

Total Cost of the 2010 Deepwater Horizon Oil Spill Reflected in US Stock Market

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Based on a market-based measure, the change (or loss) in market capitalization, this study documented that the total cost of the 2010 Deepwater Horizon oil spill was estimated to be approximately \$251.9 billion as of September 19, 2010 when the well was permanently sealed (or \$562.0 billion at the worst). It consists of: \$68.2 billion to BP at the end (or \$98.9 billion, the worst); \$23.8 billion to eight partners (or \$64.6 billion, the worst); and \$183.7 billion to other firms in the oil and gas industry at the end (or \$463.1 billion, the worst).

THE 2010 DEEPWATER HORIZON OIL SPILL

The blowout on April 20, 2010, and the subsequent explosion of BP Exploration and Production Inc. (BP hereafter) leased mobile offshore drilling unit Deepwater Horizon, located in the Macondo Well, led to the death of 11 rig workers and spillage of tens of thousands of barrels of oil per day into the Gulf of Mexico for the next five months. BP, as the owner of the oil well and lessee of the oil rig, made various attempts to stop and contain the oil spill, and clean the affected areas along the Gulf of Mexico. On September 19, 2010, when the well was declared permanently sealed, a total of 4.9 million barrels of oils had been released to the Gulf of Mexico.

As a natural consequence, the disaster resulted in a huge financial loss to BP. BP spent \$13.6 billion on oil spill response efforts according to its 2010 annual report. Also, a \$20.0 billion Disaster Relief Fund was set up to compensate victims of the Deepwater Horizon oil spill; in 2010, BP paid \$7.3 billion out of this fund. Thus, the 2010 Gulf of Mexico disaster became the largest and worst disaster in the United States offshore drilling history. As a reference, prior to the Deepwater Horizon oil spill, the most disastrous oil spill that occurred in the US was the 1989 Exxon Valdez oil spill. However, the 1989 Exxon Valdez oil spill was not comparable to the 2010 BP oil spill in terms of the amount of oil spilled and the damage to the environment. The amount of crude oil spilled in 1989 to the Sea of Alaska was estimated to be 250 thousand barrels, which is only 5 % of BP's oil spill of 4.9 million barrels, and the total cost of oil spill bore by Exxon corporation was estimated to be \$3 billion, including 2 billion clean-up costs and 1 billion settlement with the US and Alaskan government agreed to in 1991, which is also only 5% of BP's total cost of \$60 billion (see Patten and Nance, 1998).

Determining the party responsible for the accident was probably the most widely discussed topic of the 2010 Gulf of Mexico disaster from day one. The issue has serious financial consequences not only to

BP but also to other related parties who are both directly and indirectly associated with the operation of the Deepwater Horizon. As documented in its accident report, BP viewed that decisions made by multiple companies and work teams contributed to the disaster, and therefore is not the only party responsible for the failure in the oil well operation and its cost. Considering the fact that BP already billed other co-owners of the well \$4 billion for the fair share of the total cost of oil spill, fierce battles among the responsible parties are expected to occur in the next several years on who should share what portion of the total cost of the oil spill. The complex legal and regulatory framework in relation to the liabilities and responsive funding of the responsible parties will ultimately play a key role to determine who should share what portion of the costs of oil spill (GAO 2011). Although it has been a year and a half since the accident occurred, the total cost of massive oil spill following the Deepwater Horizon explosion is not known yet. It provides an impetus of this study.

The primary objective of this article is to approximate the costs of oil spill to BP and its working partners in the operation of the oil rig based on an alternative measure, the change (or loss) in market capitalization. How the stock market responds to the information disclosed by a firm in the valuation of the securities has widely been investigated in the accounting and finance literature. Based on empirical findings on the semi-strong form of market efficiency in the US stock market, a great number of studies have documented the value relevance of the significant corporate events, including catastrophic accidents. They include: nuclear accident at the Three Mile Island (Bowen et al, 1983; Hill and Schneeweis, 1983), chemical leak at Union Carbide's Bhopal (Blacconiere and Patten, 1994), and Exxon Valdez oil spill in Alaska (Patten and Nance, 1998). Consistent with the extant literature, this study viewed that the changes (or loss) in market capitalization of BP and its partners reflect the market's assessment of the changes in firms' value after the oil spill.

