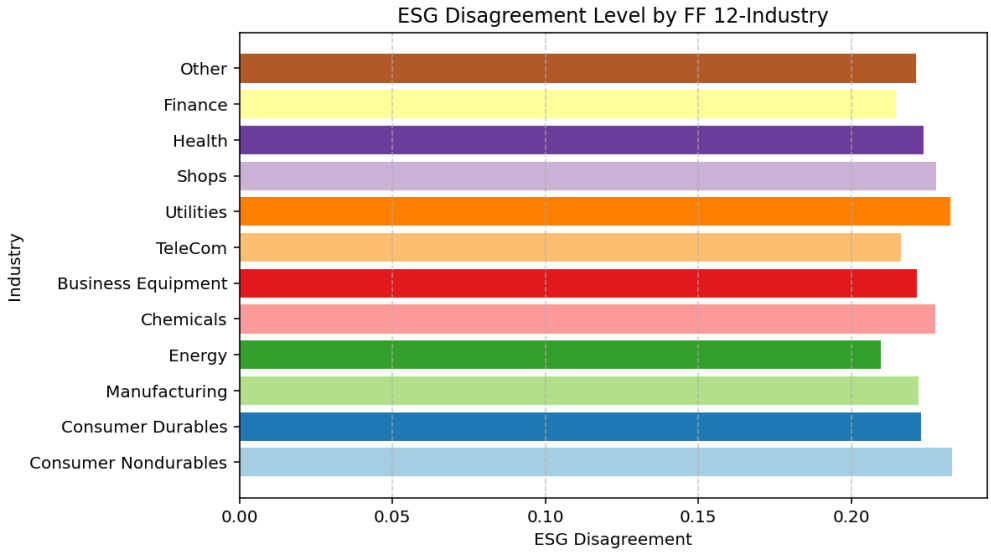


Figure 4. Event Study: ESG Disagreement Shock

This figure shows the time-series average of the differences in delta-hedged return with daily rebalance (RET), option open interest (OI), and implied volatility (IV) between the treatment group and the control group, after PSM. The month -1 (prior to the event month) is set as the benchmark (for the delta-hedged return, we set month 0 is the benchmark as holding month for the shock is month +1). We plot the point estimate and the 90% confidence interval in vertical lines on the time-series level. The event shocks are defined as sharp increases in ESG disagreement, given that the monthly %change in ESG disagreement is greater than 3 standard deviations from the time-series mean.

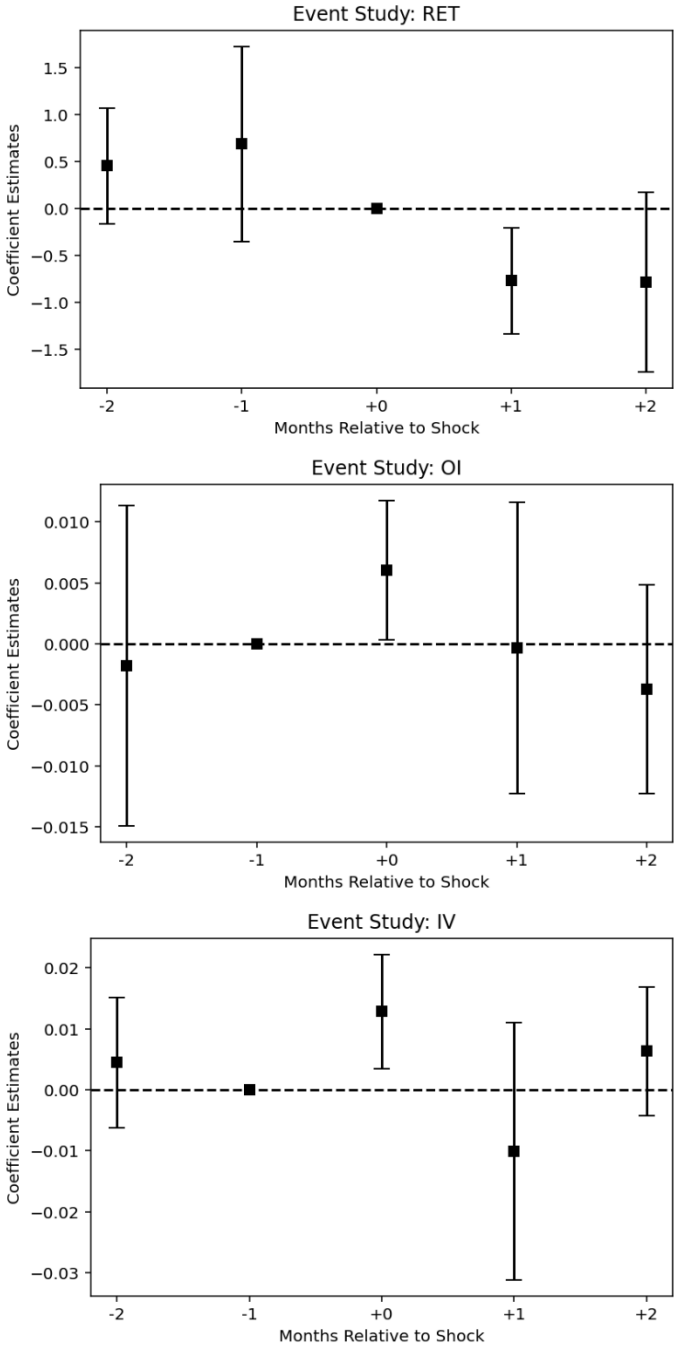


Figure 5. ESG Disagreement Level by the FF 12-Industry

This figure illustrates the changes in ESG disagreement surrounding the occurrence of ESG incidents.

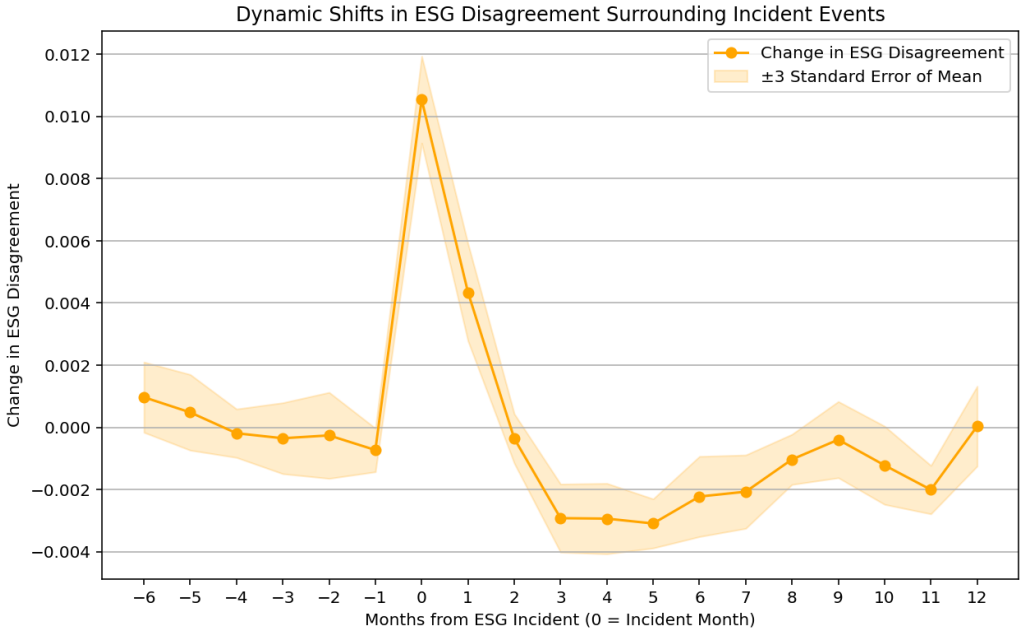


Figure 6. Event Study: ESG Incident Shock

This figure shows the time-series average of the differences in delta-hedged return with daily rebalance (RET), option open interest (OI), and implied volatility (IV) between the treatment group and the control group, after PSM. The month -1 (prior to the event month) is set as the benchmark (for the delta-hedged return, we set month 0 as the benchmark, as holding month for the shock is month +1). We plot the point estimate and the 90% confidence interval in vertical lines on the time-series level. The event shocks are defined as there is at least one ESG incident that is recorded in the Reprisk incident database in month t.

