Risks of Offshore Oil Drilling:

Did the Deepwater Horizon Accident impact

BP's Corporate Reputation and Stock Price

William McGuire, University of Washington, Tacoma

Ellen Holtmaat, London School of Economics

Aseem Prakash, University of Washington, Seattle

Abstract

While opinion polls show high levels of concerns about climate change, fossil fuel companies continue to explore for new resources, both onshore and offshore. In addition to their climate impact, offshore oil spills can have severe ecological consequences. They can also damage corporate reputations, a critical asset for most firms, and potentially a firm's stock price. We examine the implications of the Deepwater Horizon accident for the oil giant, BP's reputation and its impact on BP's stock price. This offshore oil rig in the Gulf of Mexico leased by BP exploded and sank on April 20, 2010, causing deaths and the largest marine oil spill in US history. Using data from YouGov's BrandIndex and Capital IQ's financial data for the period 2007-2017, we employ a synthetic control analysis to examine the extent and duration of the damage to BP's reputation and stock price. We find that in the aftermath of the Deepwater Horizon accident, BP's reputation declined by approximately 50% relative to the synthetic control. This decline has persisted through the end of 2017. In terms of financial performance, we find evidence of a short run (2 years), but no long run, negative impact on its stock price. We also looked for reputational spillovers and we find no evidence that BP's reputational shock spilled over to the rest of the oil and gas industry. These findings imply that while environmental accidents invite swift and lasting reputational penalties for the firm, this might not be translated in the firm's stock price, in addition, the reputational impact may not necessarily spill over to other firms in the same industry.

Introduction

Climate concerns are leading to intense scrutiny of fossil fuel firms, including how they access capital, what sorts of subsidies they get from the government, and the ecological damage their activities pose for local communities. "Naming and shaming" of fossil fuel firms, along with their supply infrastructure such as banks and cloud computing companies such as Amazon, is an integral part of the advocacy tool kit of climate groups. While the ecological impact of fracking continued to draw public scrutiny, the issue of offshore oil spills seems to gather less attention.[1] This is problematic because offshore production accounts for about 30% of global crude output (EIA, 2016).

Industrial accidents can cause lasting reputational and financial damage on firms. The 1979 Three Miles accident brought a halt to the construction of new nuclear plants in the United States. In the wake of the 2011 Fukushima accident, Germany decided to phase out even existing nuclear plants. Thus, by strategically leveraging both the reputational and financial harms of offshore accident, climate movement can exert additional pressure on fossil fuel firms to forgo offshore oil drilling and production, and the financial institutions not to fund such activities.

Indeed, the 1989 Exxon Valdez disaster in 1989 revealed the ecological consequences when offshore oil production and transportation systems suffer accidents. The legitimacy of the industry suffered and its claims about state-of-the-art safe transportation technologies were no longer valid. Not surprisingly, in addition to lawsuits seeking financial damages from Exxon, it led to the enactment of the Oil Pollution Act of 1990, which substantially increased oil

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[1] A google trend comparison of "fracking pollution" and "offshore oil spills" for the last 5 years reveals that the former was searched more than 4 times the latter: https://trends.google.com/trends/explore?date=today%205-y&geo=US&q=offshore%20oil%20spills,fracking%20pollution

transportation costs by requiring a double hull design for new tankers and tank-barges. The industry also developed elaborate safety protocols.[2].

The offshore oil industry suffered a major disaster in 2010 with the explosion and eventual sinking of the Deepwater Horizon oil platform in the Gulf of Mexico. In this paper we examine how this accident affected the corporate reputation and the stock price of Deepwater's operating firm, BP (formerly, British Petroleum). What is corporate reputation and why study it? Corporate reputation can be viewed as "the accumulated impressions that stakeholders form of the firm" (Chun 2005, p. 92). It is a crucial asset for any firm (Zyglidopoulos 2001) because outside stakeholders often do not possess information about the internal workings of the firm. To pass an evaluative judgment on the firm, they rely on proxies such as its corporate reputation. Consequently, firms view corporate reputations as an important strategic resource (Deephouse, 2000) that create benefits such as better relationship with regulators (Prakash and Potoski, 2004), lowering firm's cost of capital (Robert and Dowling 1997; Vergin and Qoronfleh 1998), and attracting and retaining customers and managerial talent (Markham 1972). Given the substantial payoffs of a good reputation, firms invest vast sums in building and protecting their reputations, be it for high-quality products, ethical conduct, environmental stewardship, or community engagement (De Castro, López, and Sáez 2006).

But corporate reputations could be fragile. They could be damaged when firms suffer industrial accidents, recall faulty products, or face media scrutiny for their poor labor or environmental practices. The Deepwater Horizon accident is probably one such event. On April

[2] https://www.api.org/oil-and-natural-gas/health-and-safety/exploration-and-production-safety/offshore-safety

20, 2010, a blowout of the Deepwater Horizon offshore drilling rig led to the death of eleven workers and caused the largest marine oil spill in history. The oil spill caused catastrophic environmental damage to ecosystems in the Gulf of Mexico. BP was criticized sharply for the failures that led up to the accident and ultimately pled guilty to eleven counts of manslaughter and other misdemeanor and felony charges. To date, BP has paid over $60 billion to settle criminal and civil complaints along with other fines.

