The Financial Spillovers of the Gulf of Mexico Oil Accident

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Abstract
The paper examines the effects of the April 20, 2010, Deepwater Horizon oil spill in the Gulf of Mexico on the stock value of the firms involved in the Oil and Gas industry. Market evidence reported herein reveals that as the oil pollution expanded in the Gulf of Mexico over the five months it took to seal the leak, there were significant cumulative abnormal returns both for the BP stock price as well as the rest of the Oil and Gas sector. Furthermore, the reported findings also reveal noteworthy differences in how the NYSE and the LSE listed companies and stocks were affected by the event. Differences that can tentatively be attributed to the direct environmental impact the accident had on IS shares. Hence, the greater and more persistent media attention on the catastrophic environmental effects, has probable affected not only public opinion but also investors' sentiment.

Keywords: oil, pollution, capital markets, contagion, volatility, event study

JEL Classifications: G14, Q54

Introduction

The Deepwater Horizon accident in the Gulf of Mexico is considered to be the world's largest accidental discharge of oil with unprecedented environmental repercussions for the wider region. Approximately 4.300.000 barrels of crude oil leaked in the Gulf of Mexico during the course of this catastrophic event from April 21 to September 19, 2010. According to the third quarter nine months 2010 group results, the accident cost $39.9 billions. They were spent for underwater and surface operations, the claims process, the escrow account and the restoration of the area that suffered a grave environmental blow with long lasting effects with the regional ecosystem probably requiring decades to fully recover.

As many studies have shown, apart from the loss of life, the massive and multidimensional environmental costs, catastrophic events of such magnitude have a direct impact on markets since from their perspective they represent unanticipated external shocks that can affect investor

sentiment, asset valuation and portfolio allocation (inter allia: Kaplanski, 2010; Capelle-Blancard and Laguna, 2009; Bosch et al.1998; Blose et al.1996; Hamilton, 1995). Such events become the focus of intense and negative media coverage with the concomitant widespread public attention, generate a lot of negative sentiment and can thus exert a lot of pressure on the market value of the companies involved. However, such events have a high contagion potential. Their effects are often not limited to the firm involved in the accident but they spillover to others that operate in the same industry, thus putting under strain the whole sector. This study sets out to examine the financial impact the oil spill had on both BP as well as other firms involved in the Oil and Gas industry. To this effect a GARCH model is used to examine the impact on time varying volatility and an event study analysis on conditional volatility is employed to assess the impact of important developments and key dates as the incident unfolded. The paper is structured as follows. The next section is a brief literature review of previous studies that have addressed the financial impact of unexpected catastrophic events. The data used and the methodologies employed are presented in section three. Then, in section four, the results of the estimations are presented and discussed while section five concludes the paper.

Catastrophic Events Literature: A Brief Survey

From the markets' perspective, major unexpected events represent external shocks that can directly affect market risk premium and investors' sentiment highly increasing volatility and thus exert an adverse impact on asset valuation, investment decisions and portfolio allocation. Investors and market agents can hedge against expected events but not so when it comes to unanticipated ones. Although the probability of natural catastrophes, industrial disasters such as nuclear and chemical accidents, aviation accidents even terrorist attacks; is omnipresent, they can nevertheless shake and unsettle markets. Their net impact on markets depends upon a cohort of factors such as their severity and duration. A number of studies have turned their attention to the effects major catastrophic events had on markets and in particular major industrial and technological accidents with a heavy toll on life and grave environmental consequences.