The secondary objective of this article is to determine the cost effects of the 2010 Deepwater Horizon oil spill to other firms in the oil and gas industry. As reported in BP's own accident report, the BP oil spill involves multiple parties; everyone involved in the operation of the well appear to be responsible in part for the tragic accident to a certain degree. BP is not the only party who suffered from the disaster. Many other firms, either directly or indirectly associated with the oil well operation, also suffered from the disaster. In the accident report released on August 1, 2010, BP acknowledged that the accident is a joint failure of a complex and interlinked series of mechanical failures, human judgments, engineering design, operational implementation and team interfaces. Therefore, in order to determine the differential effects of oil spill to the industry, the results on the stock price movements of the six sub-categories of oil and gas industries are compared and contrasted in this article.

METHODOLOGY

Based on the literature from capital market research, it is posited in this study that all these value-relevant information have been incorporated in the revision process of the firm's market value. This study first surveyed the news items on the Deepwater Horizon oil spill that were released over the five-month period between April 20, 2010 and September 19. TABLE 1 shows the summary of news articles on the oil spill, where the news items are classified into three categories: the development of the oil spill such as the attempts to curve the oil spill and to contain spilled oil in Panel A; the ban on offshore drilling and the changes in regulation in Panel B; and the cost of oil spill related to the changes in estimates of the flow of the oil spill and the estimated damages to the coastline and environments in Panel C.

Sample

This study estimates the costs of the oil spill incurred by BP, BP's working partners, and all other firms in the value chain of the oil and gas industry. Thus, the sample of this study consists of: 1) BP as an operator of the leased Deepwater Horizon oil rig and the owner (65%) of the Macondo Oil Well; 2) the eight operating partners of BP in the oil well operation; and 3) a total of 383 firms in the six sub-categories of the oil and gas industry.

BP Exploration and Production Inc. (BP)

BP Exploration and Production Inc. as an operator of the Deepwater Horizon oil rig leased from Transocean, is the primary sample of this study. BP also is a majority co-owner of the Macondo Oil Well. While BP owns 65% of the Macondo Well in the Gulf of Mexico, the remainder was owned by Anadako (25%) and by Mitsubishi Oil Exploration (10%). Considering that the BP is the operating partner in the Operating Agreement (OA), BP is likely to be a major responsible party for most of the costs of Deepwater Horizon disaster. For instance, according to the civil complaint against BP and other relating parties, the firms violated various federal safety and operating regulations in the days leading up to the Gulf disaster.

TABLE 1
TIMELINE OF 2010 DEEPWATER HORIZON OIL SPILL

Panel A)	News Related to the Accident, Oil Spill, Containment and Sealing
04/19/2010	Accident occurred on the Transocean rig
04/20/2010	Initial estimate of oil spill is 1,000 barrels per day (bpd).
04/25/2010	Revised estimate of oil spill is increased to 5,000 bpd.
05/04/2010	Work begins to drill "Relief Well" to stop oil spill
05/20/2010	Newly revised estimate of oil spill is increased to 20,000 bpd.
05/25/2010	Attempts to stop leaking with 'Top Kill' procedure but it is failed ultimately.
05/31/2010	BP sets out LMRP containment strategy to keep oil out of Gulf
06/03/2010	Revised estimate of oil spill is increased to 40,000 barrels bpd.
07/15/2010	Successful installation of a capping stack that shut in the well
08/05/2010	Successful "Static Kill" cements operation completed.
09/19/2010	Successful completion of "Well Kill" operations in Gulf of Mexico

Panel B)	News Related to the Regulation on Offshore Drilling and Fishing
04/30/2010	Moratorium is issued for deepwater drilling by Obama administration
05/02/2011	A ten-day ban on fishing around the area is issued.
05/28/2011	A six-month ban on new deepwater drilling is issued.
06/02/2010	Restriction on fishing in federal waters in the Gulf of Mexico is broadened.
07/12/2010	A second ban on deepwater drilling is issued by Secretary of Interior
10/12/2010	A six-month ban on new deepwater drilling is ended.

Panel C)	News Related to the Cost of Oil Spill
06/01/2010	Civil and criminal investigation begin by US Attorney General
06/04/2010	Chairman gives assurance that BP will meet its obligations in Gulf of Mexico
06/16/2010	BP establishes \$20 billion claims fund for Deepwater Horizon spill
06/18/2010	BP emphasize the promise to clean up the spill and pay legitimate claims
07/27/2010	BP sets out pre-tax charge of \$32.2 billion for oil spill
08/09/2010	BP forms Gulf of Mexico Oil Spill Escrow Trust.
09/08/2010	BP releases report on causes of Gulf of Mexico tragedy

The complaint alleges that those violations contributed to the massive oil spill, and thus, it holds the defendants responsible for the removal costs and damages under the Oil Pollution Act. The complaint also alleges that those companies violated the Clean Water Act, which prohibits the unauthorized discharge of oil into the nation's waters, because they failed to use the best available and safest drilling technology to monitor the oil well conditions and maintain equipment and material to ensure the safety and protection of personnel, equipment, natural resources, and the environment.

