Zürcher Hochschule
für Angewandte Wissenschaften

School of
Management and Law

How do stocks and options react to negative ESG Incidents?

Building Competence. Crossing Borders.

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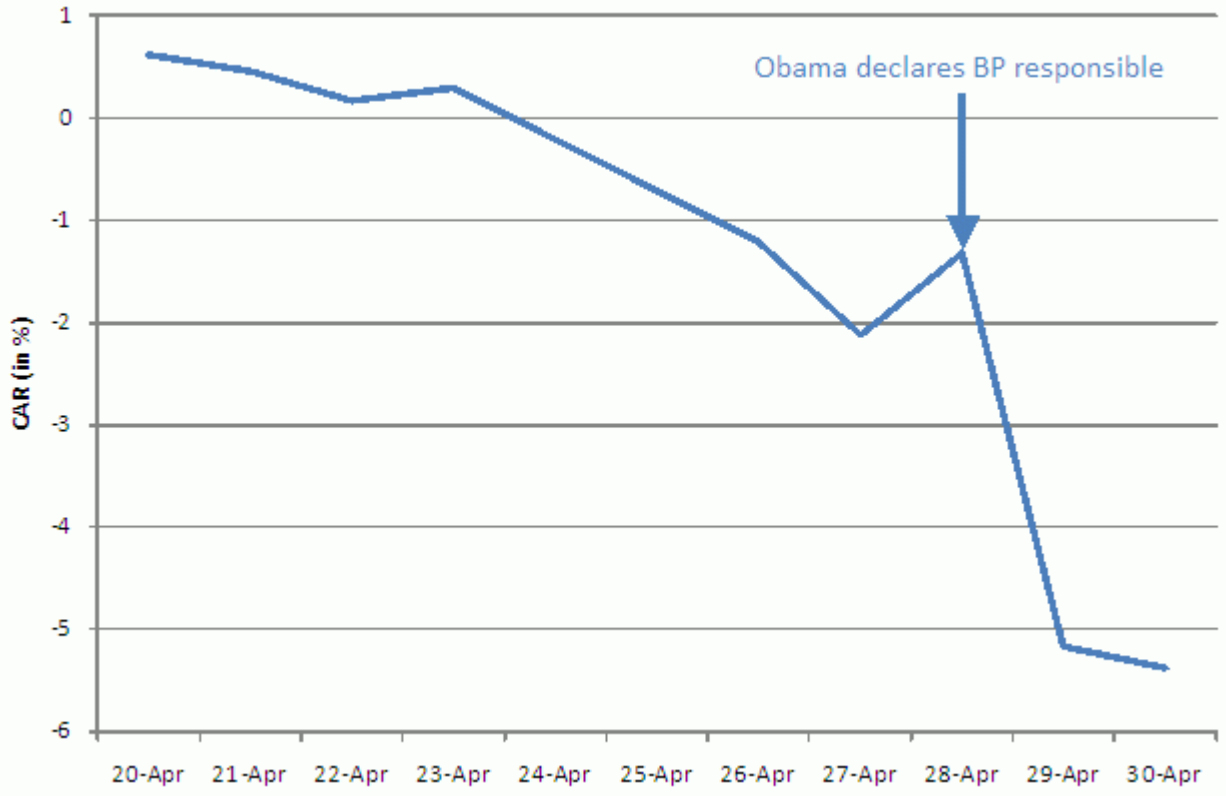
BP Oil Spill in 2010

On the 20th of April 2010, the Deepwater Horizon rig exploded, collapsed and released large amounts of oil into the Gulf of Mexico .

It was operated by the multinational oil company British Petroleum (BP).



Source: CEPR Voxeu

Motivation and Business Rationale

ESG Challenges

1. ESG investing is on the rise globally, with strong consequences for asset allocation and prices.

2. For S&P 500 companies, every day there are at least 20 negative ESGnews and reports, ranging from major oil spills to minor governance scandals.

3. RepRisk has succesfully tackled the challenge how to identify and classify these ESG news.

Business Challenges

1. How important are these ESG events for asset prices?
2. Can investors protect their portfolios or even make money from the ESG news?