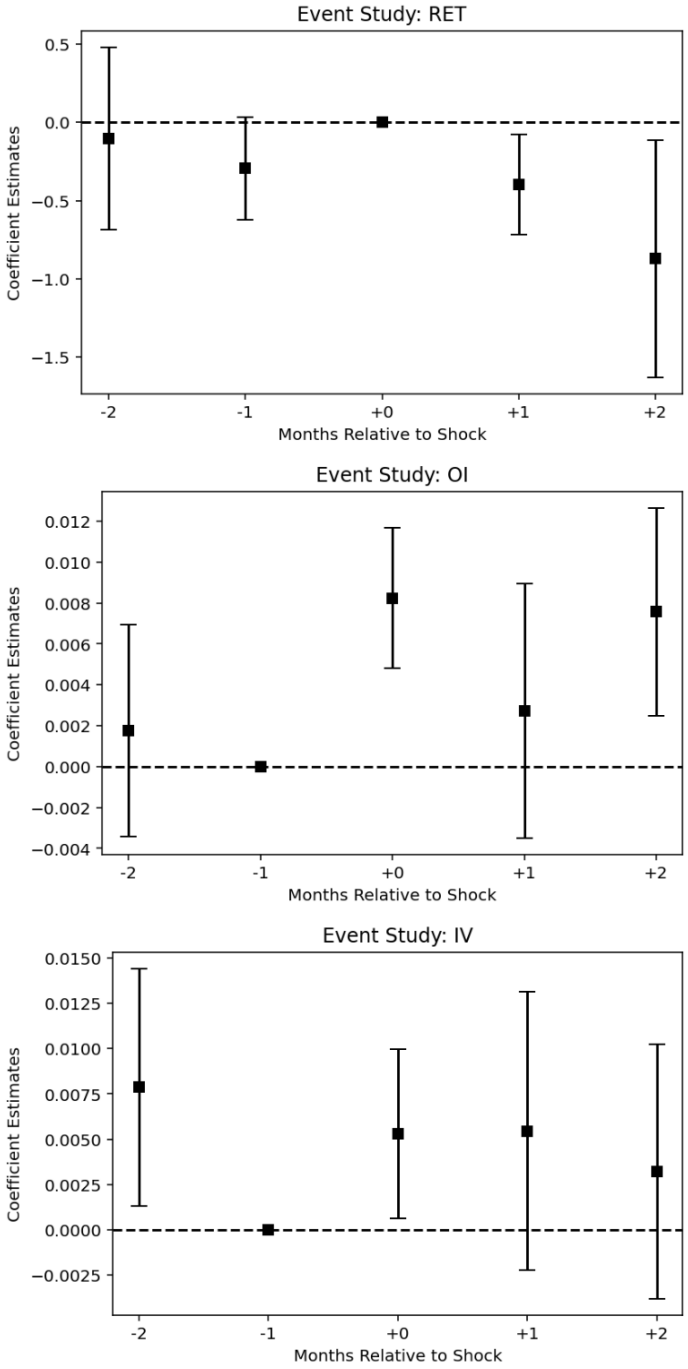


Figure 7. LMH 7-factor Alpha around COVID-19 NYSE Floor Trading Closure

This figure plots the monthly time series of the LMH delta-hedged return and the LMH 7-factor alpha for NYSE and non-NYSE stocks surrounding the NYSE floor trading closure during the COVID-19 pandemic. For each group and each month, we construct the LMH portfolio by buying the delta-hedged option portfolio in the bottom quintile of ESG disagreement and selling the delta-hedged option portfolio in the top quintile of ESG disagreement. The LMH 7-factor alpha is defined as the alpha from regressing the LMH delta-hedged return on the seven risk factors. March 2020 is treated as the event month, when the NYSE suspended floor trading, and May 2021 marks the full reopening of floor trading. Subgraph A (B) presents the LMH delta-hedged return (LMH 7-factor alpha) from May 2019 to December 2021, separately for NYSE (blue solid line) and non-NYSE stocks (orange dashed line). Subgraph C (D) plots the corresponding NYSE minus non-NYSE difference in LMH delta-hedged returns (7-factor alphas). The horizontal dashed lines indicate the average level in the pre-closure, closure, and post-reopening periods.

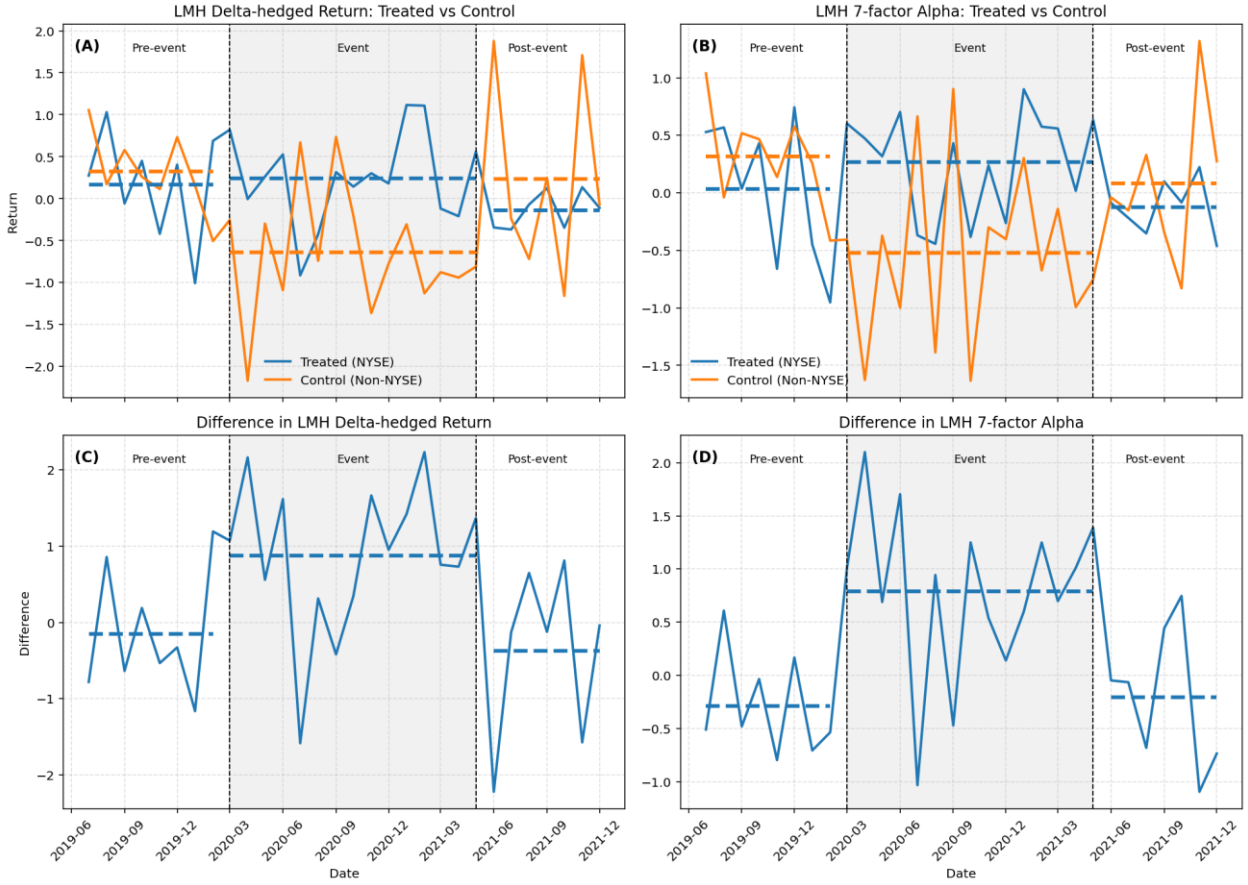


Table 1. Pairwise ESG Rating Disagreement and Correlation

Panel A shows the in-sample standard deviation between two rating percentiles from each pair of raters. After merging the option data and ESG data, for each ESG rater and each holding month, we calculate every firm's ESG ranking in percentile (standardized from 0 to 1). Then, for each firm, we compute the pairwise rating disagreement using standard deviation, following Avramov et al. (2022). Finally, we compute the average rating disagreement across all firms and over time. Panel B shows the in-sample correlation between pairs of rating percentiles, and the *p*-values are in parentheses.

Panel A. Pairwise ESG Rating Disagreement

	Reprisk	TruValue Labs	Sustainalytics	FTSE Russell	MSCI IVA
Reprisk	-				
TruValue Labs	0.165	-			
Sustainalytics	0.195	0.162	-		
FTSE Russell	0.201	0.155	0.139	-	
MSCI IVA	0.172	0.163	0.133	0.129	-

Panel B. Pairwise ESG Rating Correlation

	Reprisk	TruValue Labs	Sustainalytics	FTSE Russell	MSCI IVA
Reprisk	1				
TruValue Labs	0.039	1			
	(0.00)				
Sustainalytics	-0.184	0.008	1		
	(0.00)	(0.03)			
FTSE Russell	-0.239	0.005	0.287	1	
	(0.00)	(0.58)	(0.00)		
MSCI IVA	-0.010	0.007	0.291	0.347	1
	(0.01)	(0.05)	(0.00)	(0.00)	

Table 2. Summary Statistics

Panel A and Panel B are statistical summaries for call options and put options, respectively. Delta-hedged Gain is the delta-hedged option return with daily rebalance. Moneyness is the underlying stock price divided by the strike price. Days to Maturity is the number of days from the day we construct the portfolio to the expiry date of the option. Bid-ask Spread is the difference between the best offer and best ask divided by the midpoint of the bid price and ask price. Option OI is the open interest of the day that begins to hold the portfolio, divided by the monthly stock volume of the month before the holding month, then times 1000. In Panel C shows the stock characteristics, and Panel D presents the correlation matrix. ESG Score is the average percentile of the available raters' ratings. ESG Disagreement is the average pairwise standard deviation of rating percentiles. LnME is the log of market equity, and LnBM is the log of the book-to-market ratio. IDVOL is idiosyncratic volatility (Ang et al., 2006). ILLIQ is the log of the Amihud illiquidity measurement (Amihud, 2002) multiplied by 100 million. Market Beta is the market beta of rolling 60-month FF-3 (Fama and French, 1995) monthly return regressions. RET1 is the stock return in the last month, and RET212 is the cumulative monthly stock return in the last year, except for last month. ANLST is the number of analysts; IV is the implied volatility; #Incidents is the number of incidents that happened in the month before the holding month, based on the Reprisk ESG Incident database.