BP's Working Partners

Under the semi-strong form of market efficiency, stock market would incorporate all available information into its market valuation. Accordingly, news about BP oil spill is believed to have transferred to other related firms, particularly to BP's working partners in the oil well operation as listed in Table 2. As explained in BP's own accident report, the BP oil spill involves multiple parties, so everyone participating in the operation of the well could have been responsible in part for the tragic accident to certain extent.

TABLE 2 lists the name of the companies known to be working partners of BP in the operation of the Deepwater Horizon rig, include: Anadarko, Transocean, Halliburton, M-I SWACO, Weatherford, Cameron in the International, Dril-Quip, and Oceaneering. The names of the related parties were also listed by the Department of Justice in its civil lawsuit based on OPA including: BP Exploration and Production Inc., Anadarko Exploration & Production LP, Anadarko Petroleum Corp., MOEX Offshore 2007 LLC, Triton Asset Leasing GMBH, Transocean Deepwater Inc., Transocean Holdings LLC, and Transocean Offshore Deepwater Drilling Inc. Mitsui Oil Exploration who owns 10% of the Macondo Well was excluded in the analysis because it is traded outside the U.S. in the Tokyo Stock Exchange.

TABLE 2
PARTNERS INVOLVED IN THE OPERATION OF THE DEEPWATER HORIZON RIG

Firms	Ticker	Roles Played in the Operation
BP	BP	Operator and Co-owner of the oil well (65%).
Anadarko Petroleum	APC	Co-owner of the oil well (25%).
Transocean	RIG	The provider of the drilling rig the Deepwater Horizon.
Halliburton	HAL	The provider of the engineering services, materials, testing, mixing and pumping for cementing operations.
Cameron Int'l	CAM	Installed a blowout preventer that did not work as designed.
Schlumberger	SLB	A subsidiary of Schlumberger, M-I SWACO, provided rig-related services.
Weatherford	WFT	A provider of casting components including the float collar, shoe, and centralizers.
Dril-Quip	DRQ	A provider of wellhead equipment, including casting hangers, seal assembly and lockdown sleeve used on the well.
Oceaneering Int'l	OII	A provider of remote operated vehicle (ROV) equipment and personnel.
Mitsui Oil Exploration	N/A	Co-owner of the oil well (10%) and a subsidiary of a foreign firm traded in Tokyo Stock Exchange.

Sub-Categories of Oil and Gas Industry

This study also measures the stock market response of other firms in the oil and gas industry who may not have a direct business association with BP's oil well operation but by being in the same industry, they suffer from a contagion effect. This movement is commonly called as an information transfer effect. It is posited in this study that the financial effects of the spill are not limited to BP and its working partners because by being active in the same or related activities to BP, other firms in the industry can suffer from BP's mishap.

This article employs the framework commonly referred as the (intra-industry) information transfer study to document the effects of oil spill to other firms in the value chain of the oil and gas industry. For the purposes of mapping the firms and industries to the information believed to have transferred, a value chain approach was employed. Value chain approach views companies as a system consisting of several subsystems that each has the process of inputs, transformation and outputs (Stabell and Fjeldstad, 1998).

Subsystems involve the purchase and consumption of resources (i.e., material, labor, equipment, building, money, and management) in order to convert these inputs to outputs (Dess and Picken, 1999).

This study identified six sub-categories of the oil and gas industry using the Global Industry Classification Standard contained in DataStream. In order to prevent duplication, BP was excluded from the 'major integrated' sub industry and the Rest of the Industry samples.

Measurement of the Cost of Oil Spill

A widely used approach used to test the value-relevance of significant events is to use market-adjusted returns in a short-term window. This method identifies a sample of similar events occurred across firms at different points in time and then stock returns are examined in a short-term window, usually two to five days surrounding the event. This type of studies adjusts market returns into abnormal or excess returns to account for the different market conditions across the sample. Given that the objective in this study is to estimate dollar costs of the Deepwater Horizon oil spill, and not percentage returns, we will only be using the market capitalization losses (instead of the returns) as a proxy measure of that cost. The initial values of each company, and sub industry have been provided in TABLES 3 and 4 so interested readers could calculate returns if so desired. Market capitalization $MC_{i,t}$ (market cap hereafter) is used as a measure of the equity value of a firm and is computed. May multiplying the market price of a stock $MP_{i,t}$ to the number of shares outstanding $NSO_{i,t}$. Any changes in a firm's market cap, calculated as $\Delta MC_{i,t} = MC_{i,t} - MC_{i,0}$, should reflect the changes in the information set up to time t from the event day (time=0) relevant to the firm's value (or prospect).