→ Negative ESG events can be seen as opportunity for shorting stocks and buying put options on stocks

Research Gaps and Objective

Research Gaps:

1. No empirical research on ESG incidents with regard to option pricing and volatility
2. No empirical research on ESG incident characeristics (severity, reach, novelty) with regard to stocks & options

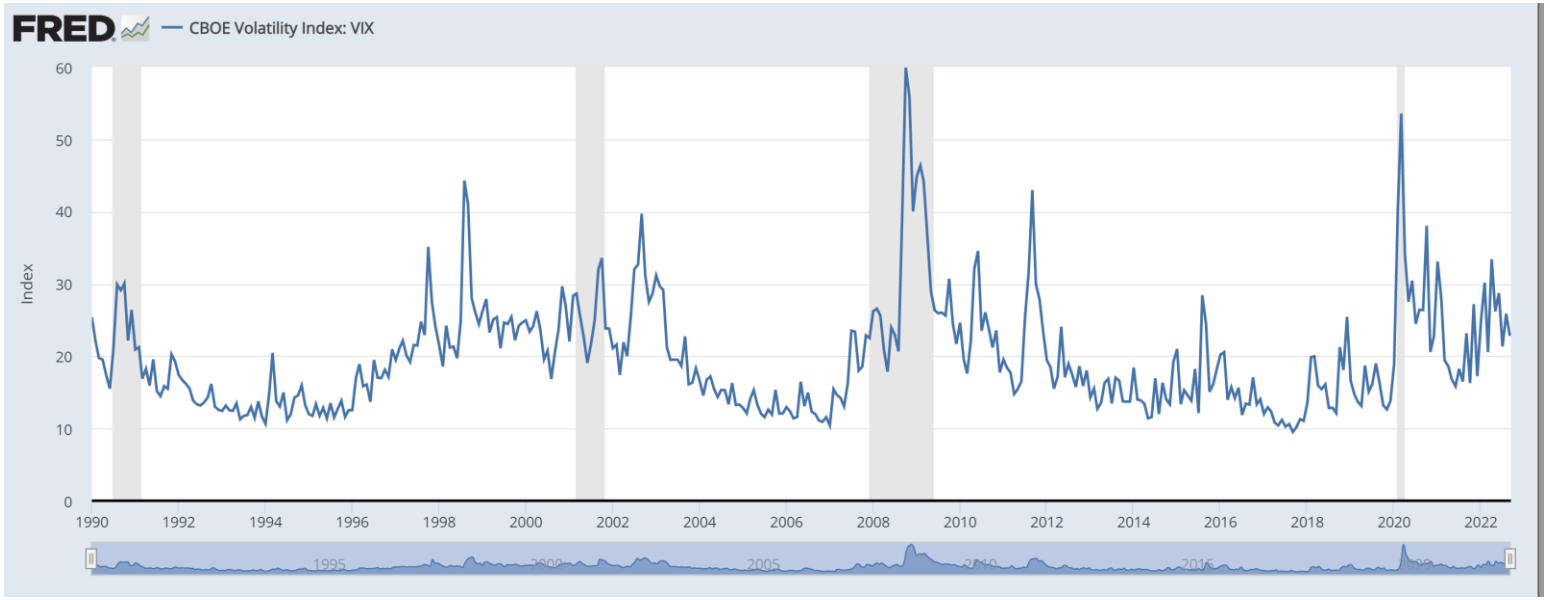
Main Hypothesis: Negative ESG news should trigger negative action in stock prices and an increase in option implied volatility.

Research Objective: Analyse the behavior of stock prices and IV 10 days following the ESG event

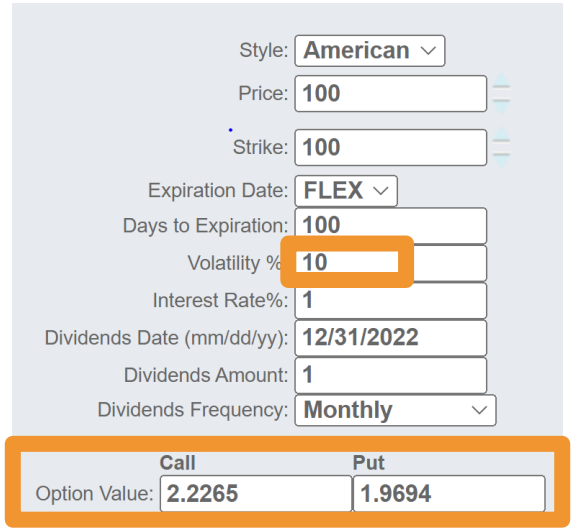
Reminder on Option Implied Volatility

Option implied volatility is the main input to the option pricing models. IV can not be observed, it is deducted from the option prices at the moment in time.