While BP became a subject of criticism and legal action, it is not clear the extent to which, and for how long, the Deepwater accident affected BP's reputation in the eyes of citizens, the key actors granting firms the "social license to operate" (Gunningham et al., 2004). Firms depend on the external environment for critical resources. They need physical infrastructure to produce goods and services, secure inputs, attract employees, and sell to their customers. For these activities, they rely on a supportive government that provides the appropriate regulatory environment. In addition, firms need a de facto "social license to operate:" citizens and communities must view firms as responsible actors who are meeting societal expectations. Without social legitimacy, firms might find it difficult to access physical inputs and financial capital as well as obtain permits and other resources to function. They may even face political and environmental protests (Prono and Slocombe, 2012). Of course, profits may help firms to secure social legitimacy. But profits alone may not give them the social license to operate. Hence, even highly profitable firms invest in building their reputations for good citizenship, environmental stewardship, and workplace safety.

Given that a firm's reputation is an important intangible asset, we also look at the impact the disaster has on BP's stock price. If reputation is an important intangible asset for a firm, we

would expect that a shock in a firm's reputation will translate in a shock of a firm's stock price (among other things).

Do Corporation Reputational Shocks Spillover to the Rest of the Industry?

Firms' stakeholders typically function in an information-scarce environment. They are also boundedly rational (Simon, 1955) and resort to stereotypes to economize on their limited cognitive capacities (Tversky and Kahneman, 1980). Sometimes, they make assumptions about all firms across the industry based on the actions of a single firm. This leads to the issue of reputational spillovers, where actions of one firm can bear upon the reputations of other firms in the industry (Barnett and Hoffman 2008). Indeed, this is an important reason why industry associations often develop industry-wide certification programs to protect the reputation of the industry as a whole (Barnett and King, 2006; Prakash and Potoski, 2007) and to insulate other firms from any reputation problems that a particular member might face.

Reputational spillovers are not inevitable because stakeholders could differentiate among firms that sell differentiated products. The Volkswagen diesel scandal did not necessarily sully the reputation of Toyota or even other German car companies such as BMW. Nevertheless, reputation spillovers remain a serious concern especially when firms sell an undifferentiated product such as gasoline. We extend our study beyond BP to see if the Deepwater Horizon disaster also affected the reputations of Arco, Chevron, Citgo, Gulf, Marathon, Shell, Sunoco, and Valero.

Data and Empirical Methodology

A key methodological challenge in assessing the reputational damage (or stock price changes) from an industrial accident is the absence of a counterfactual: what would BP's reputation have looked like if there were no accident? Comparing BP's post-disaster reputation to its pre-disaster one is problematic because it imposes a strong assumption that no other events after April 2010 affected BP's reputation. However, we could compare BP's reputation to that of another firm provided we can establish that the comparison firm's reputation was sufficiently similar to BP's before the disaster. This is the logic motivating the synthetic control method: create a "synthetic brand" that closely resembles BP's reputational record before the accident. We can then compare the change in BP's reputation after the accident with that of change in the synthetic brand's reputation for the same time period. This approach allows us to establish the causal relationship of the impact of the Deepwater Horizon accident on BP's reputation.

BP's Deepwater Horizon accident occurred on April 20, 2010. To study the effect of this accident on BP's reputation, we look for a change reputation post-2010, with the pre-2010 reputation as the baseline. We draw on data from YouGov's BrandIndex database. These data report respondents' evaluation of reputations of different corporate brands measured in terms of their general impression of the brand, the perceived quality of the product, the value for money, and the respondent's willingness to work for the company (About BrandIndex: Track and Evaluate, 2020). These data are observed at the brand-level rather than at the firm-level. This is appropriate for our study because brands are typically the locus of a firm's reputation. The data are recorded daily, but we construct monthly aggregates in order to make the model estimation less demanding. The data are collected through surveys and used to calculate "scores" by subtracting negative feedback from positive feedback. The scores can range from -100 to +100. A score of zero indicates equal amounts of positive and negative feedback. Scores closer to -100

indicate a predominance of negative feedback, while scores closer to +100 indicate a predominance of positive feedback.

Our objective is to compare the change in BP's reputation from before to after the accident to that of a "synthetic control" brand. This brand needs to be sufficiently similar to BP in terms of various attributes and yet should *not* have experienced the negative reputation impact of the Deepwater accident. This approach would reveal how BP's reputation may have fared in the counterfactual scenario where the accident did not take place.