DataStream is used to compile the daily stock prices ($MP_{i,t}$) of the firms being examined and the number of shares outstanding ($NSO_{i,t}$) to compute the market capitalization of firm i at time t , $MC_{i,t}$. Changes in market capitalization from April 19, when the oil spill started, to September 19, when the oil spill officially ended with the permanent sealing of the oil well, are computed and constitute our estimate for the total cost of the event. Accordingly, we assume that investors, at the release of the information on the Gulf of Mexico oil spill, revise the value of a firm whether it is BP or other related firms in the oil and gas industry. Therefore, we collect stock price and market capitalization data for BP, its partners, and all companies that compose the six sub sub-category of the oil and gas industries.

Our approach of using gross market cap losses, that is, without any adjustment for market wide movement, deviates from methodology commonly used in event studies. We offer two reasons for using unadjusted market cap losses. First, in the current study, there is only one event so the need to adjust for the market conditions across different sampling periods is eliminated. Second, the use of unadjusted market cap losses has its own merits, including the simple computation of metrics, easy interpretation of results, and more importantly, cumulative nature of the measure. We consider that changes in market cap are intuitively more compatible with the cumulative nature of the cost of a catastrophe from the date of the event to the date being examined. Some studies in the literature used to study the economic effect of catastrophes include Kalra et al. (1993) on Chernobyl nuclear accident; Herbst et al. (1996) and Cohen (1995) on Exxon Valdez disaster; Garza et al on the Prestige Oil Spill, and Capelle-Blancard and Laguna (2010) on chemical disasters. The most common approach in these studies is the use economic impact studies, use of economic models to assess social cost and the identification of specific damages. This paper presents a simpler and much faster method to estimate total cost of this type of events.

RESULTS AND FINDINGS

Cost of Deepwater Horizon Oil Spill to BP

As depicted in Figure 1, BP's market cap changed significantly along the flow of news on the firm's liabilities, whether it is recognizable or contingent, and its efforts to stop the spill to the Gulf of Mexico over the five-month period.

As shown in TABLE 3, for instance, BP lost \$26.1 billion in market cap within the first ten days after the accident. BP's stock further tumbled down by \$98.9 billion by the beginning of June when the civil and criminal investigation began by the US Attorney General, reaching its lowest point of \$104.8 billion

loss in the last week of June. BP's stock gradually recovered with a series of good news—that a capping stack that shut in the well was successfully installed on July 15, that a 'static kill' cement operation was successfully completed on August 5, and that a 'bottom-kill' cementing operation in connection with the successful interception of the oil well by relief well succeeded on September 19, 2010. The final figure of the BP's loss in market cap was \$68.2 billion.

One notable observation is that BP's stock moved relatively consistently along with the estimated flow of oil spill particularly in the early part of the five-month period. For instance, when the initial estimate of the oil spill, i.e., 1,000 barrels per day (bpd), was raised up to 5,000 bpd on April 25, BP's market cap decreased \$9.4 billion. When the estimate was increased to 20,000 bpd on May 20, the loss increased to \$49.8 billion. Similarly, when the estimate was raised to 40,000 bpd on June 3, the loss in market cap reached \$66.4 billion.