Early studies have focused on the effects of the nuclear accidents at Three Mile Island and Chernobyl (Fields and Janjigian, 1989; Chen, 1984; Bowen *et al*. 1983; Hill and Schneeweis, 1983; Kalra et el. 1993). In particular, Fields and Janjigian (1989) examined the impact of the Chernobyl nuclear accident on US electric utility stock prices and found that it caused significant abnormal returns especially for nuclear firms. The Three Mile Island nuclear accident was the subject of the papers by Hill and Schneeweis (1983), Bowen *et al*. (1983) and Chen (1984). Significant stock losses albeit transitory were the findings reported. The impact of the Bhopal chemical disaster on the returns of Union Carbide as well as other chemical producers was the issue addressed by Karla *et al*. (1995) with findings pointing to significant but small, in terms of economic impact, contagion effects. Chemical disasters are also the theme of a study by Capelle-Blancard and Laguna (2009). Using event study and multivariate analysis they examine 64 explosions in chemical plants and refineries. They report an average drop in market value of around 1.3% over the two days after the event occurred. The actual size of the losses incurred depended upon severity of the event, the number of casualties as well as the environmental impact of the accident.

Worth noting, since it is related to the event examined here, is that the environmental dimension has been identified as a factor that influences the market performance of a stock. Hamilton (1993), using data released by the Environmental Protection Agency, identifies an inverse relationship between bad environmental performance, such as air emissions, and stock behaviour. Results reported therein, indicated that stockholders experienced negative and statistical significant abnormal returns. Lundgren *et al*. (2010) in an event study of 142 environmental incidents concluded that the events were associated with loss of firm value while noteworthy differences between U.S. and European investors' reactions are also reported with the former emerging as more insensitive to environmental incidents. Colwell *et al*. (2009) investigate whether a firm's market capitalization influences the effect of negative environmental events on the firm's abnormal returns using as a sample ten oil and gas companies from the 2006 Fortune-500 list and their negative environmental events listed in the U.S. Environmental Protection Agency's database for the period from 1990 to 2006. The reported findings suggest that the market does not penalize all firms for their negative environmental behaviour.

Other studies have focused on catastrophic events with no particular environmental impact but either with significant loss of life or with strong symbolism embedded in them. For instance, Kaplanski and Levy (2010), examining the financial effects of aviation disasters, find that they cause a significant negative effect on stock prices and that they are also accompanied by an increase in the perceived risk with implied volatility increasing. Air crashes are also the theme of Bosch *et al*. (1998) who focus their analysis on whether respond to such events either by flying less or by switching to other airlines than the one involved in the accident. Their evidence suggests both switching behaviour as well as negative spillover effects for the industry. Finally, in the case of the Space Shuttle Challenger disaster, Blose *et al*. (1996) find that the stocks of NASA contractors exhibited significant negative abnormal returns on the day of the accident.

Data Description and Methodology

For the purposes of our analysis, that also addresses the contagion dimension of the disaster in question, it was decided to include other companies in the oil and gas industry apart from the one directly involved. Thus, along with the double listed BP stock, Gazprom and Shell were selected from the London Stock Exchange and Petrobras and Exxon from the New York Stock Exchange. They were chosen on the basis of their market capitalization, along with the FTSE Oil and Gas Index and the NYSE Energy Index. Our sample covers the period from 10/06/2009 to 18/11/2010 and includes 384 trading days. The first step in our methodology is to analyse the stock returns' reaction to a series of important news released and related to the oil spill. In the second step an event study analysis will be applied on conditional volatilities. A general asset pricing model equation is extended with the inclusion of dummy variables for the key dates that characterised the course of the event as it unfolded. The dates are as follows:

- 21/04/2010: Official announcement for the incident
- 29/04/2010: US Coast Guard designates BP as the responsible party

- 31/05/2010: BP announced that top kill had not stopped the flow of oil
- 10/06/2010: BP says it is not aware of any reason which justifies this share price movement
- 16/06/2010: BP cancels dividend payment and committed a $20bn claims fund

In order to estimate the conditional volatility of stock returns the GARCH modeling technique by Bollerslev (1986) that extends the ARCH framework introduced by Engle (1982) is employed. Specifically the following equations are used to estimate mean return and variance for a set of the oil stocks in question:

$$R_t = c_0 + c_1 RM_t + c_2 FX_t + \sum_{j=1}^{5} c_3 D1_{i,t} + \sum_{j=1}^{4} c_{4,j} D2_{j,t} + c_5 R_{t-1} + \varepsilon_t \,,\ \varepsilon_t \sim N(0, h_t) \quad (1)$$