	Mean	STD	10%	25%	50%	75%	90%
Panel A. Call Options (94,757 Obs)							
Delta-hedged Return	-0.78	5.16	-4.50	-2.38	-0.83	0.64	2.78
Moneyness	1.00	0.05	0.95	0.98	1.00	1.02	1.06
Days to Maturity	49.42	2.05	46	49	50	51	52
Option Bid-ask Spread	0.17	0.20	0.03	0.06	0.11	0.20	0.36
Option Open Interest	0.02	0.07	0.00	0.00	0.01	0.02	0.06
Panel B. Put Options (94,757 Obs)							
Delta-hedged Return	-0.72	4.13	-3.86	-2.11	-0.76	0.56	2.47
Moneyness	1.00	0.05	0.94	0.98	1.00	1.02	1.05
Days to Maturity	49.42	2.05	46	49	50	51	52
Option Bid-ask Spread	0.17	0.21	0.03	0.06	0.11	0.20	0.36
Option Open Interest	0.02	0.06	0.00	0.00	0.00	0.01	0.03
Panel C. Stock Characteristics							
ESG Score	0.49	0.16	0.29	0.38	0.50	0.61	0.70
ESG Disagreement	0.23	0.10	0.09	0.16	0.23	0.29	0.35
LnME	8.32	1.55	6.41	7.25	8.22	9.33	10.37
LnBM	-1.08	0.98	-2.30	-1.62	-1.00	-0.43	0.03
RET1	0.02	0.15	-0.12	-0.05	0.01	0.08	0.16
RET212	0.27	1.05	-0.34	-0.11	0.14	0.43	0.86
IDVOL	0.35	0.28	0.14	0.19	0.28	0.42	0.62
ILLIQ	-4.31	1.33	-6.06	-5.19	-4.25	-3.37	-2.67
Market Beta	1.18	0.66	0.46	0.78	1.13	1.51	1.94

Panel D. Correlations											
	ESG Score	ESG Disagreement	LnME	LnBM	RET1	RET212	IDVOL	ILLIQ	ANLST	IV	#Incidents
ESG Score	1	-0.011	-0.005	-0.09	0.009	0.034	-0.021	0.076	0.001	-0.025	-0.06
ESG Disagreement	-0.011	1	0.151	-0.003	-0.004	-0.017	-0.036	-0.156	0.058	-0.047	0.102
LnME	-0.005	0.151	1	-0.18	-0.066	-0.096	-0.369	-0.708	0.600	-0.514	0.249
LnBM	-0.09	-0.003	-0.18	1	0.022	0.014	0.018	-0.032	-0.143	0.010	0.016
RET1	0.009	-0.004	-0.066	0.022	1	0.153	0.25	0.017	-0.026	0.026	-0.013
RET212	0.034	-0.017	-0.096	0.014	0.153	1	0.103	0.037	-0.077	0.122	-0.018
IDVOL	-0.021	-0.036	-0.369	0.018	0.250	0.103	1	0.216	-0.196	0.629	-0.059
ILLIQ	0.076	-0.156	-0.708	-0.032	0.017	0.037	0.216	1	-0.528	0.292	-0.218
ANLST	0.001	0.058	0.600	-0.143	-0.026	-0.077	-0.196	-0.528	1	-0.277	0.146
IV	-0.025	-0.047	-0.514	0.010	0.026	0.122	0.629	0.292	-0.277	1	-0.088
#Incidents	-0.06	0.102	0.249	0.016	-0.013	-0.018	-0.059	-0.218	0.146	-0.088	1

Table 3. ESG Rating Disagreement and Delta-hedged Option Return

This table shows the monthly Fama-Macbeth (Fama and Macbeth, 1973) cross-sectional regression results, using Newey-West (Newey and West, 1987) adjusted *t*-statistics. The variable ESG Disagreement follows Avramov et al. (2022): the standardized average of ESG ranges, where each range is the difference between two ESG rating percentiles from two raters. ESG Score is the average of ESG score percentiles from raters. LnME is the natural logarithm of the market value of the firm's equity at the end of last year; LnBM is 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; RET1 is the stock return in the prior month; RET212 is the cumulative stock return from the prior second through the 12th month; ILLIQ is the logarithm of the illiquidity measurement following Amihud (2002) of the previous month; IDVOL is the standard deviation of the regression residual of individual stock returns on the Fama-French (Fama and French, 1995) three factors using daily data in the previous month, following Ang et al. (2006); Option OI is the total number of option contracts that are open at the end of the previous month and scaled by the stock trading volume of last month, multiplied by 1000, following Cao and Han (2013). Option BA is the ratio of the difference between the bid and ask quotes of the option to the midpoint of the bid and ask quotes at the end of the previous month. Market Beta is the market beta of the FF 3-factor model (Fama and French, 1995), using monthly data for a 60-month rolling regression. VRP is the variance risk premium (Carr and Wu, 2009; Bollerslev et al., 2020), which is the difference between implied variance and realized variance. RN SKEW and RN KURT are model-free risk-neutral skewness and kurtosis (following Bakshi et al., 2003; Rehman and Vilkov, 2012) using implied volatility of 30 days from the Volatility Surface form in the OptionMetrics database, to perform linear interpolation, and extrapolate using the respective boundary values for moneyness levels outside the available data. The t-statistics are in parentheses. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). In columns (1) to (4), the dependent variable is the delta-hedged return with daily rebalance. In columns (5) to (8), the dependent variable is option open interest (the total number of option contracts that are open at the end of the month and scaled by the stock trading volume, multiplied by 1000) at the end of the month before the holding month. In columns (9) to (12), the dependent variable is implied volatility at the end of the month before the holding month.

Variables	Delta-hedged Return (RET)				Implied Volatility (IV)				Option Open Interest (OI)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ESG Disagreement	**-0.849*****	**-0.523*****	**-0.366*****	**-0.371*****	**0.074*****	**0.033*****	**0.027*****	**0.026*****	**0.014*****	**0.016*****	**0.016*****	**0.016*****
.	**(-6.18)**	**(-4.22)**	**(-3.45)**	**(-3.57)**	**(5.49)**	**(3.98)**	**(3.48)**	**(3.72)**	**(5.75)**	**(5.99)**	**(6.04)**	**(6.04)**
ESG Score	0.470***	0.236**	0.133	0.097	-0.083***	-0.048***	-0.044***	-0.039***	0.002	0.000	0.001	0.001
.	(3.76)	(2.10)	(1.58)	(1.20)	(-9.85)	(-8.25)	(-8.01)	(-7.73)	(1.10)	(0.23)	(0.37)	(0.30)
LnME	0.373***	0.380***	0.042	0.077***	-0.067***	-0.066***	-0.058***	-0.060***	-0.005***	-0.005***	-0.004***	-0.003***
.	(14.84)	(10.16)	(1.56)	(2.81)	(-29.14)	(-35.65)	(-39.67)	(-41.98)	(-15.41)	(-11.69)	(-9.88)	(-9.49)
LnBM	0.194***	0.208***	0.115***	0.094***	-0.018***	-0.019***	-0.017***	-0.014***	-0.000	-0.000	-0.000	-0.000
.	(6.42)	(6.39)	(5.37)	(4.57)	(-6.20)	(-9.45)	(-8.74)	(-7.94)	(-1.08)	(-1.11)	(-0.64)	(-0.83)
RET1	-0.519**	-0.194	-0.300	-0.290	-0.069***	-0.114***	-0.107***	-0.094***	0.006**	0.007***	0.007***	0.008***
.	(-2.16)	(-0.74)	(-1.61)	(-1.57)	(-3.84)	(-10.55)	(-9.92)	(-9.38)	(2.40)	(3.15)	(3.38)	(4.22)
RET212	0.021	-0.055	-0.231***	-0.188***	-0.019**	-0.005	-0.001	-0.003	-0.003***	-0.004***	-0.003***	-0.003***
.	(0.39)	(-0.86)	(-4.51)	(-3.79)	(-2.02)	(-0.96)	(-0.21)	(-0.55)	(-3.74)	(-5.00)	(-4.43)	(-2.80)
Market Beta	-0.109**	-0.015	-0.019	0.011	0.059***	0.038***	0.037***	0.034***	-0.002***	-0.001***	-0.001**	-0.001*
.	(-2.12)	(-0.34)	(-0.66)	(0.38)	(11.73)	(11.48)	(11.25)	(10.93)	(-4.20)	(-2.63)	(-2.51)	(-1.74)
IDVOL		-2.034***	-1.030***	-0.872***		0.383***	0.354***	0.328***		-0.017***	-0.019***	-0.019***
.		(-11.23)	(-9.07)	(-7.93)		(38.65)	(35.72)	(33.58)		(-9.98)	(-10.64)	(-9.49)
ILLIQ		0.276***	0.019	0.041*		-0.032***	-0.025***	-0.026***		0.001**	0.002***	0.002***
.		(7.99)	(0.83)	(1.78)		(-21.14)	(-22.83)	(-26.76)		(2.49)	(3.52)	(4.24)
Option OI		-2.131***	-0.646***	-0.735***		0.107***	0.073***	0.078***				
.		(-7.64)	(-2.71)	(-3.05)		(9.15)	(7.84)	(8.89)				
Option BA		-0.759***	0.314	-0.055		-0.015	-0.043***	-0.003				
.		(-3.22)	(1.45)	(-0.26)		(-1.17)	(-3.80)	(-0.28)				
VRP			-5.100***	-5.219***			0.117***	0.122***			0.011***	0.010***
.			(-12.26)	(-12.07)			(12.01)	(11.58)			(7.97)	(7.41)
RN SKEW				-0.110***				0.027***				0.002*
.				(-2.74)				(13.95)				(1.71)
RN KURT				0.307***				-0.031***				0.002**
.				(9.44)				(-10.82)				(2.37)
Adj-R2	0.041***	0.068***	0.238***	0.244***	0.446***	0.620***	0.661***	0.685***	0.019***	0.023***	0.027***	0.031***
Observations	194914	194914	194914	194914	194914	194914	194914	194914	194914	194914	194914	194914