TABLE 3
CHANGES IN MARKET CAPITALIZATION AFTER THE OIL RIG EXPLOSION
FOR BP, INDUSTRY AND MAJOR WORKING PARTNERS

Firms (ticker)	Market cap on 4/19/10	Value lost (million dollars)							
		4/30/10	5/31/10	6/30/10	7/15/10	7/31/10	8/5/10	8/31/10	9/19/10
BP	189,333	-26,077	-54,878	-98,897	-67,458	-68,824	-61,936	-80,223	-68,195
Rest of Industry (N=382)	2,427,852	-34,843	-314,616	-364,162	-227,703	-198,311	-99,406	-276,112	-115,506
Industry Total (N=383)	2,617,185	-60,920	-369,494	-463,059	-295,161	-267,135	-161,341	-356,335	-183,701
RIG	29,601	-6,464	-11,439	-14,779	-12,101	-14,861	-11,122	-13,365	-10,392
APC	36,581	-5,828	-10,691	-18,719	-12,290	-12,251	-8,410	-13,820	-9,162
HAL	30,155	-2,408	-7,677	-7,930	-4,716	-3,040	-1,797	-4,555	-1,298
CAM	11,260	-1,624	-2,420	-3,318	-2,681	-1,671	-1,695	-2,352	-1,463
OII	3,564	47	-1,013	-1,088	-976	-885	-692	-857	-714
SLB	80,932	4,258	-13,956	-14,898	-10,925	-9,744	-5,448	-8,062	-533
DRQ	2,630	-324	-690	-877	-670	-548	-504	-524	-285
WFT	12,712	665	-2,282	-3,006	-1,773	-707	-396	-1,663	85
Total for partners	207,436	-11,677	-50,168	-64,617	-46,133	-43,707	-30,064	-45,197	-23,760
Partners & BP	396,769	-37,755	-105,046	-163,515	-113,590	-112,531	-91,999	-125,420	-91,955

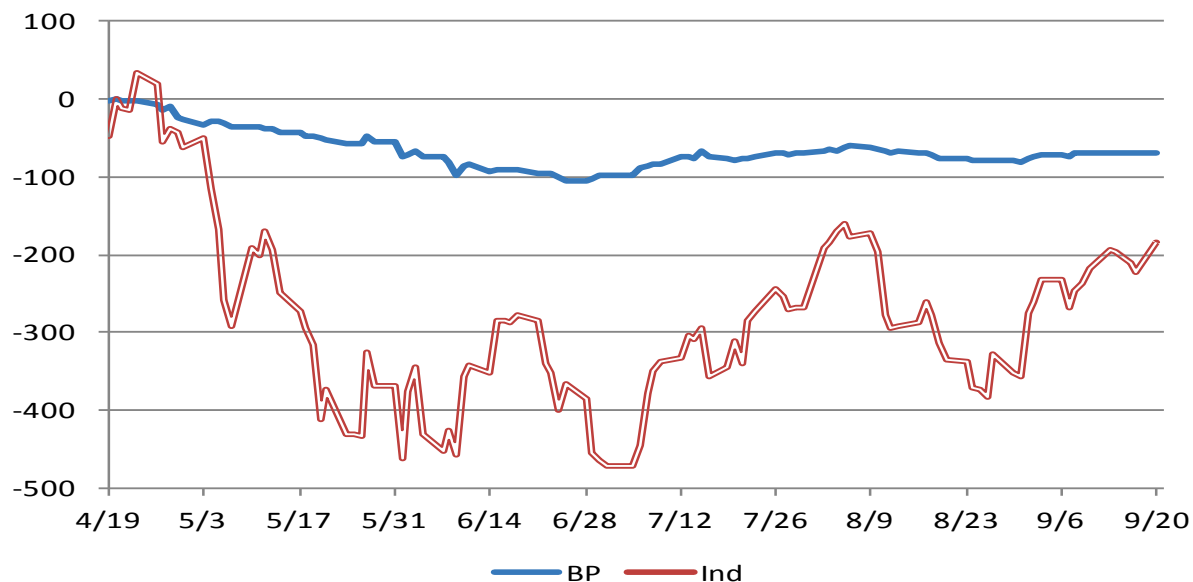
We interpret that the changes in market cap surrounding these catastrophic events reflect investors' perception on the cash flow prospects of the firm involved in the accident. It is also worthy to mention that the figure based on stock market, \$104.8 billion loss at the worst or \$68.2 billion at the end of the period, clearly exceed the loss of \$40.9 billion loss before tax disclosed by BP in its 2010 annual report (or 10-K). The total costs of the oil spill based on stock market are still much higher than the newly reformulated figure of \$53.5 billion by adding back \$12.6 billion reimbursements of assets to \$40.9 billion, given the fact that this figure should be incurred in the next two years and beyond.

In both TABLE 3 and FIGURE 1, the changes (or losses) in BP's market cap were compared to the rest of the oil and gas industry and also to BP's partner firms. It is evident that the industry also followed

the same pattern of price declines as BP. Market cap of the rest of the industry dropped continually through the end of May to reach the a loss of \$314.6 billion and reached the largest loss level of \$364.1 billion around the end of June. As of July 15, the loss in market cap by the rest of the industry decreased to a level of \$227 billion and decreased further to reach \$99.4 billion by August 5 when the ‘static kill’ cement operation was completed. At the end of the ordeal, the loss in market cap by the other companies in the oil and gas industry was \$115.5 billion.