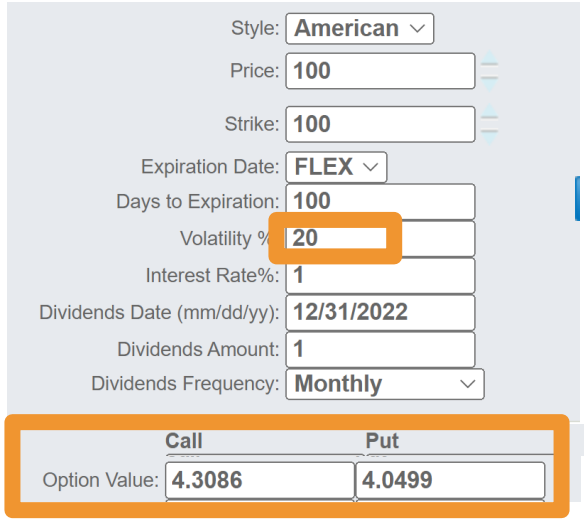
$$C(S_t, t) = N(d_1)S_t - N(d_2)Ke^{-r(T-t)}$$
$$d_1 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)\right]$$
$$d_2 = d_1 - \sigma\sqrt{T-t}$$



Implied Volatility and Option Pricing: Example



Higher IV = Higher Option Price



Source: https://www.optionseducation.org/toolsoptionquotes/optionscalculator

Data Overview

Data	Source
ESG Incident Data	RepRisk
Option Implied Volatility	Optionmetrics
FF Factors	Fama French Website
Stock Data, Fundamental Financial Data, ESG Scores	Refinitiv

RepRisk ESG Data: Multiple Relevant Dimensions

Scope	• S&P 500 Index, including 700 companies since 2007
Number of Events	• Start with 98’000 negative ESG indicents • Use 40’000 events to avoid double counting
Event Characteristics	• Environment, Social, Governance
	• Severity, Reach, Novelty
	• SASB Materiality
	• Country of Incident

2-stage Methodology for Abnormal Returns and Volatility

Stage 1

- **Methods**: time-series regressions for stock returns and implied volatilities
- **Output**: abnormal returns and IVs around ESG incidents

Stage 2

- **Methods**: panel regressions on abnormal returns and IVs
- **Output**: identification of factors that determine the direction and magnitude of the response to ESG incidents

Outlook

- **Methods**: backtests for stock and option strategies
- **Output**: trading strategies with P&L component

Stage 1: Equity Model for Abnormal Returns

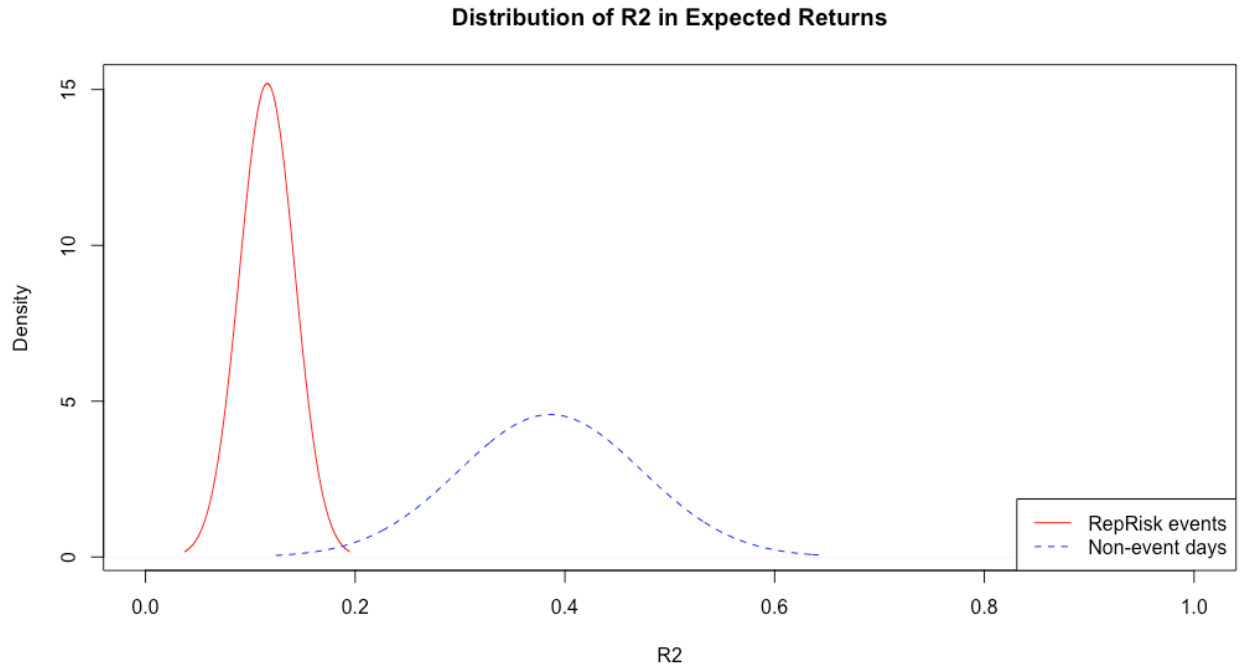
Equity Model We define the residual abnormal returns ($\tilde{r}_{k,t}$) as the logged-difference price returns ($r_{k,t}$) of a stock (k) minus the expected returns at a time (t):