What might this control brand be? Rather than choose the control brand at random or by appealing to theory, we employ a nonparametric estimation method, "synthetic control," to construct a counterfactual brand for BP, based on a weighted average of fifteen other brands (listed in Table 1 below) in our data set. The synthetic control estimator selects brands for comparison based on their similarity in terms of other variables (as opposed to the specific measure of corporate reputation that we employ as our dependent variable) in our dataset. These include respondents' reported impression (favorable or not) of the brand, their sense of the value they get from the brand, the perceived quality of the brand, their satisfaction with the brand, their willingness to recommend the brand, and the "buzz" they've heard associated with the brand. The estimator then calculates weights for other brands based on their similarity before "treatment" (i.e., the 2010 accident) in terms of a set of variables. We then constructed the weighted average "control" brand as follows:

Table 1: Components of Synthetic Control

Weight	Brand
0.756	Shell
0.054	Craigslist

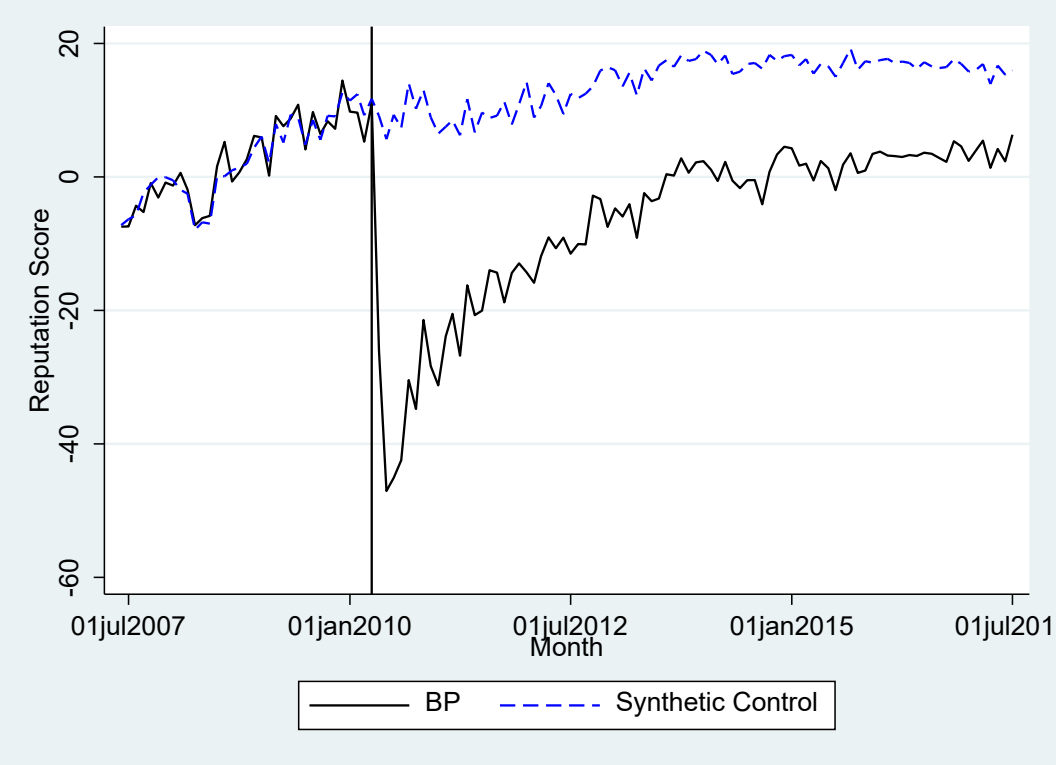
0.046	Verizon Wireless
0.027	Walmart
0.026	Big Lots
0.012	Cialis
0.009	Visa
0.004	Costco
0.004	TJMaxx
0.004	YouTube
0.001	Red Bull
0.001	Abercrombie & Fitch
0.001	Kohl's
0.001	Sunoco
0.001	Ikea

Note: Weights sum to one by construction

Results

The synthetic control method is nonparametric, meaning there is not a simple hypothesis test we can use to judge whether the accident had a "significant" effect on BP's reputation. Instead, we can look at the apparent size of the treatment effect and perform additional robustness tests to make sure our result is meaningful. We begin by examining the standard synthetic firm graph, comparing the outcome for our treated brand (BP) against our synthetic control. This is presented in Figure 1 below:

Figure 1: Reputation of BP vs. Synthetic Firm

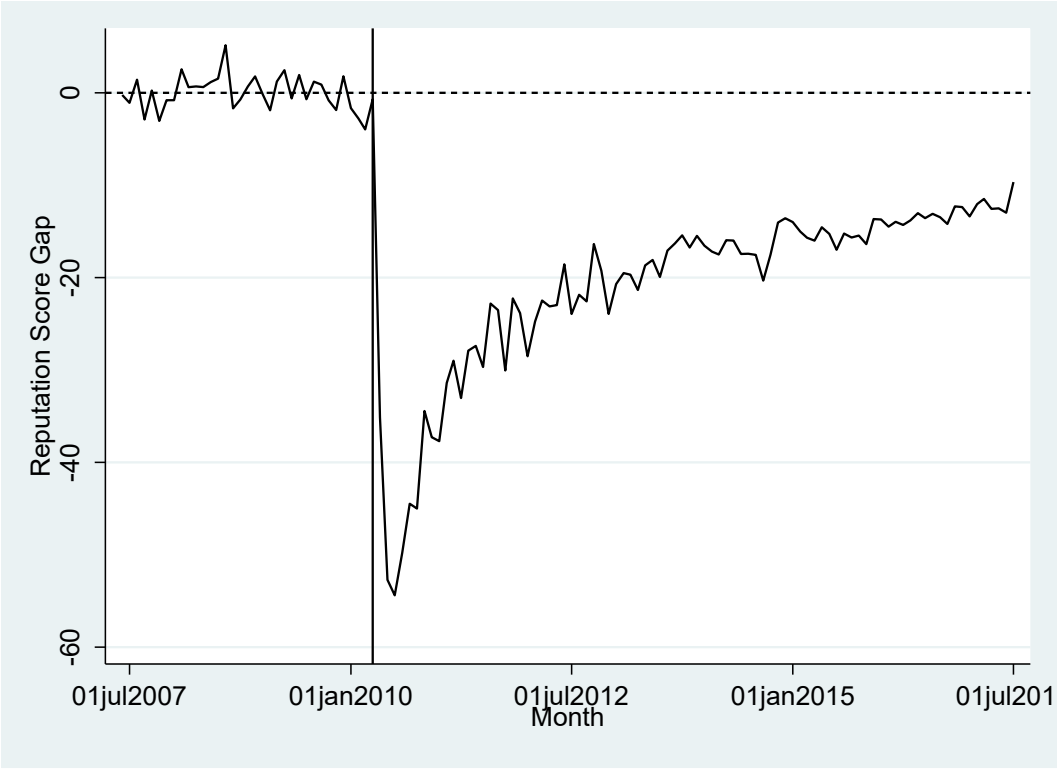


The vertical line indicates April 2010, the month of the Deepwater Horizon accident. We can see that our "treated unit" (BP) performed quite similarly to our synthetic control before the accident. Both exhibited a long-term upward trend in their reputation scores with a similar short-term variation.

After the 2010 accident, BP's reputation dropped more than 50 points relative to the synthetic control (recall, the reputation scale range is 200 point, from minimum of -100 to the maximum of +100 points). Though BP's reputation recovered almost half of its losses over the next 18 months, it did not recover to the same level even by December 2017, the end of the period covered by our data set. BP's reputation seems to have stabilized around a lower level (15 points) compared to the synthetic control, suggesting BP has suffered a long term reputational damage by the Deepwater accident.

We can also see the extent of the reputational damage by plotting the gap between the synthetic firm's reputation and BP's. Figure 2 presents this comparison, where a value of zero on the vertical axis represents no difference between the reputation of BP and synthetic control.

Figure 2: Gap Between BP and Synthetic Control Reputation



This figure has the same intuitive interpretation as Figure 1. We can see the gap widened to approximately 50 points in the months immediately following the accident. About half of the reputational damage was undone within the next 18 months, but the size of the gap decreased only very slowly by the end of the period covered by our data set.

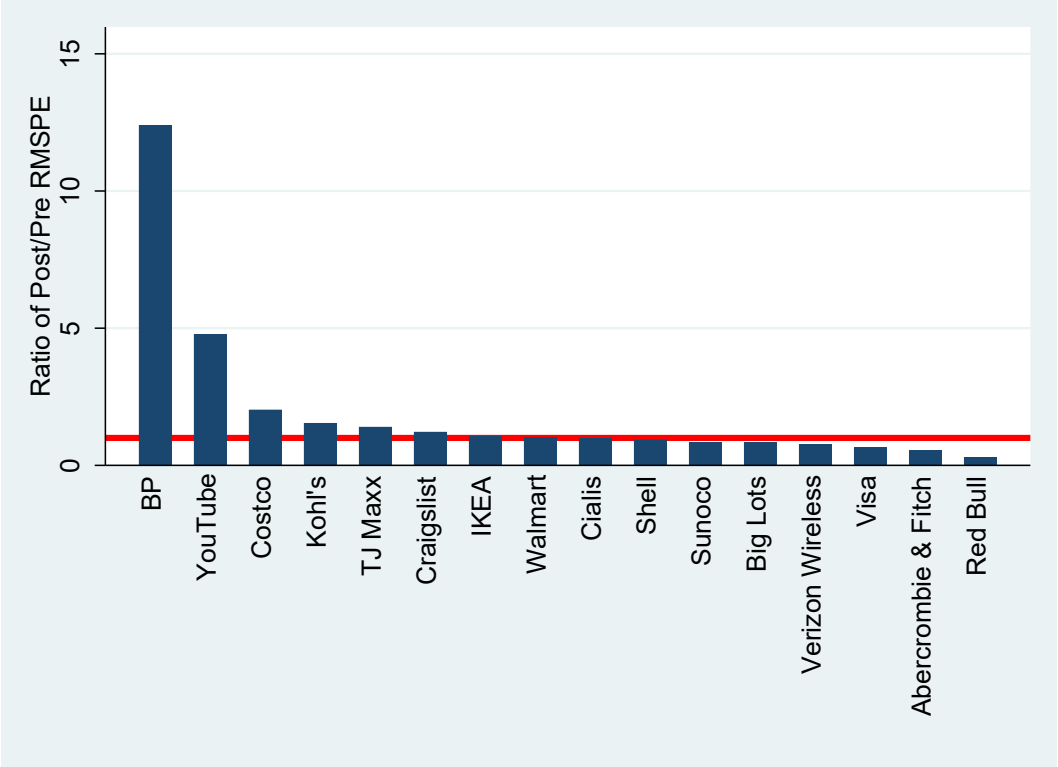
Robustness

Our reputational comparisons are meaningful only if the synthetic control brand is a good estimate of BP's reputation in the counterfactual scenario where the Deepwater Horizon accident