FIGURE 1
CHANGES IN MARKET CAPITALIZATION DURING THE OIL SPILL
FOR BP AND THE ENTIRE OIL AND GAS INDUSTRY

Changes in market capitalization for the five-month periods of the oil spill. Scale is in billion dollars.



Cost to BP’s Working Partners

The total cost of the oil spill based solely on the changes in BP’s market cap vastly understates the true cost of the oil spill because the total cost figure does not account for the loss borne by other working partners who have direct relationships with BP. Thus, based on the information transfer framework, the effects of the oil spill on related firms are investigated in this article. Information transfer effects are known to occur when the value-relevant information of a firm is transferred to other firms with structural relationships with the firm. Empirical support for such information transfer effects has been provided by various corporate contexts, including the horizontal mergers (Eckbo, 1983), nuclear accident (Bowen, Castinas, and Daley, 1983), retailer’s sales announcements (Olsen and Districh, 1985), and bankruptcy (Lang and Stulz, 1992). Accordingly, it is anticipated that BP’s oil spill can reveal new information about the future cash flow of the BP’s working partners.

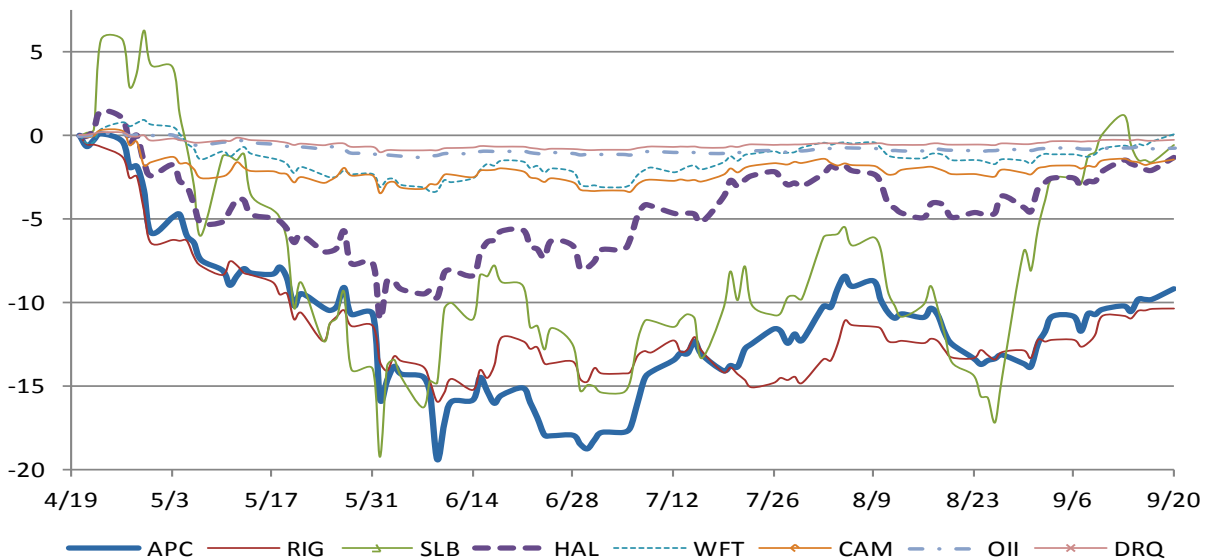
Overall, most of the partners of BP experienced a significant loss in their stock price over the five-month period. As shown in FIGURE 2 and TABLE 3, all the firms experienced a significant loss until sometime around the middle of July when a capping stack was successfully installed. For instance, the total loss in market cap by these nine working partners at their worst point was \$64.6 billion, but the loss was reduced with the news on some success in BP’s efforts to stop leaking: to \$46.1 billion on July 15 and to \$30.1 billion on August 5.

Findings from this study can be summarized as follows. First, stocks of all these partners dropped significantly for the first couple of months, but in the following months the direction of the stock price

movement varies among firms. For instance, stocks of some partners continued to decrease throughout the five-month period, but some firms recovered from the losses in the middle of the five-month period. The pattern of the stock price movements changed significantly sometime around May 31 when the BP's internal report on the cause of accident was released. Among those firms experiencing the losses, Transocean and Anadarko suffered the most. These two companies together lost a total of \$33.5 billion by the end of June, but these firms soon recovered at least one third of their previous losses to arrive at \$19.6 billion. One viable explanation is that recovering from the losses is somehow related to the series of successful efforts to stop oil spill and the release of the updated information on the causes of the accident and the responsibilities of each party.