Table 4. Portfolio Return Double-sorted by ESG Disagreement and Arbitrage Conditions

This table shows the daily-rebalanced delta-hedged return and 7-factor alpha, horizontally sorted by ESG disagreement (5-rank), and vertically in 2-rank, by firm size (using the 50th NYSE breakpoint) in Panel A, idiosyncratic volatility (using the monthly medians of idiosyncratic volatility) in Panel B, and option bid-ask spread (using the monthly medians of option bid-ask spread) in Panel C. The *t*-statistics are in parentheses.

Panel A. Low-minus-high Portfolio Return Ranked by Firm Size and ESG Disagreement

Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-1.26	-1.16	-1.24	-1.25	-1.46	0.20
	(-8.55)	(-9.21)	(-8.44)	(-7.91)	(-9.32)	(2.77)
High	-0.31	-0.29	-0.28	-0.22	-0.29	-0.02
	(-2.14)	(-2.37)	(-2.06)	(-1.63)	(-2.21)	(-0.53)
LMH	-0.95	-0.87	-0.96	-1.04	-1.17	**0.22**
	(-12.86)	(-10.12)	(-13.78)	(-12.42)	(-14.49)	**(2.50)**

7-factor Alpha of Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-0.87	-0.86	-0.94	-0.99	-1.02	0.15
	(-8.97)	(-9.94)	(-9.15)	(-9.08)	(-10.02)	(2.16)
High	-0.07	-0.03	-0.02	0.02	-0.04	-0.03
	(-0.78)	(-0.41)	(-0.28)	(0.25)	(-0.42)	(-0.91)
LMH	-0.80	-0.83	-0.92	-1.02	-0.98	**0.18**
	(-12.80)	(-11.04)	(-13.69)	(-13.10)	(-14.11)	**(2.25)**

Panel B. High-minus-low Portfolio Return Ranked by Idiosyncratic Volatility and ESG Disagreement

Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
High	-1.11	-0.96	-0.91	-0.97	-1.21	0.10
	(-7.08)	(-7.26)	(-6.15)	(-6.01)	(-7.46)	(1.63)
Low	-0.35	-0.28	-0.29	-0.19	-0.31	-0.05
	(-2.47)	(-2.27)	(-2.24)	(-1.53)	(-2.46)	(-1.04)
HML	-0.76	-0.69	-0.61	-0.78	-0.90	**0.15**
	(-9.56)	(-8.99)	(-9.00)	(-9.86)	(-11.06)	**(1.87)**

7-factor Alpha of Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
High	-0.74	-0.65	-0.61	-0.68	-0.81	0.07
	(-7.38)	(-7.07)	(-6.08)	(-6.31)	(-7.50)	(1.31)
Low	-0.09	-0.02	-0.03	0.06	-0.04	-0.05
	(-1.00)	(-0.26)	(-0.37)	(0.75)	(-0.54)	(-1.10)
HML	-0.65	-0.63	-0.58	-0.74	-0.77	**0.12**
	(-9.80)	(-9.60)	(-10.05)	(-10.75)	(-11.48)	**(1.69)**

Panel C. High-minus-low Portfolio Return Ranked by Option Bid-ask Spread and ESG Disagreement

Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
High	-0.97	-0.77	-0.77	-0.79	-1.15	0.17
	(-6.37)	(-5.80)	(-5.22)	(-5.16)	(-7.45)	(2.78)
Low	-0.55	-0.44	-0.42	-0.35	-0.41	-0.14
	(-4.05)	(-3.74)	(-3.19)	(-2.73)	(-3.07)	(-3.32)
HML	-0.43	-0.33	-0.35	-0.44	-0.74	**0.31**
	(-7.32)	(-5.31)	(-5.85)	(-7.45)	(-11.04)	**(3.95)**

7-factor Alpha of Delta-hedged Return with Daily Rebalance

	Low	_2	_3	_4	High	LMH
High	-0.64	-0.50	-0.49	-0.53	-0.75	0.12
	(-6.66)	(-6.33)	(-5.20)	(-5.50)	(-7.93)	(2.01)
Low	-0.23	-0.15	-0.14	-0.08	-0.13	-0.10
	(-2.75)	(-1.82)	(-1.65)	(-0.99)	(-1.45)	(-2.55)
HML	-0.41	-0.35	-0.35	-0.45	-0.62	**0.22**
	(-7.89)	(-6.74)	(-6.19)	(-8.58)	(-12.09)	**(3.03)**

Table 5. ESG Rating Disagreement and Arbitrage Constraints

This table shows the Fama-Macbeth (Fama and Macbeth, 1973) regression results on subsamples. We divide our sample into different groups by the level of arbitrage limits. Specifically, the sample is divided by firm size (using the NYSE 50th breakpoint), idiosyncratic volatility (using the monthly medians of IDVOL), option bid-ask spread (using the monthly medians of Option BA), and stock bid-ask spread (using the monthly medians of stock bid-ask spread). Basic Controls include the ESG Score, LnME, LnBM, RET1, RET212, and Market Beta. Arbitrage Conditions include IDVOL, ILLIQ, and Option BA and Option OI if the dependent variable is not OI. RN Moments include RN SKEW and RN KURT. RET is the delta-hedged return with daily rebalance; IV is the implied volatility at the end of the month before holding month; OI is the Option OI at the end of the month before holding month. The *t*-statistics are in parentheses.

Panel A. High Limits to Arbitrage												
	Small Firm			**High IDVOL**			**High Option BA**			**High Stock BA**		
	RET	IV	OI	RET	IV	OI	RET	IV	OI	RET	IV	OI
ESG Disagreement	-0.472***	0.026**	0.013*	-0.388**	0.049***	0.008***	-0.557***	0.033***	0.011***	-0.396**	0.041***	0.013***
.	(-2.65)	(2.18)	(1.96)	(-2.40)	(4.40)	(2.62)	(-3.63)	(3.56)	(2.96)	(-2.39)	(4.36)	(3.28)
Basic Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Arbitrage Conditions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VRP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RN Moments	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adj-R2	0.341***	0.619***	0.062***	0.316***	0.584***	0.065***	0.275***	0.682***	0.060***	0.309***	0.620***	0.059***
Observations	76710	76710	76710	97380	97380	97380	96846	96846	96846	97380	97380	97380
Panel B. Low Limits to Arbitrage												
	Large Firm			**Low IDVOL**			**Low Option BA**			**Low Stock BA**		
	RET	IV	OI	RET	IV	OI	RET	IV	OI	RET	IV	OI
ESG Disagreement	-0.029	0.004	0.007***	-0.139	0.002	0.013***	-0.078	0.015***	0.009***	-0.006	-0.006	0.006***
.	(-0.25)	(0.66)	(3.37)	(-1.15)	(0.50)	(3.92)	(-0.74)	(2.74)	(4.72)	(-0.06)	(-1.63)	(2.72)
Basic Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Arbitrage Conditions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VRP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RN Moments	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adj-R2	0.278***	0.639***	0.021***	0.255***	0.579***	0.054***	0.364***	0.711***	0.048***	0.337***	0.628***	0.025***
Observations	118204	118204	118204	97534	97534	97534	98068	98068	98068	97534	97534	97534

Table 6. ESG Rating Disagreement and ESG Score

This table shows the daily-rebalanced or buy-and-hold delta-hedged return (in Panel A) and 7-factor alpha (in Panel B), horizontally sorted by ESG disagreement (5-rank), and vertically in 5-rank by ESG score. The *t*-statistics are in parentheses. Panel C and Panel D show the results for call options and put options, respectively; the left hand side is for the delta-hedged return with daily rebalance, and the right hand side is for the 7-factor alpha of the delta-hedged return with daily rebalance.