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (2)$$

where R_t is the daily return for the stock, RM_t is the daily market return used (FTSE100 in LSE and DJIA in NYSE), FX_t is the daily exchange rate of USD and GBP which includes the exchange rate risk in our model, $D1_{i,t}$ is a dummy variable which takes the value of 1 for the event day (i) (i=1 – 21/04/2010, i=2 – 29/04/2010, … i=5 – 16/06/2010), $D2_{j,t}$ is a dummy variable for the days of the week (j=1 – Monday, …,j=4 – Thursday) and ε_t is the error term with conditional mean zero and conditional variance h_t. Volatility is modeled by using a simple GARCH(1,1) model. Using the results from GARCH model and applying an event study methodology (MacKinlay, 1997), we can then measure the abnormal price of conditional volatility for stock or index j as follows:

$$ACV_{jt} = CV_{jt} - \overline{CV_j} \quad (3)$$

where ACV_{jt} is the abnormal price of conditional volatility for stock or index *j* at time *t*, CV_{jt} is the calculated conditional volatility, and $\overline{CVj}$ is the mean of stock or index *j's* daily conditional volatility in the (-50,-1) estimation period. $\overline{CVj}$ is computed as follows:

$$\overline{CVj} = \frac{1}{50} \sum_{t=-50}^{-1} CV_{jt} \quad (4)$$

The analysis also includes a cumulative abnormal volatility (CAV) 3 days following the event (*t=3*) which is estimated as follows:

$$CACV_j = \sum_{t=0}^{2} ACV_{jt} \quad (5)$$

Empirical Findings

In this section we present and discuss the results of the methodologies employed to assess the financial impact of the Deepwater Horizon oil spill. In order to model time varying volatility, equations (1) and (2) are estimated jointly. In Tables 1&2 the results from the GARCH (1,1) model with the dummy variables for the most important dates are reported for LSE and NYSE respectively. Looking at the coefficients of the dummies, all the dates except from 21/04/2010 (i.e. the date of the official announcement of the incident) have a negative effect on the daily stock return for BP in both stock exchanges. This finding for the aforementioned date can tentatively be interpreted as indicating that the severity of the event was not immediately assessed by market agents and hence no particular reaction is recorded for BP's shares listed either in LSE (Table 1) or NYSE (Table 2). This, however, ceases to be the case once the US Coast Guard designates BP as the responsible party on 29/04/2010. The reaction of in both markets is strongly negative once responsibility is officially assigned to BP. This effect can also be visually inspected in Figure 1 where the evolution of stock prices during the period of the event is shown.

Table 1: Estimation results for the LSE listed stocks

	BP		Shell		Gazprom		Oil Sector	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Mean Equation								
constant	5.42E-04	(0.65)	2.94E-05	(0.97)	-3.22E-04	(0.87)	6.14E-04	(0.40)
R^{Index}	0.9407	(0.00)***	0.9923	(0.00)***	1.1745	(0.00)***	1.0184	(0.00)***
FX	0.1869	(0.11)	0.2910	(0.00)***	-0.4630	(0.00)***	0.1611	(0.00)***
D1_2104	-0.0030	(0.45)	0.0073	(0.31)	-0.0053	(0.15)	-0.0025	(0.24)
D2_2904	-0.0684	(0.00)***	-0.0074	(0.00)***	-0.0012	(0.68)	-0.0290	(0.00)***
D3_3105	-0.1373	(0.00)***	0.0021	(0.14)	-0.0303	(0.00)***	-0.0380	(0.00)***
D4_1006	-0.0702	(0.00)***	-0.0117	(0.00)***	-0.0100	(0.00)***	-0.0427	(0.00)***
D5_1606	-0.0221	(0.00)***	0.0151	(0.00)***	0.0021	(0.38)	0.0048	(0.00)***
D^M	-0.0007	(0.70)	0.0002	(0.84)	-0.0008	(0.78)	-0.0009	(0.38)
D^T	-0.0002	(0.91)	0.0015	(0.23)	-0.0018	(0.50)	0.0002	(0.87)
D^W	-0.0011	(0.62)	-0.0017	(0.19)	0.0002	(0.95)	-0.0014	(0.20)
D^{TH}	-0.0012	(0.48)	-0.0007	(0.58)	0.0013	(0.66)	-0.0011	(0.31)
R_{t-1}	-0.0777	(0.09)*	-3.11E-05	(0.99)	0.0109	(0.79)	-0.0458	(0.15)
Variance Equation								
constant	8.22E-06	(0.17)	4.83E-06	(0.21)	7.63E-06	(0.04)	1.39E-05	(0.06)
e_{t-1}^2	0.1099	(0.03)**	0.1326	(0.04)**	0.0696	(0.04)**	0.1681	(0.07)*
h_{t-1}	0.8513	(0.00)***	0.8037	(0.00)***	0.9080	(0.00)***	0.5772	(0.00)***
Adjusted R-squared	0.36		0.69		0.50		0.73	
Log likelihood	1115.65		1271.347		956.4642		1347.765	
Prob(F-statistic)	(0.00)***		(0.00)***		(0.00)***		(0.00)***	
Durbin Watson Stat	1.87		2.15		2.18		2.04	