FIGURE 2
CHANGES IN MARKET CAPITALIZATION DURING THE OIL SPILL
FOR BP'S WORKING PARTNERS

Changes in market capitalization for the five-month periods of the oil spill. Scale is in billion dollars.



Cost to Other Firms in the Oil and Gas Industry

In terms of the six sub-industries of the oil and gas industry, Figure 3 shows that most of the six sub-industries of the oil and gas industry experienced a loss in their market capitalization with the breakout of the news on the oil spill. As shown in TABLE 4, aggregate losses of the oil and gas industry reached \$60.1 billion within the first 10 days, \$369.5 billion by the end of May, and reached the largest loss of \$463.1 billion by the end of June. After the industry hit the floor, it recovered by almost \$170 billion on July 15 with the news of the successful installation of the top kill method and by another \$110 billion up until September 20 when the oil leakages officially ended.

One interesting observation is that all the sub-industries, except for the 'storage and transportation' sub-industry experienced significant losses for the whole five-month periods, from the day of the accident to the day the well was declared permanently sealed. For instance, the transportation sub-industry like other sub-industries experienced a loss up until the end of June, but it recovered completely from the loss by sometime around the middle of July, and it has remained positive since then. The most viable interpretation of such finding is that the bad news (oil spill), specific to BP may not be bad news to some other firms in other sub-categories of the oil and gas industry.

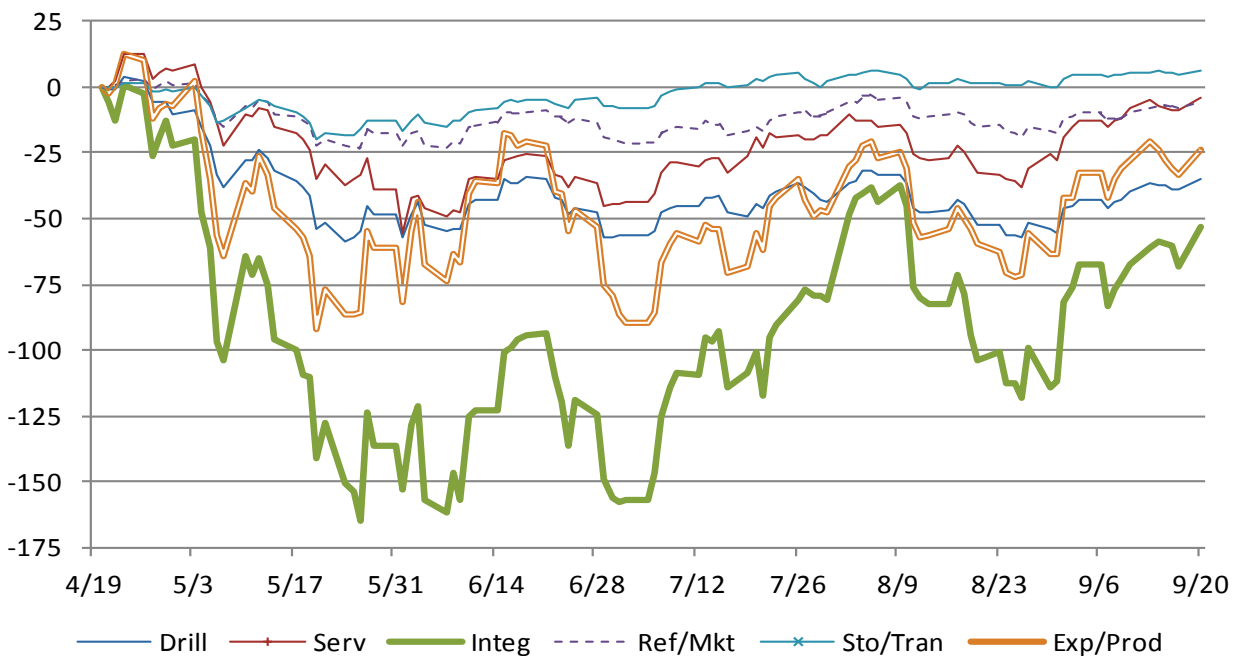
TABLE 4
CHANGES IN MARKET CAPITALIZATION AFTER THE OIL RIG EXPLOSION
FOR OIL AND GAS SUB-INDUSTRIES