In the Fama-French model, the expected returns are a function of the market rate of return ($R_m - R_f$), a premium for small stocks (SMB), higher returns for value stocks (HML), quality (RMW), and high investment (CMA).

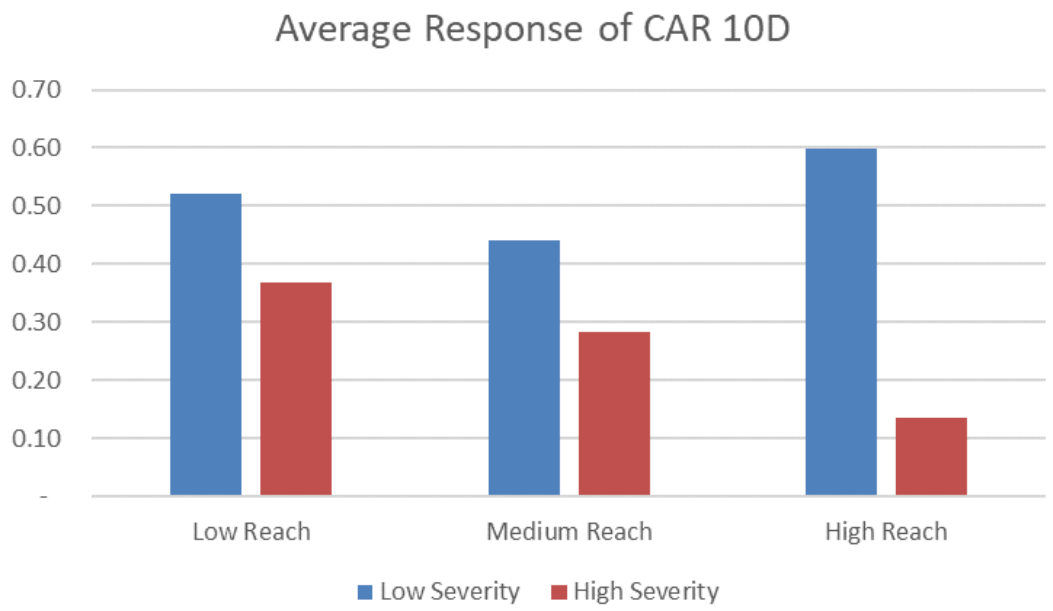
$$\tilde{r}_{k,t} = r_{k,t} - E[r_{k,t}|\Omega_{k,t-1}] \tag{1}$$