did not happen. Following the synthetic control literature, we perform a series of "placebo" tests to substantiate this claim (Abadie et al., 2015). The objective is to explore whether brands that make up our synthetic control experienced shifts in reputation similar to BP's around the time of the Deepwater Horizon accident. If so, that would call into question our estimate of the reputational shock in Figure 1.

To conduct the placebo tests, we construct synthetic controls for each of the 15 brands listed in Table 1. Thus, for say Walmart, we construct a synthetic control using their own unique set of comparison brands. Our objective is to assess if reputational gaps between the focal brand and its synthetic control are similar to those revealed in Figure 2, where we examined the reputational gap between BP and its synthetic control. We do this by calculating the root mean square prediction error (RMSPE) in the case of BP vs. synthetic control and the RMSPE in the case of each brand in Table 1 vs. their respective synthetic controls. The RMSPE measures the extent to which the actual performance of the brand deviates from what we would have predicted based on the performance of the synthetic control brand. When treatment effects are large, we should expect a very low RMSPE before treatment and a large RMSPE after treatment. Figure 3 shows the ratio of post- vs. pre-April 2010 RMPSE for BP and the components of its synthetic firm list in Table 1.

Figure 3: RMPSE Ratios for BP and Components of Synthetic Firm



The horizontal line corresponds to a value of one, indicating equivalent pre- and post-Deepwater Horizon RMPSE. The ratio for BP is over 12, indicating that the RMPSE was very low before the disaster and very high afterward. This is consistent with a large treatment effect. The ratio is for the rest of the brands ranges from 4.8 for Youtube to 0.29 for Red Bull. The highest RMPSE ratios are for YouTube and Costco, but each of these brands collectively received a weight of 0.008 in the construction of the synthetic control. Their relatively large RMPSE ratios do not undermine our estimate of the treatment effects in Figures 1 and 2.

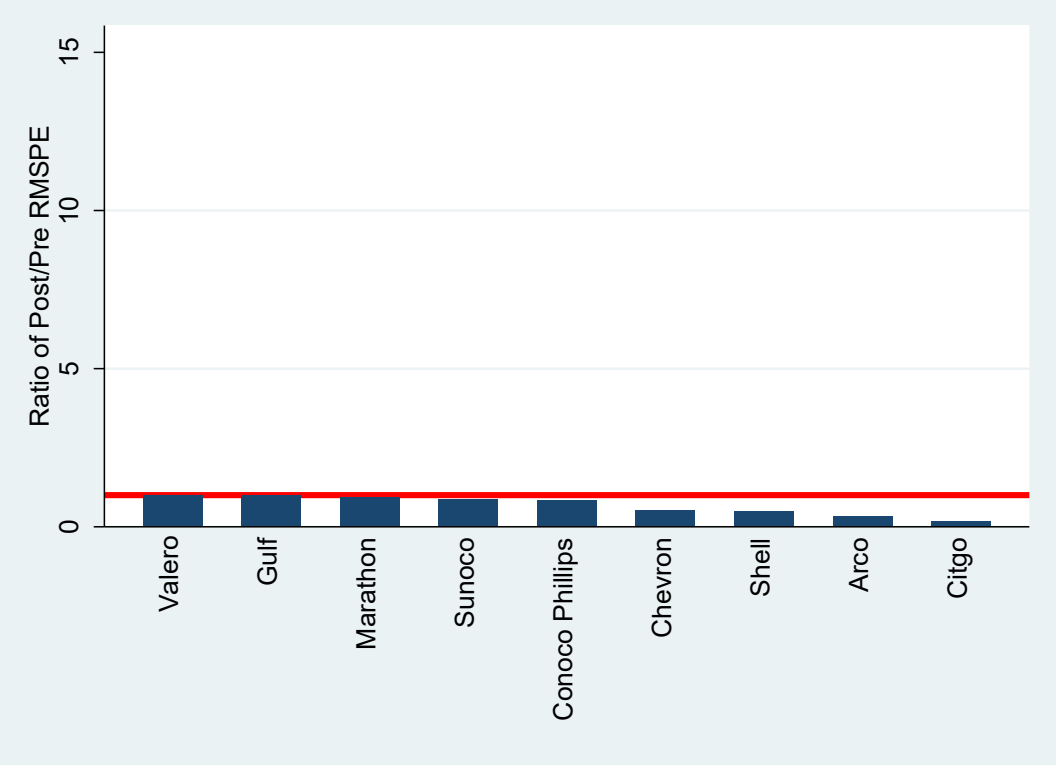
Spillover Effects

Arguably, because gasoline is an undifferentiated product, an industrial accident in a single oil firm could have tarnished the reputation of other firms in the industry. It is also important to consider potential spillovers from a methodological perspective; the single largest component of

BP's synthetic control is Shell, another oil and gas brand. If Shell was positively or negatively affected by the Deepwater Horizon disaster, it would bias our measurement of the reputational shock in Figures 1 and 2.