Notes: ***,**,* asterisks indicate statistical significance at 1%,5% and 10% level of significance respectively.

Table 2 Estimation results for the NYSE listed stocks

	BP		Exxon		PetroBras		Energy Sector	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Mean Equation								
constant	2.990E-06	(0.99)	-1.314E-03	(0.04)**	1.683E-03	(0.33)	-4.760E-05	(0.94)
R^{Index}	0.9660	(0.00)***	0.9427	(0.00)***	1.4245	(0.00)***	1.2494	(0.00)***
FX	-0.6842	(0.00)***	0.0046	(0.93)	-0.5189	(0.00)***	-0.2843	(0.00)***
D1_2104	0.0094	(0.53)	-0.0030	(0.08)*	-0.0057	(0.75)	-0.0037	(0.00)***
D2_2904	-0.1276	(0.00)***	-0.0175	(0.00)***	-0.0240	(0.00)***	-0.0201	(0.00)***
D3_3105	-0.1866	(0.00)***	-0.0097	(0.00)***	0.0138	(0.90)	-0.0315	(0.00)***
D4_1006	0.0929	(0.00)***	0.0058	(0.00)***	-0.0147	(0.97)	0.0119	(0.00)***
D5_1606	0.0136	(0.00)***	0.0004	(0.68)	0.0170	(0.90)	0.0012	(0.23)
D^{M}	-0.0002	(0.92)	0.0016	(0.13)	-0.0052	(0.03)**	-0.0005	(0.57)
D^{T}	-0.0003	(0.87)	0.0019	(0.04)**	-0.0027	(0.25)	0.0009	(0.33)
D^{W}	-0.0012	(0.48)	0.0003	(0.74)	-0.0043	(0.06)*	-0.0012	(0.26)
D^{TH}	-0.0010	(0.51)	0.0007	(0.48)	-0.0025	(0.30)	-0.0001	(0.95)
R_{t-1}	0.0388	(0.24)	0.0112	(0.69)	0.0100	(0.78)	0.0094	(0.65)
Variance Equation								
constant	1.210E-05	(0.16)	1.050E-05	(0.25)	3.030E-05	(0.08)*	2.200E-06	(0.06)*
e_{t-1}^{2}	0.2356	(0.09)*	0.0857	(0.12)	0.0471	(0.16)	0.0974	(0.07)*
h_{t-1}	0.7356	(0.00)***	0.6588	(0.01)**	0.8036	(0.00)***	0.8499	(0.00)***
Adjusted R-squared	0.36		0.69		0.50		0.73	
Log likelihood	1105.37		1392.99		1075.83		1373.04	
Prob(F-statistic)	(0.00)***		(0.00)***		(0.00)***		(0.00)***	
Durbin Watson Stat	1.99		1.87		1.95		2.30	

Notes: ***,**,* asterisks indicate statistical significance at 1%,5% and 10% level of significance respectively.