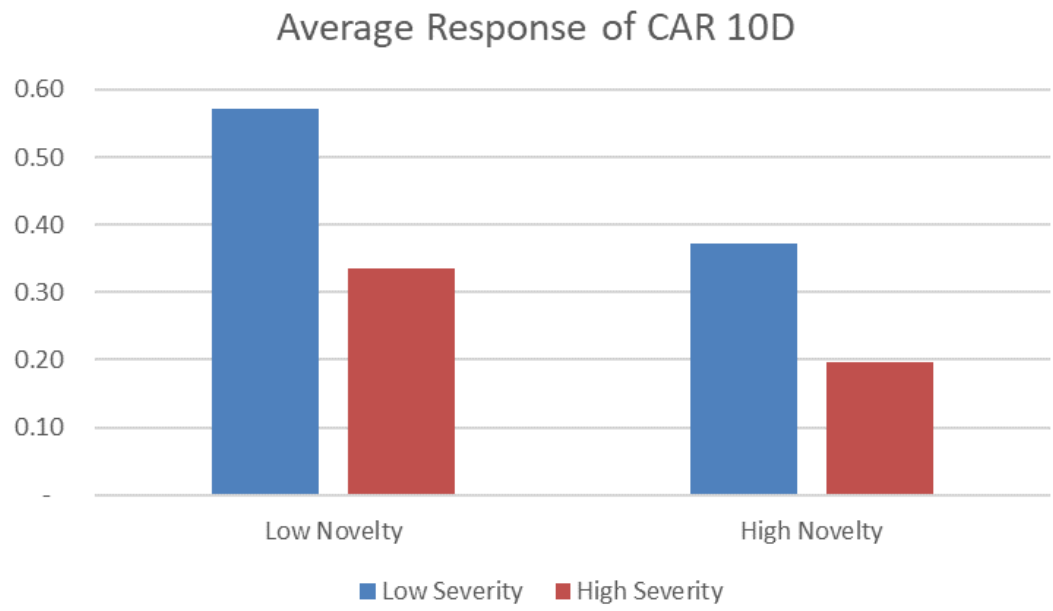
$$\hat{r}_{k,t} = \alpha_{k,t} + \lambda_{k,t} r_{k,t} + \beta_{k,t}(R_m - R_f) + \nu_{k,t}\text{SMB} + \eta_{k,t}\text{HML} + \upsilon_{k,t}\text{RMW} + \kappa_{k,t}\text{CMA} + \rho_{k,t} R_f + \epsilon_{k,t} \tag{2}$$

$$(C)AR_{k,T} = \sum_{t=0}^{T} \tilde{r}_{k,t} \tag{3}$$



Stage 1: Equity Model Selected Results





Stage 1: Volatility Model for Abnormal Implied Volatility

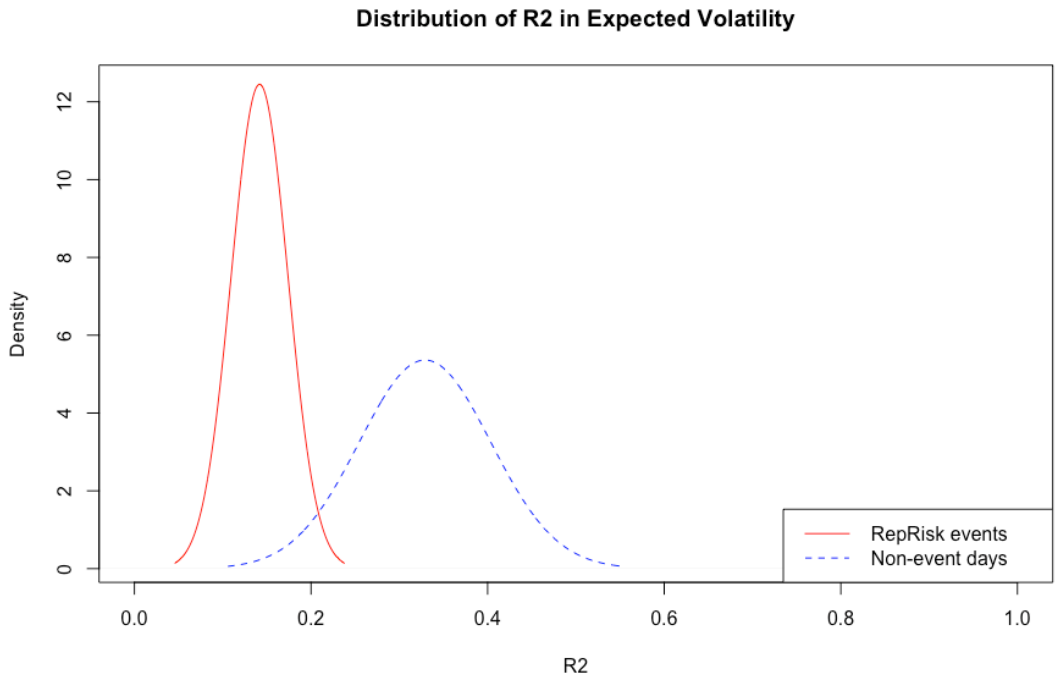
Equation 4 represents the difference between the implied volatility ($IV_{k,t}$) minus the previous period implied volatility ($IV_{k,t-1}$) of the stock (k) at time t.

This difference in IV ($v_{k,t}$) has its own expectation ($E[v_{k,t}|\Psi_t]$), which is conditional on the information set (Ψ) at time t. The abnormal IV ($\tilde{v}_{k,t}$) in excess of our expectations ($\tilde{v}_{k,t} = v_{k,t} - E[v_{k,t}|\Psi_{k,t}]$) forms the basis of our implied volatility analysis.