Panel A. Delta-hedged Return with Daily Rebalance

Disagreement Rank	Low	2	3	4	High	LMH
ESG Rank						
Low	-0.79	-0.70	-0.67	-0.85	-1.06	0.27
	(-4.78)	(-5.42)	(-4.69)	(-5.83)	(-6.11)	(1.95)
2	-0.74	-0.41	-0.65	-0.56	-1.01	0.34
	(-3.87)	(-2.81)	(-4.55)	(-4.21)	(-6.37)	(2.77)
3	-0.77	-0.69	-0.51	-0.50	-0.65	-0.11
	(-4.25)	(-4.84)	(-3.39)	(-3.25)	(-4.64)	(-0.87)
4	-0.70	-0.56	-0.51	-0.34	-0.54	-0.16
	(-4.45)	(-4.44)	(-3.38)	(-2.13)	(-3.93)	(-1.94)
High	-0.79	-0.60	-0.52	-0.47	-0.48	-0.31
	(-5.58)	(-4.74)	(-3.55)	(-2.96)	(-2.75)	(-2.47)
HML	0.00	0.10	0.16	0.38	0.59	**0.58**
	(0.02)	(1.14)	(1.83)	(3.46)	(3.51)	**(3.16)**

Panel B. 7-factor Alpha of Delta-hedged Return with Daily Rebalance

Disagreement Rank	Low	2	3	4	High	LMH
ESG Rank						
Low	-0.44	-0.40	-0.39	-0.52	-0.64	0.19
	(-4.37)	(-4.55)	(-3.95)	(-5.01)	(-4.75)	(1.64)
2	-0.34	-0.18	-0.39	-0.33	-0.62	0.31
	(-2.62)	(-1.79)	(-4.13)	(-3.86)	(-6.13)	(2.73)
3	-0.44	-0.39	-0.23	-0.23	-0.33	-0.12
	(-3.30)	(-4.02)	(-2.44)	(-2.17)	(-3.45)	(-0.96)
4	-0.37	-0.32	-0.20	-0.11	-0.27	-0.10
	(-3.41)	(-3.40)	(-1.92)	(-0.94)	(-3.07)	(-1.34)
High	-0.52	-0.29	-0.27	-0.24	-0.31	-0.22
	(-5.70)	(-3.27)	(-2.64)	(-2.13)	(-2.30)	(-1.98)
HML	-0.08	0.12	0.11	0.27	0.33	**0.42**
	(-1.06)	(1.39)	(1.37)	(2.67)	(2.16)	**(2.53)**

Panel C. Call Options

	Delta-hedged Return with Daily Rebalance							7-factor Alpha of Delta-hedged Return with Daily Rebalance					
	Low	2	3	4	High	LMH		Low	2	3	4	High	LMH
Low	-0.85	-0.78	-0.73	-0.93	-0.96	0.11	Low	-0.48	-0.48	-0.41	-0.54	-0.61	0.13
	(-4.51)	(-5.42)	(-4.62)	(-6.08)	(-4.20)	(0.54)		(-4.00)	(-4.60)	(-3.62)	(-4.47)	(-3.27)	(0.74)
2	-0.84	-0.48	-0.67	-0.51	-1.04	0.25	2	-0.33	-0.26	-0.40	-0.29	-0.62	0.32
	(-3.56)	(-3.37)	(-4.37)	(-3.36)	(-5.93)	(1.50)		(-2.02)	(-2.43)	(-3.71)	(-2.76)	(-5.41)	(2.11)
3	-0.63	-0.69	-0.52	-0.51	-0.73	0.11	3	-0.25	-0.40	-0.24	-0.24	-0.38	0.12
	(-2.70)	(-4.49)	(-3.38)	(-3.17)	(-5.01)	(0.56)		(-1.32)	(-3.60)	(-2.39)	(-2.01)	(-3.58)	(0.67)
4	-0.73	-0.60	-0.47	-0.27	-0.60	-0.13	4	-0.39	-0.32	-0.25	-0.04	-0.31	-0.07
	(-4.28)	(-4.63)	(-2.93)	(-1.52)	(-4.06)	(-1.30)		(-3.19)	(-3.28)	(-2.03)	(-0.26)	(-3.13)	(-0.84)
High	-0.83	-0.54	-0.47	-0.41	-0.49	-0.34	High	-0.52	-0.19	-0.24	-0.21	-0.33	-0.20
	(-5.52)	(-3.85)	(-2.91)	(-2.27)	(-2.34)	(-1.89)		(-5.01)	(-1.84)	(-1.96)	(-1.48)	(-2.01)	(-1.29)
HML	0.02	0.25	0.26	0.52	0.47	0.47	HML	-0.05	0.29	0.16	0.33	0.28	0.34
	(0.17)	(2.07)	(2.34)	(3.54)	(1.91)	(1.71)		(-0.51)	(2.66)	(1.50)	(2.36)	(1.25)	(1.45)

Panel D. Put Options

	Delta-hedged Return with Daily Rebalance							7-factor Alpha of Delta-hedged Return with Daily Rebalance					
	Low	2	3	4	High	LMH		Low	2	3	4	High	LMH
Low	-0.74	-0.62	-0.61	-0.78	-1.17	0.42	Low	-0.40	-0.32	-0.36	-0.49	-0.67	0.26
	(-4.76)	(-5.11)	(-4.38)	(-4.82)	(-6.65)	(2.81)		(-4.27)	(-4.04)	(-3.74)	(-4.36)	(-4.79)	(1.90)
2	-0.64	-0.34	-0.63	-0.61	-0.98	0.42	2	-0.35	-0.10	-0.38	-0.36	-0.62	0.30
	(-3.94)	(-2.09)	(-4.40)	(-4.81)	(-6.20)	(3.69)		(-3.08)	(-0.88)	(-3.97)	(-4.48)	(-5.70)	(2.64)
3	-0.91	-0.68	-0.50	-0.49	-0.57	-0.34	3	-0.63	-0.39	-0.22	-0.21	-0.28	-0.36
	(-4.50)	(-4.63)	(-3.14)	(-3.10)	(-4.01)	(-2.02)		(-3.82)	(-3.70)	(-2.10)	(-2.03)	(-2.96)	(-2.31)
4	-0.67	-0.52	-0.55	-0.41	-0.49	-0.18	4	-0.35	-0.31	-0.15	-0.18	-0.23	-0.12
	(-4.14)	(-3.81)	(-3.48)	(-2.49)	(-3.57)	(-1.97)		(-2.99)	(-2.87)	(-1.33)	(-1.50)	(-2.67)	(-1.37)
High	-0.75	-0.66	-0.56	-0.53	-0.47	-0.28	High	-0.52	-0.38	-0.30	-0.28	-0.28	-0.25
	(-5.28)	(-4.93)	(-3.73)	(-3.28)	(-2.78)	(-2.60)		(-5.77)	(-3.95)	(-2.76)	(-2.47)	(-2.12)	(-2.27)
HML	-0.02	-0.04	0.05	0.24	0.70	**0.70**	HML	-0.12	-0.06	0.07	0.22	0.39	**0.50**
	(-0.20)	(-0.44)	(0.58)	(2.13)	(4.24)	**(3.93)**		(-1.57)	(-0.65)	(0.71)	(2.01)	(2.44)	**(2.85)**

Table 7. Delta-hedged Return During COVID-19 Liquidity Shock

This table shows the difference-in-difference estimates of delta-hedged option gains during the liquidity shock. We run the time-series regression by using the following formula:

$$\alpha_{t+1} = Intercept + \beta CV_t + \gamma NYSE_t + \delta CV_t \times NYSE_t + \epsilon_{t+1}$$

We follow Brogaard et al. (2025) and use the closure of floor trading in the NYSE during COVID-19 (from March 2020 to May 2020, matching the month we construct the delta-hedged portfolio in our sample) as the liquidity shock. We divided our sample into NYSE stock options and non-NYSE stock options. For each group-month, we calculate the LMH delta-hedged return by buying the delta-hedged portfolio with the bottom quintile of ESG disagreement and selling the delta-hedged portfolio with the top quintile of ESG disagreement. And we use the 7-factor alpha of the LMH delta-hedged return as the dependent variable. We execute the process for the whole sample, and the low (high) IDVOL (as well as Option BA and Stock BA) sample. The IDVOL (as well as Option BA and Stock BA) subsamples are divided by using the monthly medians of IDVOL (Option BA, or Stock BA) in our sample. We define the month dummy variable CV_t as one during the COVID-19 closure of the floor trading period, otherwise zero. We define the treatment dummy $NYSE_t$as one if the exchange code of the option's underlying stock is 1 (NYSE stocks), otherwise zero. $CV_t \times NYSE_t$ is the interaction term between CV_t and $NYSE_t$. These results are shown in the columns with "3M". We also use only March 2020 (the beginning month of liquidity shock, columns with "1M"), and from March 2020 to May 2021 (the whole floor trading closure period, columns with "15M") to define the COVID-19 dummy, as the robustness tests. The *t*-statistics are in parentheses.