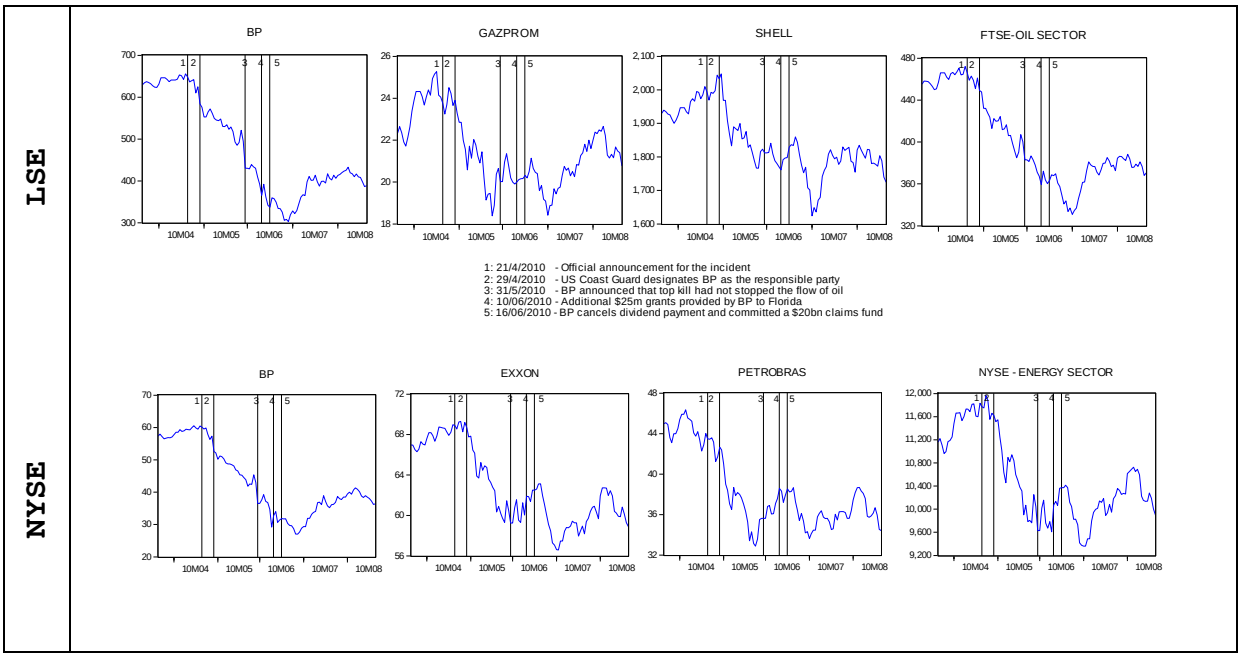

Figure 1: The stock prices reaction to news in the period of the event

As one would expect, the oil energy indices both in LSE and NYSE are also heavily affected by the impact on BP's share. The 31/5/2010 BP announced that operation Top Kill did succeed in stopping the oil leak, also brings about significant negative pressures on BP's stock prices. Generally speaking other stocks in the two oil sectors are also negatively affected but not as extensively as BP´s shares. This result suggests the absence of significant benefits through

diversification across stocks within the oil sectors. Perhaps interesting to observe is the difference of the reaction found in BP's stock returns between NYSE & LSE, on 10/6/2010 and 16/6/2010 (Tables 1&2). It would appear that in the case of NYSE market agents discounted more quickly the stabilization of BP price compared to investors in LSE. Examining stock returns in the reported results is also worth pointing out the absence of any substitution effect among oil stocks. Finally, to conclude this part of the empirical analysis, the evolution of conditional volatilities estimated by the GARCH(1,1) models are presented graphically in Figure 2. As it can easily be observed, the impact on volatility is more pronounced and persistent in the case of BP. However, the volatilities of Exxon and Shell returns also seem to be affected albeit by a smaller degree.