To test for potential spillovers within the oil and gas industry, we constructed synthetic controls for all of the other oil and gas brands included the YouGov database. These are Arco, Chevron, Citgo, Gulf, Marathon, Shell, Sunoco, and Valero. To account for possible spillovers within the oil and gas industry, we excluded other oil and gas brands from the construction of these synthetic controls. We then calculated the pre- and post-Deepwater Horizon RMSPE for each of these brands relative to their own synthetic controls. The ratios of post- vs. pre-Deepwater Horizon RMSPE are presented in Figure 4:

Figure 4: RMSPE Ratios for non-BP Oil Brands



Once again, the horizontal line corresponds to a value of one, indicating no difference in post- vs. pre-Deepwater Horizon disaster RMSPE. If BP's reputational shock spilled over to the rest of the industry, we would expect the ratios for other oil and gas brands to be higher than one. The highest ratio we see is for Valero, with a value of 1.01. The lowest is Citgo, with a value of 0.17. Shell, the largest component of BP's synthetic control, exhibits a ratio of 0.49. This indicates that Shell more closely matched its synthetic control *after* the Deepwater Horizon disaster, a strong indication that there were no spillover effects that biased our results. The low level of RMSPE ratios among all of the oil and gas brands indicates the absence of any significant reputational spillovers within the oil and gas industry.

Stock Market Implications

A firm's reputation is one of its most important intangible assets, which suggests that the negative reputational shock documented in the previous section should have (among other things such as regulatory and legal penalties) serious financial implications for BP. Yet one might argue that citizen perceptions about the firm which we assess in this paper might diverge from those of stock market actors who influence the stock price. After all, stock analysts are supposed to have a deep expertise about the industry and therefore are in a superior position to assess how an industrial accident might influence the stock price.

To arbitrate the debate on the relationship between corporate reputation and stock price, we estimate how the disaster affected BP's stock price. As per the classic Miller-Modigliani model (1991), in competitive financial markets, a firm's stock price represents the net present value of expected future dividends, or the value investors will receive for owning the company. Thus, if Deepwater affected BP's reputation and this led to say a consumer boycott or expensive

regulatory or legal penalties, then it would affect BP's profitability, and therefore its dividend. We should then see BP's stock price decline after the disaster. On the other hand, consistent with the Miller-Modigliani model, stock analysts might assess the implications of the Deepwater disaster on future dividends differently. They may not view this disaster affecting BP's long term financial health. If so, this disaster would not affect the stock price of the company in the long term.

We estimate the effect of the Deepwater Horizon spill on BP's stock price using the same synthetic control approach described above. Once again, the key question is how to identify an appropriate counterfactual for BP – a firm that shows us what BP's stock price would have been if the Deepwater Horizon disaster had not happened. We construct a synthetic control for BP using firms that were part of the S&P 500 in 2010, the year of the disaster. Our synthetic control is constructed by matching BP with a weighted average of other S&P 500 firms in terms of their revenue per share, earnings per share, gross profit per share, dividends per share, return on assets, and a proprietary "broker recommendation" score that ranges from zero (lowest) to five (highest). All of these variables, along with the stock price[3], were gathered from S&P's Capital IQ database.

Using these data, we construct a synthetic control for BP based on 273 S&P 500 firms. A comprehensive list, including weights (analogous to Table 1) is presented in the appendix. The

[3] Unlike our reputational measures, our measures of financial performance are generally not constrained to vary within the same range of -100 to +100. To adjust for differences in initial levels, we normalized our measures of stock price, earnings per share, gross profit per share, dividends per share and revenue per share to be equal to 100 in the first month of our data set, January 2007.