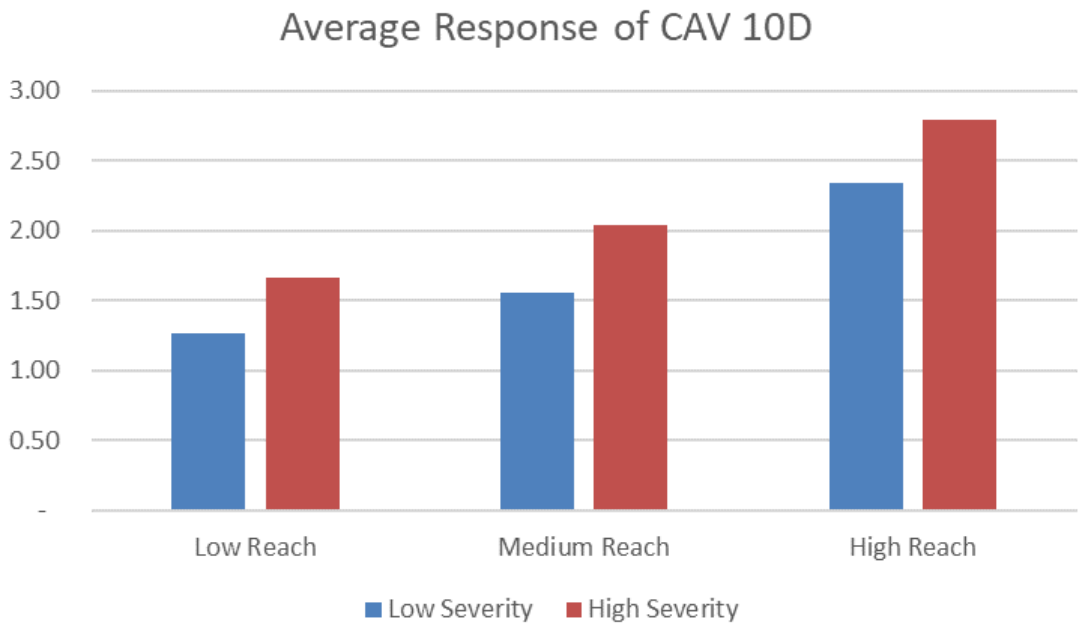
$$v_{k,t} = IV_{k,t} - IV_{k,t:t-1} \tag{4}$$

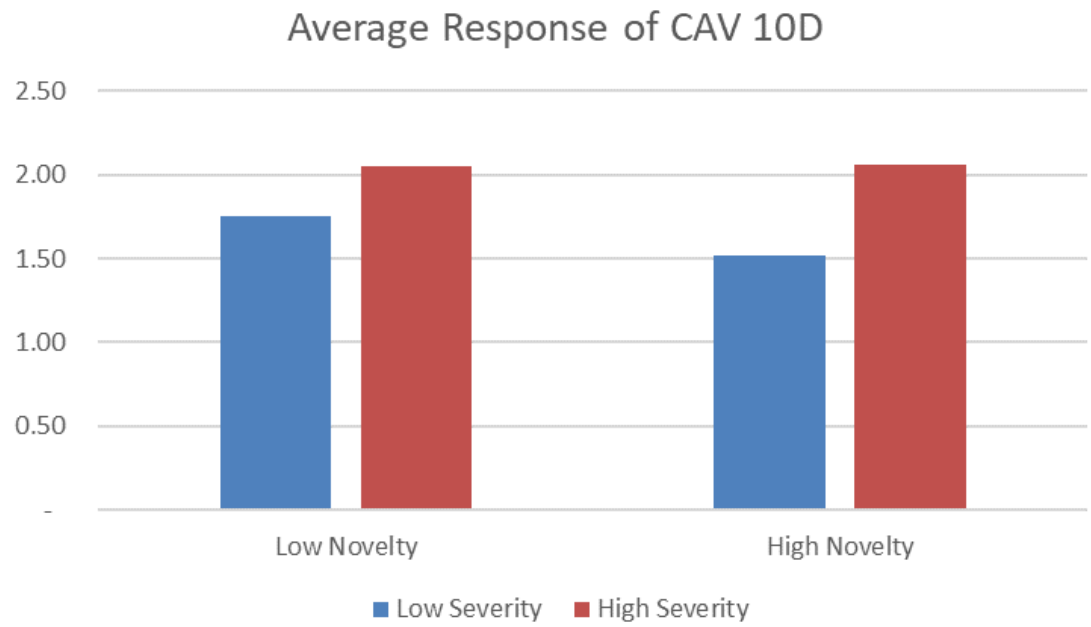
$$\hat{v}_{k,t=0} = \gamma_{k,t} + \sum_{t=-3}^{-1} \omega_{k,t} v_{k,t-1} + \sum_{t=-3}^{0} \zeta_t (\mathrm{VIX}_{k,t} - \mathrm{VIX}_{t-1}) + \epsilon_{k,t} \tag{5}$$