	Whole Sample			**High IDVOL**			**Low IDVOL**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	3M	1M	15M	3M	1M	15M	3M	1M	15M
Intercept	0.021	0.006	0.067	-0.006	-0.023	0.060	-0.022	-0.040	-0.018
	(0.30)	(0.08)	(0.94)	(-0.05)	(-0.21)	(0.55)	(-0.36)	(-0.63)	(-0.29)
NYSE	-0.089	-0.072	-0.158*	0.033	0.046	-0.061	-0.020	0.003	-0.037
	(-0.96)	(-0.76)	(-1.69)	(0.23)	(0.32)	(-0.42)	(-0.26)	(0.04)	(-0.45)
CV	-0.966***	-0.305***	-0.712***	-2.046***	-3.230***	-1.149***	-0.227	2.297***	-0.089
	(-3.47)	(-4.26)	(-3.68)	(-4.44)	(-30.20)	(-3.37)	(-0.25)	(35.99)	(-0.31)
CV × NYSE	**1.356*****	**1.146*****	**1.039*****	**1.910*****	**3.575*****	**1.429*****	**1.073**	**-0.749*****	**0.406**
	(5.31)	**(12.13)**	**(3.58)**	**(3.82)**	**(24.96)**	**(2.76)**	**(1.36)**	**(-9.20)**	**(1.31)**

	High Option BA			**Low Option BA**			**High Stock BA**			**Low Stock BA**		
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	3M	1M	15M	3M	1M	15M	3M	1M	15M	3M	1M	15M
Intercept	0.153	0.139	0.181*	-0.126	-0.132*	-0.068	0.029	0.013	0.089	0.107	0.106	0.104
	(1.53)	(1.39)	(1.74)	(-1.67)	(-1.77)	(-0.89)	(0.30)	(0.13)	(0.90)	(1.25)	(1.25)	(1.15)
NYSE	-0.207	-0.200	-0.257*	0.134	0.143	0.050	-0.042	-0.027	-0.176	-0.100	-0.098	-0.114
	(-1.58)	(-1.53)	(-1.89)	(1.47)	(1.59)	(0.56)	(-0.28)	(-0.19)	(-1.32)	(-1.10)	(-1.08)	(-1.19)
CV	-1.603***	-2.472***	-0.636	0.019	1.124***	-0.648***	-1.436***	-1.589***	-0.955***	0.149	0.621***	0.061
	(-3.62)	(-24.73)	(-1.63)	(0.05)	(15.00)	(-3.82)	(-3.75)	(-16.21)	(-2.91)	(0.72)	(7.34)	(0.33)
CV × NYSE	**1.560****	**3.443*****	**0.870***	**0.263**	**-0.793*****	**0.996*****	**2.324*****	**4.503*****	**1.963*****	**-0.339**	**-1.400*****	**0.088**
	(2.17)	**(26.35)**	**(1.83)**	**(0.68)**	**(-8.80)**	**(4.02)**	**(2.65)**	**(30.80)**	**(2.75)**	**(-1.08)**	**(-15.52)**	**(0.34)**

Table 8. The Impact of the Paris Agreement

This table shows the impact of the Paris Agreement on the pricing of ESG disagreement in the option market. We divided our sample into the high limits to arbitrage group and the low limits to arbitrage group, by IDVOL, stock bid-ask spread, and option bid-ask spread. For each month and each group, we calculate the LMH portfolio return by buying the delta-hedged portfolio with the bottom quintile of ESG disagreement and selling the delta-hedged portfolio with the top quintile of ESG disagreement. We run the time-series regression by using the following formula:

$$R_{t+1} = \alpha_0 + \alpha_1 PA_t + \boldsymbol{\gamma' Factors_{t+1}} + \epsilon_{t+1}$$

We follow Cao et al. (2024) to determine the period from January 2016 to June 2017 as the Paris Agreement period (matching with the holding month in our sample), and the dummy PA equals one during this period, otherwise zero. Factors include the Fama-French 6-factor (Fama and French, 2018) and the options market factor (Coval and Shumway, 2001). Panel A and Panel B show the results of the high arbitrage constraints group and the low arbitrage constraints group, respectively. Panel C reports the Fama-Macbeth regression result for before the Paris Agreement (from 2008 to 2015) and after the Paris Agreement (from 2016 to 2021) subsamples. The *t*-statistics are in parentheses.

Panel A. High Limits to Arbitrage						
	High IDVOL		High Stock BA		High Option BA	
	(1)	(2)	(3)	(4)	(5)	(6)
α_0	0.014	0.038	0.020	0.052	0.059	0.014
	(0.18)	(0.48)	(0.26)	(0.62)	(0.82)	(0.19)
PA	0.483***	0.429***	0.418**	0.371*	0.354*	0.351*
	(3.03)	(2.64)	(2.30)	(1.90)	(1.77)	(1.73)
Factors	N	Y	N	Y	N	Y
Panel B. Low Limits to Arbitrage						
	Low IDVOL		Low Stock BA		Low Option BA	
	(1)	(2)	(3)	(4)	(5)	(6)
α_0	-0.040	0.012	0.006	0.042	-0.092	-0.060
	(-0.95)	(0.26)	(0.14)	(1.02)	(-2.24)	(-1.28)
PA	-0.106	-0.113	-0.047	-0.053	-0.081	-0.078
	(-1.00)	(-1.19)	(-0.48)	(-0.52)	(-0.68)	(-0.64)
Factors	N	Y	N	Y	N	Y
Panel C. Pre-Paris Agreement and Post-Paris Agreement						
	Pre-Paris Agreement			Post-Paris Agreement		
	(1)	(2)	(3)	(4)	(5)	(6)
	RET	IV	OI	RET	IV	OI
ESG Disagreement	-0.208**	-0.000	0.010***	-0.584***	0.060***	0.022***
.	(-2.02)	(-0.03)	(4.32)	(-3.17)	(7.11)	(4.95)
Basic Controls	Y	Y	Y	Y	Y	Y
Arbitrage Conditions	Y	Y	Y	Y	Y	Y
VRP	Y	Y	Y	Y	Y	Y
RN Moments	Y	Y	Y	Y	Y	Y
Adj-R2	0.266***	0.677***	0.036***	0.216***	0.696***	0.025***
Observations	97114	97114	97114	97800	97800	97800

Table A1. Number of Rated Stocks Over Time

Panel A shows the in-sample number of stocks rated by different raters for each year. Panel B shows the number of rated stocks with a certain number of ratings for each year. N is the number of raters' ratings. S&P 500 % represents the fraction of S&P 500 constituent firms covered by our sample. All the results are calculated after merging the option data and ESG data.

Panel A: Number of Rated Stocks by Raters

Year	Reprisk	Sustainalytics	TruValue Labs	FTSE Russell	MSCI IVA
2008	1308		1115		503
2009	1289	527	1193		503
2010	1299	784	1279		515
2011	1250	804	1285		525
2012	1176	782	1243		893
2013	1259	796	1419		1379
2014	1305	799	1524		1442
2015	1279	785	1530		1451
2016	1323	1531	1581		1495
2017	1336	1600	1623		1538
2018	1314	1568	1647	658	1542
2019	1309	1693	1665	748	1590
2020	1282	1742	1683	774	1643
2021	1392	2016	1896	823	1866

Panel B: Number of Raters for Stocks

Year	N=1	N=2	N=3	N=4	N=5	N>=2	N>=3	N>=4	N>=5	S&P500 %
2008	551	592	397			64.22	25.78			90.81
2009	426	570	162	365		72.03	34.6	23.97		91.41
2010	363	511	252	434		76.73	43.97	27.82		90.68
2011	318	470	262	455		78.87	47.64	30.23		89.58
2012	180	355	332	552		87.32	62.3	38.9		86.65
2013	135	332	494	643		91.58	70.89	40.09		85.52
2014	120	352	550	649		92.82	71.75	38.84		86.35
2015	79	345	532	670		95.14	73.92	41.21		84.32
2016	40	113	424	1098		97.61	90.87	65.55		82.35
2017	36	109	417	1148		97.89	91.52	67.13		83.08
2018	51	97	375	621	575	97.03	91.39	69.58	33.45	83.94
2019	28	82	359	634	640	98.39	93.69	73.09	36.72	83.43
2020	56	120	383	601	655	96.91	90.3	69.2	36.09	83.14
2021	126	230	482	654	669	94.17	83.53	61.22	30.96	84.14

Table A2. Sample Coverage

Panel A shows the time-series distribution across 168 months. EW Stock % of stock universe is the equal-weighted proportion of stocks within our sample to the stock universe, which is the number of stocks in each observed month, divided by the total number of stocks in CRSP; VW Stock % of stock universe is the value-weighted proportion of stocks within our sample to the stock universe, which is the total market capital in each observed month, divided by the total market capital in CRSP; Stock % traded at NYSE is the percentage of stocks traded at NYSE in our chosen sample. Panel B shows the time-series average of the cross-sectional distribution. Size CRSP percentile and Book-to-market CRSP percentile are the percentiles of observations' firm size and book-to-market ratio, of the full CRSP sample, respectively. Analyst coverage is the number of analysts following the firm in the previous month.