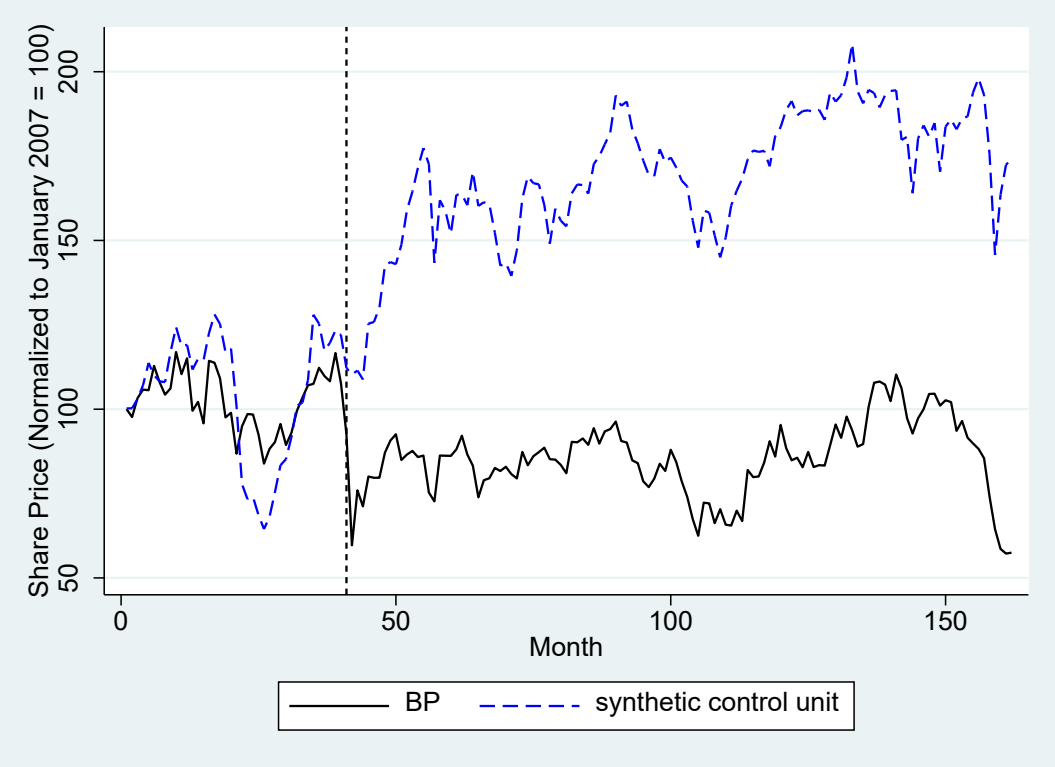
large number of components makes it difficult to compare BP to any individual firm, but we can compare the mean pre-disaster levels of our predictors between BP and its synthetic control, also known as the "predictor balance" (Botosaru and Ferman, 2019). The predictor balance is shown in Table 2:

Table 2: Predictor Balance for Financial Performance

	BP	Synthetic Control
Earnings per Share	102.26	107.86
Return on Assets	10.29	10.28
Broker Recommendation	2.11	2.12
Gross Profit per Share	105.56	105.52
Dividends per Share	126.28	126.58
Revenue per Share	115.24	115.62

These results suggest that our synthetic control is a good match for BP's pre-disaster stock price performance. Since this is a nonparametric estimation technique, we cannot perform a simple hypothesis test to see if there are significant differences between BP and its synthetic control after the Deepwater Horizon spill. As with our reputation analysis, we can simply look at the difference in stock price between BP and the synthetic control after the disaster. Figure 5 illustrates our results:

Figure 5: Share Price of BP vs. Synthetic Control



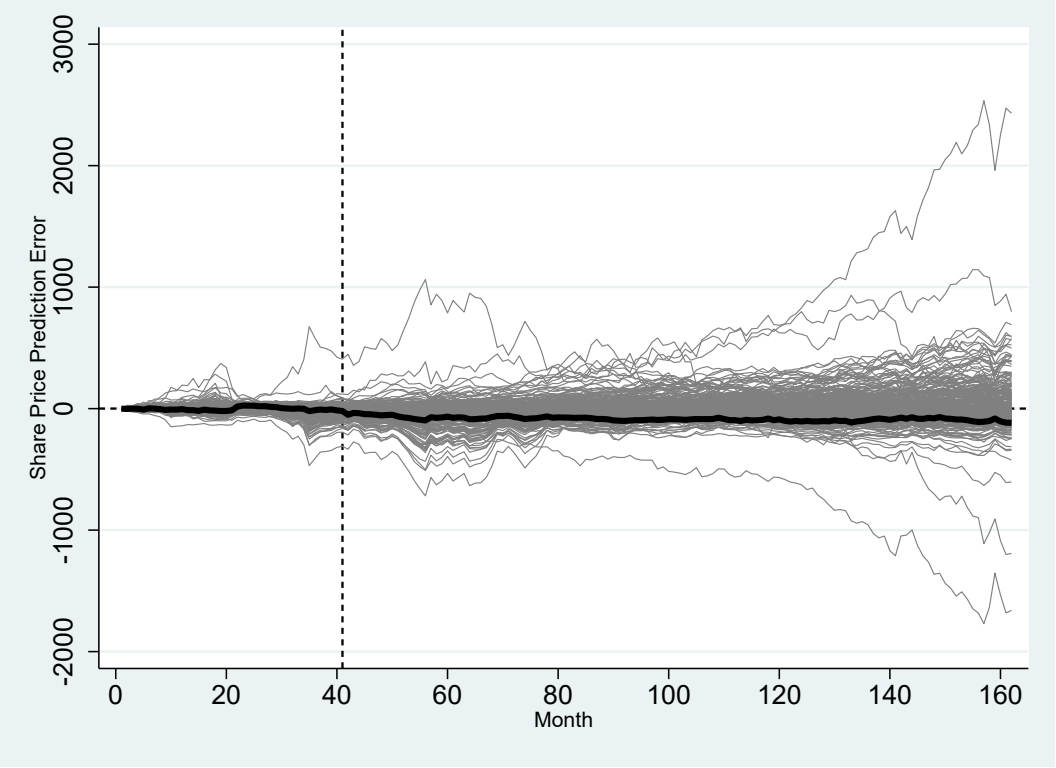
The figure above shows that the stock price for BP dropped abruptly below that of our synthetic control after the Deepwater Horizon disaster, which is indicated by the vertical dashed line. This means that that BP's reputational damage also had financial consequences, substantially decreasing the firm's stock price. BP was able to return to the initial level of its stock price (normalized to 100) by the end of our sample period, but its counterfactual *had grown* by roughly 75% over the same period.