$$(C)AIV_{k,T} = \sum_{t=0}^{T} (\tilde{v}_{k,t}) \tag{6}$$



Stage 1: Volatility Model Results





Stage 2: Determination of Drivers of Abnormal Returns and IV

Objective: determine which event- or company-specific variables affect the CARs and CAIVs

Methods: panel regressions on CAR and CAIV, controlling for industry and time fixed effect, s.e. robust to heteroscedasticity and clustered at the firm level

Research Design:

1. Separate regressions for CAR5, CAR10 as well as CAIV5, CAIV10 as calculated in stage 1
2. Table 1: RR Intensity indicator
3. Table 2: Event severity, novelty, reach
4. Table 3: Financial Materiality
5. Table 4 and 5: Country of incident and disclosure-based ESG score

Controls: Market cap (Ln), Market to Book, RoE, CAPEX_PPE, SG&A / Sales, Earnings Yield

Stage 2: General Setting with RR Intensity indicator

Table 1 Baseline Regression for CARs and CAIVs, including trimmed versions

	(1) car5_excl	(2) car10_excl	(3) cav5_excl	(4) cav10_excl
ESG_score	-0.06	-0.06	1.24***	1.12**
	(0.17)	(0.23)	(0.41)	(0.54)
RR_intensity	-0.03	-0.10**	0.25***	0.36***
	(0.03)	(0.04)	(0.04)	(0.06)
Environment	-0.03	-0.09	0.18*	0.40***
	(0.06)	(0.09)	(0.10)	(0.14)
Social	0.00	-0.04	0.17**	0.21*
	(0.05)	(0.08)	(0.08)	(0.12)
Governance	-0.06	-0.08	0.21**	0.23*
	(0.06)	(0.08)	(0.09)	(0.13)
Market cap (Ln)	0.06**	0.03	-0.03	0.38***
	(0.03)	(0.03)	(0.07)	(0.09)
Market to Book	0.00	0.00*	0.00**	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
RoE	-0.00	0.21*	0.01	-0.24
	(0.08)	(0.11)	(0.16)	(0.22)
CAPEX_PPE	-0.00	-0.00	-0.00	0.01
	(0.00)	(0.00)	(0.01)	(0.01)
SG&A / Sales	0.15	-0.24	-0.34	-0.31
	(0.21)	(0.27)	(0.59)	(0.74)
Earnings Yield	-0.16	-0.90**	-0.82	-0.62
	(0.28)	(0.40)	(0.53)	(0.72)

Event intensity increases the response of IV

Stage 2: Focus on event severity, novelty, reach

Table 2: Trimmed CAR and CAIV for Sub-samples based on different variations of Severity, Reach, Novelty

	CAR5	CAR10	CAIV5	CAIV10	CAR5	CAR10	CAIV5	CAIV10	CAR5	CAR10	CAIV5	CAIV10
						Various Controls						
Severity_high	0.02	-0.08	0.27***	0.49***	0.02	-0.08	0.27***	0.48***	0.02	-0.09	0.28***	0.48***
	(0.05)	(0.08)	(0.08)	(0.12)	(0.05)	(0.08)	(0.08)	(0.12)	(0.05)	(0.08)	(0.08)	(0.12)
Novelty_adj	-0.10*	-0.13*	0.14*	0.36***	-0.10*	-0.13*	0.12	0.34***	-0.10*	-0.14*	0.16*	0.37***
	(0.05)	(0.08)	(0.08)	(0.12)	(0.05)	(0.08)	(0.08)	(0.12)	(0.05)	(0.08)	(0.08)	(0.12)
Reach 1	0.02	0.11	-0.32***	-0.40***								
	(0.05)	(0.08)	(0.08)	(0.11)								
Reach 2					0.03	0.00	-0.01	0.09				
					(0.05)	(0.07)	(0.07)	(0.10)				
Reach 3									-0.07	-0.14	0.41***	0.37***
									(0.06)	(0.09)	(0.09)	(0.13)
R-squared	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
Nb of Observations	34747.00	34576.00	34589.00	34426.00	34747.00	34576.00	34589.00	34426.00	34747.00	34576.00	34589.00	34426.00
Nb of Companies	678.00	677.00	667.00	667.00	678.00	677.00	667.00	667.00	678.00	677.00	667.00	667.00
Wald Test Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Higher Severity, Novelty and Reach imply higher Response in IV