Panel A: Time-series Distribution (168 months)							
	Mean	STD	10%	25%	50%	75%	90%
Number of Stocks	580.10	139.55	425.50	480.25	560.50	662.00	774.60
EW Stock % of Stock Universe	7.89	1.49	6.05	6.85	7.83	8.94	9.92
VW Stock % of Stock Universe	32.03	5.91	23.95	27.57	32.39	36.16	38.15
Stock % Traded at NYSE	54.35	6.21	46.57	49.47	54.00	59.59	63.17
Institutional Ownership Ratio %	82.32	1.04	81.04	81.59	82.37	82.96	83.68
Sample Coverage % in S&P500 Index	40.47	7.41	29.22	33.90	42.91	46.03	48.53
Stock % in S&P500	36.15	7.90	26.25	29.61	35.94	42.26	46.86
Panel B: Time-series Average of Cross-sectional Distribution (94757 Obs)							
	Mean	STD	10%	25%	50%	75%	90%
LnME Percentile	0.82	0.15	0.60	0.73	0.86	0.94	0.98
LnBM Percentile	0.35	0.25	0.05	0.14	0.30	0.52	0.74
ANLST	13	8.78	2	6	11	18	25

Table A3. ESG Rating Disagreement and Delta-hedged Option Return without Daily Rebalance

This table shows the monthly Fama-Macbeth (Fama and Macbeth, 1973) cross-sectional regression results, using Newey-West (Newey and West, 1987) adjusted *t*-statistics. The variable ESG Disagreement follows Avramov et al. (2022): the standardized average of ESG ranges, where each range is the difference between two ESG rating percentiles from two raters. ESG Score is the average of ESG score percentiles from raters. LnME is the natural logarithm of the market value of the firm's equity at the end of last year; LnBM is 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; RET1 is the stock return in the prior month; RET212 is the cumulative stock return from the prior second through the 12th month; ILLIQ is the logarithm of the illiquidity measurement following Amihud (2002) of the previous month; IDVOL is the standard deviation of the regression residual of individual stock returns on the Fama-French (Fama and French, 1995) three factors using daily data in the previous month, following Ang et al. (2006); Option OI is the total number of option contracts that are open at the end of the previous month and scaled by the stock trading volume of last month, multiplied by 1000, following Cao and Han (2013). Option BA is the ratio of the difference between the bid and ask quotes of the option to the midpoint of the bid and ask quotes at the end of the previous month. Market Beta is the market beta of the FF 3-factor model (Fama and French, 1995), using monthly data for a 60-month rolling regression. VRP is the variance risk premium (Carr and Wu, 2009; Bollerslev et al., 2020), which is the difference between implied variance and realized variance. RN SKEW and RN KURT are model-free risk-neutral skewness and kurtosis (following Bakshi et al., 2003; Rehman and Vilkov, 2012) using implied volatility of 30 days from the Volatility Surface form in the OptionMetrics database, to perform linear interpolation, and extrapolate using the respective boundary values for moneyness levels outside the available data. The t-statistics are in parentheses. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). The dependent variable is the delta-hedged return without daily rebalance. Columns (1) to (4) show the result for the whole sample; columns (5) to (8) show the result for call options only; and columns (9) to (12) show the result for put options only. The *t*-statistics are in parentheses.

	Call + Put				Call				Put			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ESG Disagreement	**-1.451*** **	**-1.223*** **	**-0.965*** **	**-0.970*** **	**-1.604*** **	**-1.341*** **	**-0.890*** **	**-0.900*** **	**-1.298*** **	**-1.086*** **	**-1.037*** **	**-1.039*** **
.	**(-6.07)**	**(-5.76)**	**(-5.03)**	**(-5.15)**	**(-5.34)**	**(-5.10)**	**(-3.87)**	**(-3.96)**	**(-6.19)**	**(-5.71)**	**(-5.67)**	**(-5.79)**
ESG Score	0.692***	0.397***	0.303**	0.259*	0.878***	0.548***	0.371**	0.315*	0.506***	0.259*	0.256**	0.225*
.	(4.37)	(2.80)	(2.23)	(1.96)	(4.68)	(3.14)	(2.20)	(1.89)	(3.34)	(1.91)	(2.07)	(1.87)
LnME	0.754***	0.517***	0.371***	0.379***	0.857***	0.615***	0.369***	0.372***	0.652***	0.408***	0.369***	0.381***
.	(21.19)	(15.59)	(12.50)	(11.92)	(17.11)	(14.59)	(11.09)	(10.09)	(27.59)	(13.32)	(11.46)	(11.88)
LnBM	0.080**	0.055*	0.014	-0.002	0.057	0.026	-0.028	-0.052	0.103***	0.082***	0.054*	0.045
.	(2.08)	(1.72)	(0.44)	(-0.07)	(1.23)	(0.65)	(-0.73)	(-1.37)	(2.99)	(2.84)	(1.97)	(1.63)
RET1	0.011	0.418*	0.299	0.191	0.358	0.949***	0.733**	0.496*	-0.336	-0.036	-0.054	-0.051
.	(0.04)	(1.79)	(1.31)	(0.84)	(1.01)	(3.26)	(2.56)	(1.78)	(-1.39)	(-0.16)	(-0.25)	(-0.24)
RET212	0.213**	0.053	-0.084	-0.087	0.330***	0.156	-0.109	-0.129*	0.097	-0.043	-0.045	-0.032
.	(2.59)	(0.76)	(-1.29)	(-1.40)	(2.79)	(1.59)	(-1.32)	(-1.68)	(1.55)	(-0.70)	(-0.74)	(-0.54)
Market Beta	-0.329***	-0.172***	-0.155***	-0.125**	-0.401***	-0.203***	-0.174**	-0.132**	-0.257***	-0.155***	-0.150***	-0.132***
.	(-4.58)	(-3.06)	(-2.81)	(-2.40)	(-4.55)	(-3.01)	(-2.55)	(-2.03)	(-4.08)	(-2.83)	(-2.89)	(-2.65)
IDVOL		-3.824***	-2.842***	-2.608***		-4.449***	-2.840***	-2.503***		-3.197***	-2.841***	-2.695***
.		(-17.44)	(-12.75)	(-12.10)		(-15.09)	(-9.27)	(-8.64)		(-19.15)	(-16.51)	(-15.51)
ILLIQ		2.260***	0.822	0.869		3.288***	0.380	0.466		1.499*	1.223*	1.235*
.		(3.05)	(1.28)	(1.30)		(3.47)	(0.45)	(0.53)		(1.97)	(1.75)	(1.69)
Option OI		-1.978***	-0.746***	-0.800***		-2.272***	0.195	0.048		-1.889***	-1.458***	-1.426***
.		(-5.90)	(-2.72)	(-2.89)		(-4.08)	(0.42)	(0.10)		(-3.90)	(-3.10)	(-3.03)
Option BA		-0.816***	-0.040	-0.309*		-0.509*	0.892***	0.510*		-1.718***	-1.471***	-1.684***
.		(-5.32)	(-0.27)	(-1.93)		(-1.82)	(3.12)	(1.72)		(-5.86)	(-5.21)	(-5.42)
VRP			-3.930***	-3.963***			-6.653***	-6.678***			-1.197***	-1.241***
.			(-11.41)	(-11.42)			(-13.83)	(-13.86)			(-3.11)	(-3.17)
RN SKEW				-0.325***				-0.581***				-0.082*
.				(-4.13)				(-4.11)				(-1.66)
RN KURT				0.219***				0.293***				0.160***
.				(4.91)				(4.59)				(3.36)
Adj-R2	0.072***	0.097***	0.144***	0.147***	0.077***	0.107***	0.271***	0.276***	0.075***	0.104***	0.203***	0.206***
Observations	194914	194914	194914	194914	97457	97457	97457	97457	97457	97457	97457	97457

Table A4. ESG Rating Disagreement and Delta-hedged Option Return: Panel Regression

This table shows the panel regression result. The dependent variable is the delta-hedged return with daily rebalance. The variable ESG Disagreement follows Avramov et al. (2022): the standardized average of ESG ranges, where each range is the difference between two ESG rating percentiles from two raters. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). The dependent variable is the delta-hedged return with daily rebalance. Columns (1) to (6) show the result for call options only, and columns (7) to (12) show the result for put options only. Basic Controls include the ESG Score, LnME, LnBM, RET1, RET212, and Market Beta. Arbitrage Conditions include IDVOL, ILLIQ, and Option BA and Option OI if the dependent variable is not OI. RN Moments include RN SKEW and RN KURT. RET is the delta-hedged return with daily rebalance; IV is the implied volatility at the end of the month before holding month; OI is the Option OI at the end of the month before holding month. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). The *t*-statistics are in parentheses.