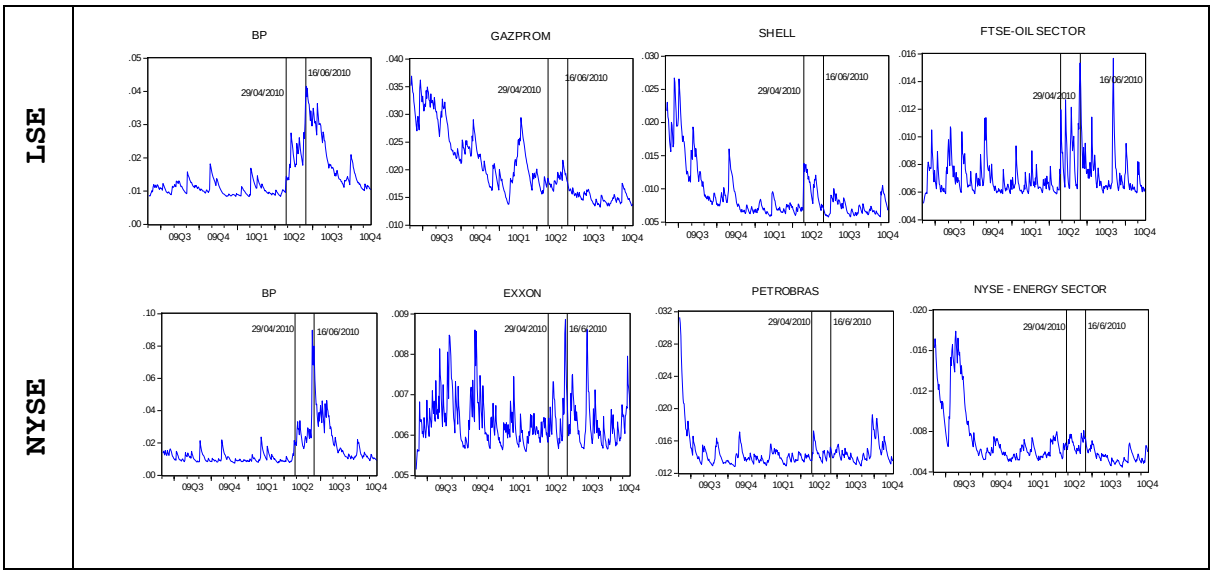

Figure 2: The conditional volatility reaction to news in the period of the event

We now turn to the discussion of the event study findings that examine the effects on volatility for each one of the five key dates mentioned earlier. The results are presented in Table 3, where the abnormal conditional volatility and statistical significance levels for the zero and three-day event window are shown. As it can be seen, the volatility has increased almost in all cases and there is sufficient evidence showing that the whole oil sector was heavily affected in both stock exchanges. The picture for the third firms is hazy and inconsistent but some inferences may be attempted. Shell, Exxon and Petrobras exhibit positive and statistical significant 3day-CCVs on 29/04 - the day that BP blamed officially. The date with the highest CV for BP/LSE is 16/06 when the dividend payment was cancelled and for BP/NY is 10/06 when BP stated that is not aware of any reason which justifies the price share movements of the previous days. Furthermore, the continuously increasing conditional volatility may be reflecting market agents' worries over BP's inability to control the oil leak and end the damage. Finally, as a broad observation on all the results reported in this section, it also appears that the volatility effect is generally more uniform across firms and markets vis-à-vis the effect on returns. However, a worth mentioning result is the significant drop in cumulative abnormal volatility for Gazprom and

Shell in LSE. This latter finding may be suggesting the presence of some diversification benefits in the market for derivatives.