Table 3: Focus on Financial Materiality

Table 3: Trimmed CARs and CAIVS for SASB Material Issues vs. Non-material (full-sample)

	-1 CAR10	-2 CAIV10	-3 CAR10	-4 CAIV10	-5 CAR10	-6 CAIV10	-7 CAR10	-8 CAIV10	-9 CAR10	-10 CAIV10	-11 CAR10	-12 CAIV10	-13 CAR10	-14 CAIV10
						Various Controls								
Social Capital	-0.05 (0.08)	0.05 (0.13)												
Human Capital			0.01 (0.10)	0.09 (0.16)										
Natural Capital					-0.13 (0.10)	0.00 (0.16)								
Leadership Governance							0.11 (0.09)	-0.28* (0.15)						
Bus. Model & Soc. Innovation									-0.03 (0.10)	-0.11 (0.16)				
SASB Material											-0.01 (0.05)	-0.02 (0.08)		
SASB Non-Material													0.01 (0.05)	0.02 (0.08)
R-squared	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
Nb of Observations	34747.00	34589.00	34747.00	34589.00	34747.00	34589.00	34747.00	34589.00	34747.00	34589.00	34747.00	34589.00	34747.00	34589.00
Nb of Companies	678.00	667.00	678.00	667.00	678.00	667.00	678.00	667.00	678.00	667.00	678.00	667.00	678.00	667.00
Wald Test Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SASB Financial Materiality classification loses relevance under presence of intensity indicators

Tables 4 and: Country of incident and ESG Rating

Table 4: Countries using Dummies

	CAR5	CAR10	CAIV5	CAIV10
	Various Controls			
US and Canada	0.04 (0.06)	-0.07 (0.09)	-0.19* (0.10)	-0.19 (0.14)
Advanced Countries	0.05 (0.07)	-0.07 (0.11)	0.00 (0.11)	0.35** (0.17)
Developing Countries	-0.05 (0.06)	-0.17* (0.09)	0.12 (0.10)	0.30** (0.14)
R-squared	0.00	0.00	0.01	0.01
Nb of Observations	34747.00	34576.00	34589.00	34426.00
Nb of Companies	678.00	677.00	667.00	667.00
Wald Test Prob.	0.00	0.00	0.00	0.00

Table 5: Trimmed 5-day CAR and CAIV for Sub-samples of High, Medium and Low ESG Scores

	CAR5	CAR5	CAR5	CAIV5	CAIV5	CAIV5
			Various Controls			
ESG_low	0.02 (0.06)			-0.32** (0.13)		
ESG_med		0.03 (0.06)			0.10 (0.10)	
ESG_high			-0.08 (0.07)			0.18 (0.13)
R-squared	0.00	0.00	0.00	0.01	0.01	0.01
Nb of Observations	34747.00	34747.00	34747.00	34589.00	34589.00	34589.00
Nb of Companies	678.00	678.00	678.00	667.00	667.00	667.00
Wald Test Prob.	0.00	0.00	0.00	0.00	0.00	0.00

Place of the incident and the company's ESG rating remain unconclusive

Conclusions and Outlook

1. Option Implied Volatility increases following ESG Events, for stocks it’s unconclusives
   → Hypothesis: sophisticated investors take ESG seriously!
2. Severity and Reach of the events increase the magnitude of the reaction
3. SASB financial materiality does not matter for stock prices, for now

Outlook:

1. Test the hypothesis on corporate bond spreads for US and Europe
2. Set up backtest environment. Design systematic trading strategies for stocks, options and bonds

Annex

Computing Option Volatilities

Options, especially those out of the money, can be notoriously illiquid; quotes get sparse and are not necessarily updated.

In order to estimate the implied volatility of a stock, we only use ATM quotes within 1 month (30 days), and we define at-the-money (ATM), as those options within 5 deltas of 50. This is done for two reason:

1. We're interested in the relative short-term response to the news event;
2. These options are the most liquid and traded;
3. This selection mirrors the term of our benchmark volatility index, the CBOE VIX.

Data Collection Process: We use the data for individual options from the Optionmetrics dataset for options on stocks from the historical index S&P.