	Call Options						**Put Options**					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	RET	RET	IV	IV	OI	OI	RET	RET	IV	IV	OI	OI
ESG Disagreement	-0.450***	-0.456***	0.045***	0.057***	0.011***	0.011***	-0.688***	-0.671***	0.047***	0.059***	0.010***	0.010***
	(-2.84)	(-2.89)	(5.66)	(7.32)	(3.32)	(3.34)	(-4.91)	(-4.81)	(5.78)	(7.33)	(3.11)	(3.08)
Basic Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Arbitrage Conditions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VRP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RN Moments	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Cluster by Firms	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	97457	97457	97457	97457	97457	97457	97457	97457	97457	97457	97457	97457

Table A5. Portfolio Return Double-sorted by ESG Disagreement and Arbitrage Conditions

This table shows the buy-and-hold delta-hedged return and 7-factor alpha, horizontally sorted by ESG disagreement (5-rank), and vertically in 2-rank, by firm size (using the 50th NYSE breakpoint) in Panel A, idiosyncratic volatility (using the monthly medians of idiosyncratic volatility) in Panel B, and option bid-ask spread (using the monthly medians of option bid-ask spread) in Panel C. The *t*-statistics are in parentheses.

Panel A. Low-minus-high Portfolio Return Ranked by Firm Size and ESG Disagreement

Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-3.30	-3.15	-3.22	-3.31	-3.69	0.38
	(-21.71)	(-20.96)	(-20.43)	(-20.61)	(-22.93)	(4.23)
High	-1.28	-1.23	-1.24	-1.14	-1.12	-0.17
	(-9.00)	(-9.53)	(-9.39)	(-8.76)	(-8.97)	(-2.53)
LMH	-2.02	-1.93	-1.98	-2.17	-2.57	**0.55**
	(-19.83)	(-14.72)	(-19.31)	(-17.26)	(-21.00)	**(5.08)**

7-factor Alpha of Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-2.74	-2.69	-2.80	-2.95	-3.11	0.37
	(-24.51)	(-21.67)	(-23.09)	(-25.62)	(-29.34)	(4.37)
High	-0.98	-0.92	-0.90	-0.82	-0.78	-0.20
	(-9.68)	(-10.57)	(-10.02)	(-9.02)	(-9.47)	(-3.11)
LMH	-1.76	-1.77	-1.91	-2.14	-2.33	**0.57**
	(-21.60)	(-16.22)	(-20.71)	(-19.47)	(-26.15)	**(5.70)**

Panel B. Low-minus-high Portfolio Return Ranked by Idiosyncratic Volatility and ESG Disagreement

Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-1.36	-1.17	-1.15	-1.01	-1.10	-0.27
	(-11.16)	(-10.44)	(-9.73)	(-9.57)	(-9.88)	(-4.82)
High	-3.02	-2.70	-2.66	-2.80	-3.17	0.15
	(-18.37)	(-18.01)	(-16.69)	(-17.35)	(-19.67)	(1.87)
HML	-1.66	-1.53	-1.51	-1.79	-2.08	**0.42**
	(-15.92)	(-14.56)	(-16.26)	(-17.03)	(-20.31)	**(4.74)**

7-factor Alpha of Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-1.05	-0.88	-0.84	-0.72	-0.76	-0.29
	(-12.50)	(-12.13)	(-10.88)	(-10.41)	(-10.24)	(-5.35)
High	-2.46	-2.24	-2.21	-2.36	-2.63	0.17
	(-20.52)	(-19.32)	(-19.18)	(-20.44)	(-24.41)	(2.10)
HML	-1.41	-1.36	-1.37	-1.64	-1.87	**0.46**
	(-16.73)	(-14.78)	(-17.43)	(-18.05)	(-23.35)	**(5.16)**

Panel C. Low-minus-high Portfolio Return Ranked by Option Bid-ask Spread and ESG Disagreement

Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-1.81	-1.56	-1.47	-1.40	-1.44	-0.38
	(-12.91)	(-12.71)	(-11.16)	(-11.05)	(-11.47)	(-5.92)
High	-2.68	-2.26	-2.32	-2.38	-2.86	0.18
	(-18.90)	(-17.45)	(-16.18)	(-17.79)	(-19.57)	(2.23)
HML	-0.87	-0.70	-0.85	-0.98	-1.42	**0.55**
	(-13.00)	(-9.85)	(-10.78)	(-12.74)	(-17.91)	**(6.13)**

7-factor Alpha of Delta-hedged Return without Daily Rebalance

	Low	_2	_3	_4	High	LMH
Low	-1.39	-1.20	-1.11	-1.05	-1.05	-0.34
	(-13.72)	(-13.35)	(-11.80)	(-11.99)	(-11.93)	(-5.56)
High	-2.21	-1.89	-1.92	-2.02	-2.36	0.14
	(-22.05)	(-21.13)	(-19.07)	(-22.23)	(-25.67)	(2.02)
HML	-0.82	-0.69	-0.81	-0.96	-1.30	**0.48**
	(-13.32)	(-11.36)	(-10.85)	(-13.31)	(-19.88)	**(6.34)**

Table A6. High ESG Disagreement and Low ESG Score

This table shows the Fama-Macbeth regression result. The dependent variable is the delta-hedged return with daily rebalance. High ESG Disagreement is a dummy variable that equals 1 when the underlying asset's ESG disagreement is in the top quintile in a given month, otherwise 0. High ESG Disagreement × ESG Score is the interaction term between High ESG Disagreement and ESG Score. Low ESG Score is a dummy variable that equals 1 when the underlying assets' average overall ESG Score is in the bottom quintile in a given month, otherwise 0. High ESG Disagreement × Low ESG Score is the interaction term between High ESG Disagreement and Low ESG Score. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). Basic Controls include the ESG Score, LnME, LnBM, RET1, RET212, and Market Beta. Arbitrage Conditions include IDVOL, ILLIQ, and Option BA and Option OI if the dependent variable is not OI. RN Moments include RN SKEW and RN KURT. All variables in Panel C of Table 1 are winsorized in (0.5, 99.5). The *t*-statistics are in parentheses.

	Call + Put		**Call**		**Put**	
	(1)	(2)	(3)	(4)	(5)	(6)
High ESG Disagreement	-0.334***		-0.257*		-0.404***	
.	(-2.75)		(-1.67)		(-2.83)	
ESG Score	0.060	0.065	0.061	0.066	0.082	0.086
.	(0.66)	(0.75)	(0.54)	(0.62)	(0.93)	(1.01)
High ESG Disagreement × ESG Score	**0.498****		0.397		0.592**	
.	**(2.04)**		(1.26)		(2.07)	
ESG Disagreement		-0.249*		-0.222		-0.275**
.		(-1.88)		(-1.31)		(-2.10)
High ESG Disagreement × Low ESG Score		**-0.098****		-0.062		-0.133***
.		**(-2.47)**		(-1.23)		(-3.07)
Basic Controls	Y	Y	Y	Y	Y	Y
Arbitrage Conditions	Y	Y	Y	Y	Y	Y
VRP	Y	Y	Y	Y	Y	Y
RN Moments	Y	Y	Y	Y	Y	Y
Adj-R2	0.245***	0.245***	0.434***	0.434***	0.284***	0.284***
Observations	194914	194914	97457	97457	97457	97457

Table A7. High ESG Disagreement and Low ESG Score

This table reports results from difference-in-difference-in-differences (DDD) regressions examining how the pricing of ESG disagreement in option returns varies across NYSE and non-NYSE stocks around the COVID-19 NYSE floor trading closure. The dependent variable is the delta-hedged option return with daily rebalance. The key variable of interest is the triple interaction term H × NYSE × CV, where H is the high ESG disagreement dummy indicating firms in the top 50th percentile of ESG rating disagreement, NYSE is an indicator for stocks listed on the New York Stock Exchange, and CV is a dummy equal to one during the COVID-19 crisis period. We omit the COVID dummy and the NYSE dummy in the dependent variables because of the multicollinearity. Column (1) reports results for the combined sample of call and put options. Columns (2) and (3) present results separately for call and put options. Control variables include the basic controls and arbitrage conditions, which are the same as column (2) in Table 3. All variables in Panel C of Table 1 are winsorized in (1, 99). The *t*-statistics are in parentheses.

	Call+Put	Call	Put
	(1)	(2)	(3)
H × NYSE × CV	-1.240**	-1.679**	-0.814**
	(-2.35)	(-2.24)	(-2.27)
H	-0.006	0.035	-0.048
	(-0.14)	(0.71)	(-1.06)
NYSE × CV	1.387**	1.766*	1.013***
	(2.63)	(2.06)	(4.23)
H × CV	0.770*	1.017*	0.532
	(1.89)	(2.02)	(1.43)
H × NYSE	-0.016	-0.037	0.006
	(-0.35)	(-0.57)	(0.12)
Basic Controls	Y	Y	Y
Arbitrage Conditions	Y	Y	Y
Firm FE	Y	Y	Y
Time FE	Y	Y	Y
Cluster by Industry	Y	Y	Y
Observations	194908	97213	97213
Adj. R-squared	0.178	0.174	0.192