Table 3: Average Abnormal Conditional Volatility during the Oil Spill

Deepwater Horizon Oil Spill Even Study on Volatility									
		London Stock Exchange				New York Stock Exchange			
Dates		**BP**	**FTSE_Oil**	**Gazprom**	**Shell**	**BP**	**NY_Energy**	**Exxon**	**Petrobras**
21April 2010	CV	0,01% (+0,023)	-0,02% (-0,126)	-0,21% (-1,88)	-0,03% (-0,11)	-0,06% (-0,07)	0,07% (+1,04)	0,04% (+1,06)	0,06% (+0,66)
	CCV-3d	-0,08% (-0,14)	-0,14% (-0,87)	-1,18% (-10,63)*	-0,12% (-0,46)	0,68% (+0,82)	0,17% (+2,55)	0,05% (+1,42)	0,07% (+0,78)
29 April 2010	CV	0,43% (+0,62)	0,54% (+1,76)	-0,17% (-0,26)	0,68% (+1,68)	0,89% (+1,12)	0,04% (+0,91)	0,03% (+0,44)	-0,02% (-0,26)
	CCV-3d	1,49% (+2,16)*	1,31% (+4,30)*	-0,91% (-1,48)	2,51% (+6,27)*	4,44% (+5,63)*	0,16% (+2,67)*	0,10% (+2,44)*	0,45% (+5,04)*
31 May 2010	CV	1,23% (+1,54)	0,25% (+1,12)	0,16% (+1,11)	0,13% (+0,52)	1,32% (+0,71)	-0,03% (-0,46)	0,00% (+0,04)	0,06% (+0,67)
	CCV-3d	3,92% (+4,93)*	0,28% (+1,25)	0,67% (+4,64)*	0,08% (+0,34)	4,21% (+2,28)*	-0,14% (-2,25)*	-0,08% (-1,06)	-0,01% (-0,07)
10 June 2010	CV	1,18% (+1,63)	0,33% (+1,54)	0,14% (+0,80)	-0,14% (-0,77)	7,06% (+3,89)*	0,15% (+2,55)*	0,26% (+3,66)*	0,03% (+0,51)
	CCV-3d	5,89% (+8,16)*	1,98% (+9,29)*	0,17% (+1,01)	-0,69% (-3,76)*	23,83% (+13,15)*	0,38% (+6,59)*	0,58% (+8,25)*	0,08% (+1,51)
16 June 2010	CV	2,40% (+3,38)*	0,53% (+2,48)*	-0,08% (-0,46)	-0,24% (-1,33)	4,39% (+2,49)*	0,03% (+0,50)	0,01% (+0,15)	0,06% (+1,06)
	CCV-3d	8,89% (+12,50)*	1,09% (+5,04)*	-0,56% (-3,13)*	-1,11% (-6,31)*	12,31% (+6,99)*	-0,07% (-1,05)	-0,07% (-0,93)	0,02% (+0,42)

Concluding Remarks

This paper set out to examine how the Deepwater Horizon accident, considered to be the world's largest accidental discharge of oil into marine waters affected the stock prices of both the company directly involved as well as of other oil companies and sectoral indices in the London and New York stock exchanges. As expected, the empirical findings reported herein indicate a strong negative impact as the event unfolded over the course of the months and as the pollution expanded in the Gulf of Mexico that brought about strong and stringent demands by the US authorities for immediate actions from the company involved to respond in a effective manner to the growing environmental pollution. The analysis revealed noteworthy differences in how the NYSE and the LSE listed companies and stocks were affected and in particular BP shares. Tentative arguments that could be advanced to partly explain this difference are as follows. Given that this catastrophic event directly affected US shares, it attracted greater and more persistent media attention and assessment of the medium and long-term detrimental environmental effects of the oil spill as well as its consequences on the local economies of the areas affected. This media focus that brought to the forth the multidimensional adverse impact of the oil spill, negatively impacted not only US public opinion in general, increasing its environmental sensitivity, but also investors' sentiment and hence the energy sector. To this, one may

also add the fact that the US government was seen to take more firm public stance in relation to the accident and its environmental repercussions whereas the British government appeared to be more placid in its treatment of BP. The comparatively more stringent and even hard-handed stance of the US administration vis-à-vis the company involved and the demands for affirmative actions by BP to deal with the catastrophic consequences of the spill, could have also affected market sentiment and performance in NYSE compared to LSE where a "*rally around the flag*" factor may have also operated. Finally, risk perception implied by conditional volatilities seems to be more uniform across markets and firms compared to stock return reactions.

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