

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).



ESG Challenge

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

Research Challenges

Lack of practical, empirical research on ESG incidents with regard to

- 1. Option pricing and volatility
- 2. Incident characteristics such as severity, reach, novelty or even location



Business Rationale and Research Goal

Hypothesis

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

Questions we want to answer

- 1. How important are these ESG events for asset prices?
- 2. How can investors protect their portfolios against ESG incidents?
- 3. Can investors actively make money from the ESG news by shorting stocks or buying options?

Research Goal

→ Analyse the behavior of Stock Prices and Option Volatilities for 10 days following the ESG event



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.

$$egin{aligned} C(S_t,t) &= N(d_1)S_t - N(d_2)Ke^{-r(T-t)} \ d_1 &= rac{1}{\sigma\sqrt{T-t}}\left[\lnigg(rac{S_t}{K}igg) + igg(r+rac{\sigma^2}{2}igg)\left(T-t
ight)
ight] \ d_2 &= d_1 - \sigma\sqrt{T-t} \end{aligned}$$





Implied Volatility and Option Pricing: Example





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 Data on ESG incidents



Zh School of **AW** Management and Law

RepRisk ESG Data has 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: 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).

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

$$\hat{r}_{k,t} = \alpha_{k,t} + \lambda_{k,t}r_{k,t} + \beta_{k,t}(R_m - R_f) + v_{k,t}SMB$$

+ $\eta_{k,t}HML + v_{k,t}RMW + \kappa_{k,t}CMA + \rho_{k,t}R_f + \epsilon_{k,t}$ (2)

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



Distribution of R2 in Expected Returns



Stage 1: Equity Model Selected Results



0.60 0.50 0.40 0.30 0.20 0.10 Low Novelty High Novelty

Average Response of CAR 10D

■ Low Severity ■ High Severity

Stock reaction is close to zero



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.

$$v_{k,t} = IV_{k,t} - IV_{k,t:t-1}$$
(4)

$$\hat{v}_{k,t=0} = \gamma_{k,t} + \sum_{t=-3}^{-1} \omega_{k,t} v_{k,t-1} + \sum_{t=-3}^{0} \zeta_t (\text{VIX}_{k,t} - \text{VIX}_{t-1}) + \epsilon_k,$$
(5)
(6)

Distribution of R2 in Expected Volatility





Stage 1: Volatility Model Results





Average Response of CAV 10D

Very strong response in 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:

Panel regressions for CAR5, CAR10 as well as CAIV5, CAIV10 as calculated in stage 1

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



RepRisk Intensity Indicator

Table I Baseline R	egression for C	JAKS and CAL	vs, including	<u>g trimmed ver</u>
	(1)	(2)	(3)	(4)
	car5_excl	car10_excl	cav5_excl	cav10_ex
				cl
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
U U	(0.28)	(0.40)	(0.53)	(0.72)
n 1	<u>`</u> ^ ^^	<u>`</u> ^ ^^	<u>`</u> ^ ^1	<u>^ ^1</u>

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

Event intensity increases the response of IV

Event severity, novelty, reach

1 0 1 11 1 0

11.00

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Table 2: Trimmed CAR and CAIV	for Sub-samp	oles based on	different var	riations of Se	everity, Reac	h, Novelty						
	CAR5	CAR10	CAIV5	CAIV10	CAR5	CAR10	CAIV5	CAIV10	CAR5	CAR10	CAIV5	CAIV10
Various Controls												
Severity_high	0.02 (0.05)	-0.08 (0.08)	0.27*** (0.08)	0.49*** (0.12)	0.02 (0.05)	-0.08 (0.08)	0.27*** (0.08)	0.48*** (0.12)	0.02 (0.05)	-0.09 (0.08)	0.28*** (0.08)	0.48*** (0.12)
Novelty_adj	-0.10* (0.05)	-0.13* (0.08)	0.14* (0.08)	0.36*** (0.12)	-0.10* (0.05)	-0.13* (0.08)	0.12 (0.08)	0.34*** (0.12)	-0.10* (0.05)	-0.14* (0.08)	0.16* (0.08)	0.37*** (0.12)
Reach 1	0.02 (0.05)	0.11 (0.08)	-0.32*** (0.08)	-0.40*** (0.11)								
Reach 2					0.03 (0.05)	0.00 (0.07)	-0.01 (0.07)	0.09 (0.10)				
Reach 3									-0.07 (0.06)	-0.14 (0.09)	0.41*** (0.09)	0.37*** (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

0.0

Higher Severity, Novelty and Reach imply higher Response in IV

Table 3: Trimmed CARs and CAIVS for SASB Material Issues vs. Non-material (full-sample)														
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14
	CAR10	CAIV10	CAR10	CAIV10	CAR10	CAIV10	CAR10	CAIV10	CAR10	CAIV10	CAR10	CAIV10	CAR10	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	34747.0 0	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

Table 4: Countries using	Dummies								
	CAR5	CAR10	CAIV5	CAIV10					
Various Controls									
US and Canada	0.04	-0.07	-0.19*	-0.19					
US and Canada	(0.06)	(0.09)	(0.10)	(0.14)					
	0.05	-0.07	0.00	0.35**					
Advanced Countries	(0.07)	(0.11)	(0.11)	(0.17)					
Developing Countries	-0.05	-0.17*	0.12	0.30**					
Developing Countries	(0.06)	(0.09)	(0.10)	(0.14)					
R-squared	0.00	0.00	0.01	0.01					
Nb of Observations	34747.0 0	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			-0.32**							
	(0.06)			(0.13)							
ESG_med		0.03			0.10						
		(0.06)			(0.10)						
ESC high			-0.08			0.18					
ESO_IIIgII			(0.07)			(0.13)					
R-squared	0.00	0.00	0.00	0.01	0.01	0.01					
Nb of Observations	34747.0 0	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



- 1. Option Implied Volatility increases following ESG Events
- \rightarrow Hypothesis: sophisticated investors take ESG seriously!
- 2. Severity and Reach of the events increase the magnitude of the reaction

Outlook:

- 1. Test the hypothesis on corporate bond spreads for US and Europe
- 2. Set up backtests, design systematic trading strategies for stocks, options and bonds







Annex



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.