Robustness

It is important to perform robustness checks before we draw any conclusions from this comparison. Most importantly, we must be sure that our synthetic control is a good approximation of BP's performance had the Deepwater Horizon disaster never happened. As we did in our reputational analysis, we do this by estimating synthetic control models for each

component of BP's synthetic control. Since there are 273 components, we are not able to present a comprehensive set of Post/Pre RMSPE ratios, as we did in Figure 3. Figure 6, below, shows the share price prediction error for BP and all of its synthetic control components, analogous to what was presented in Figure 2.

Figure 6: Share Price Prediction Error for BP vs. Synthetic Control Components



Ideally, BP (represented by the larger black line) would show a large negative prediction error, and all other components would have prediction errors near zero. Instead, we find wide variation in prediction errors among our components, some even more negative than BP. If a significant number of the components of BP's synthetic control also experienced large drops in their share

price after the Deepwater Horizon disaster, then we cannot be confident that we have identified the effect of the disaster on BP's share price.

Cunningham (2021) suggests computing the Post/Pre RMSPE ratio for the treated unit and each component of the synthetic control and seeing where the treated unit ranks in that distribution. Table 3 shows BP's ranking in the distribution of RMSPE ratios. We calculated this ranking for our full sample period, the two years following the disaster ("Short-term"), and the period two to ten years after the disaster ("Long-term"):

Table 2: BP Post/Pre RMSPE Ratios and Ranks

	Full Sample (May 2010 - June 2020)	Short-Term (May 2010 - June 2012)	Long-Term (July 2012 - June 2020)
Post/Pre RMSPE Ratio	6.49	5.22	6.78
Ratio Rank (out of 274)	44	5	46
P-value (implied by rank)	0.16	0.02	0.17

The ranking can also be used to calculate a p-value[4], which tells us the likelihood that we would observe BP's RMSPE ratio if the disaster had no effect on its stock price. The results indicate that we reject the null of no effect on stock price at the 5% level only when we look at the two years immediately following the disaster ("Short-term"). The longer-term effects are much less clear (p=0.17), and this effect is large enough to obscure the results when we look at the full sample period (p=0.16). In other words, we find some evidence that the Deepwater Horizon spill diminished BP's financial performance in the immediate aftermath of the disaster, but we can draw no firm conclusions about the long run implications.

[4] The p-value is simply the rank divided by the total number of firms, which is 274 in our case.

Conclusions

Our results have important implications for the literature on corporate environmental governance. We demonstrate that, beyond the obvious legal liability, citizens will hold firms accountable for their workplace safety and environmental records for a substantial period of time. Recall that since 2000, BP had invested a substantial sum in the "Beyond Petroleum" campaign to highlight its commitment to environmental protection. Further, after the Deepwater accident, it further invested about $500 million for brand enhancement (Team, 2012). Yet, the reputational damage caused by the Deepwater accident has persisted. This finding should be a wake-up call for any firm as it develops its workplace safety and environmental management strategies. Information about firms' safety record seems to have a lasting effect on their reputation. Future work can examine the effect of other sorts of accidents, such as product recalls and chemical spills on corporate reputations. In addition, this research provides insights on reputational spillovers among firms selling an undifferentiated product and can be a start of the puzzle answering the question under which conditions firms within the same sector hold their reputation in common.

Where reputational effects are long-lasting, the financial markets bounce back rather quickly after an initial shock. A company like BP seems to be able to get away with environmental disasters without long term compromise of its financial performance. This is in some ways disappointing: a major disaster should severely penalize the company's stock price. Because corporate compensation is often linked with the stock price, top management will pay serious attention to the issue of industrial safety only if their own compensation is affected. Of

course, in the aftermath of Deepwater, BP's CEO resigned and BP paid several billion dollars in penalty. Yet, there was no statistically significant longer term effect on its stock price, which calls into question whether stock markets create sufficiently strong incentives for firms to pay careful attention to industrial security.

Our paper raises broader questions about the relationship between corporate environmental performance and corporate financial performance. There is a substantial literature examining this issue across countries and sectors. As an extension of the CSR debate, there is now an increased emphasis on Environmental, Social, and Governance (ESG) indicators to assess firm performance. Our paper also contributes to this emerging literature by highlighting how BP's reputational problems did not translate into a stock price decline. Thus, it is not clear what sorts of conflicting incentives firms might face as they invest in industrial safety and environmental protection.

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