Sub Industry	N	Market cap on 4/19/10	Value lost (million dollars)							
			4/30/10	5/31/10	6/30/10	7/15/10	7/31/10	8/5/10	8/31/10	9/19/10
Drilling	128	258,981	-10,597	-48,203	-57,207	-41,416	-43,809	-31,586	-55,118	-34,772
Major Integrated	11	975,257	-22,036	-136,110	-155,639	-92,619	-80,847	-37,871	-111,690	-53,255
Exploration & Production	114	646,430	-7,230	-60,906	-79,486	-53,765	-47,768	-20,823	-63,725	-23,705
Equipment Services	67	226,861	6,099	-38,596	-44,687	-27,063	-18,461	-12,534	-27,432	-4,041
Refining & Marketing	27	168,599	921	-17,864	-20,183	-14,186	-9,607	-3,101	-17,819	-5,947
Storage & Transportation	35	151,724	-1,999	-12,937	-6,959	1,346	2,180	6,510	-329	6,215
Rest of Oil and Gas Industry	382	2,427,852	-34,843	-314,616	-364,162	-227,703	-198,311	-99,406	-276,112	-115,506

Note 1) BP was excluded from the major integrated sub industry

FIGURE 3
CHANGES IN MARKET CAPITALIZATION DURING THE OIL SPILL
FOR SIX OIL AND GAS SUB-INDUSTRIES

Changes in market capitalization for the five-month periods of the oil spill. Scale is in billion dollars.



For instance, firms in 'drilling' and 'major integrated' are affected negatively by the accident, thus experiencing a significant loss after the accident for the whole five-month period, thus, the results confirm a 'contagion effect.' In contrast, firms in certain other sub-categories such as the 'storage and transportation' experienced a gain despite the BP oil spill. Thus the results from this study confirm the existence of a 'competition effect.'

CONCLUSIONS

This study estimates the total cost of the 2010 Deepwater Horizon oil spill in the Gulf of Mexico as reflected in the stock market. By observing the stock market over the five-month oil spill period, from April 20, 2010 to September 19, 2010, we believe that the oil spill is a significant value-relevant event that affects the stock market value of many firms, including BP, its working partners, and other firms in the industry. Based on changes in market capitalization of BP, we documented that the cost of the oil spill to BP continued to increase from day one of the disaster to the end of June to reach its highest level, \$104.8 billion loss. However, the cost of oil spill dropped with the recovery in market value to arrive at \$68.2 billion by September 19 when the well was permanently sealed. It is worthy to mention that the cost figure based on stock market, \$68.2 billion, is larger than, but not much deviated from, the cost of \$53.5 billion disclosed by BP in its 2010 Annual Report.

This study also documented that the total cost figure based solely on BP vastly understates the true costs of oil spill because it ignored the loss borne by partners of BP in the oil well operation. It appeared that BP's working partners involved in the operation of the oil well and firms in the oil and gas industry also paid the price of the oil spill due to the negative externality of the oil spill. The total loss in market cap to these eight partners was \$64.6 billion at the worst but the loss decreased to \$23.8 billion by the end of the disaster. Similarly, the total loss in market cap to other firms in the oil and gas industry excluding BP was \$364.1 billion at the worst but recovered to a loss of \$115.5 billion at the end of the oil spill period.

One significant contribution of this study rests on the fact that it estimates the total cost of the oil spill using an alternative approach by observing changes in market capitalization, referred to as the market-based approach in this study. The issue as to whether the stock market responds to the information disclosed by a firm in the valuation of the securities has widely been investigated in the accounting and finance literature. Employing an alternative method based on a market approach, this study was able to estimate the costs of the oil spill.

Another important contribution of this study is that it expands the scope of the total costs of the oil spill to other firms in the value chain of the oil and gas industry. Consistent with the literature that a value-relevant event that occurred to one firm affects the stock price of its own (information content effects) and that of other relating firms (information transfer effects), it is posited in this study that the true costs of the oil spill should include the cost not only to BP but also to all other related firms in the industry. By tallying all the costs, including the cost of oil spill to BP, its eight working partners and six sub-categories of oil and gas industry, this study came up with a total cost of \$183.7 billion as the final count on September 19, 2010.

One limitation of this study is that it only investigates firms in the oil and gas industry. Obviously, the parties affected by the 2010 BP oil spill would not be limited to just the oil and gas industry since the disaster resulted in massive and unprecedented amounts of damages to the coastlines of the Gulf of Mexico (Alexander, 2010; Smith et al., 2011). Primarily due to the lack of relevant data on the nature and the amounts of economic and environmental damages resulting from the oil spill, this study included effects of the oil spill solely to the oil and gas industry, rather than including effects on other industries, such as fisheries and travel and tourism.

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