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ADVERTISING, REPUTATION, AND ENVIRONMENTAL STEWARDSHIP: EVIDENCE FROM THE BP OIL SPILL

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ABSTRACT

This paper explores whether and how private markets can provide environmental stewardship through green advertising. We examine the period surrounding the 2010 BP oil spill and estimate how pre-spill investment in "green advertising" affected the spill's impact on BP retail gasoline prices and demand. We use station-level prices and sales from a large sample of U.S. retail gasoline stations and market-level advertising expenditures during BP's 2000-2008 "Beyond Petroleum" campaign. We find evidence consistent with consumer punishment of BP in the months following the spill; during the spill BP margins declined significantly by 4.2 cents per gallon, and volumes declined by 3.6 percent. Losses were larger in areas where consumers express strong green preferences in their purchase of other products, and lower in areas with higher income. In areas where pre-spill exposure to BP advertising was higher, losses were significantly smaller. Advertising appears to soften the impact of the spill on retail margins in the short run, and lessen long-run losses measured as the fraction of BP gas stations switching brand affiliation post-spill. We conclude that green advertising acts as insurance against environmental damage rather than as a commitment to green production.

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1 Introduction

The majority of Americans expect companies to engage in socially responsible practices such as environmental stewardship in production (Fleishman-Hillard and National Consumers League, 2007). Companies appear to be responding: A 2011 KPMG study found that 95 percent of Global Fortune 250 companies publicly report their social and environmental efforts (KPMG, 2011). In 2008, more than 3,000 companies provided reports dedicated solely to highlighting corporate social and environmental activities (Lydenberg and Wood, 2010).

Recent growth in corporate social responsibility (CSR) suggests that public goods could be provided through private markets if companies can commit to produce and consumers are willing to pay for green product characteristics (e.g. Baron, 2003; Kotchen, 2006; Besley and Ghatak, 2007).[1] However, corporate provision of public goods is possible only if the marketplace financially punishes firms for deviating from advertised CSR promises (Besley and Gathak, 2007), otherwise firms may have an incentive to “greenwash,” shirking on promised green production investments.

This paper explores these issues in the context of the British Petroleum (BP) Deepwater Horizon Oil Spill in 2010. Preceding the spill, BP undertook one of the largest and most successful green advertising campaigns entitled “Beyond Petroleum”. Between 2000 and 2008, BP rebranded its gasoline stations with a new logo – a Helios (sun) symbol – and a new name behind the BP acronym (Beyond Petroleum replaced British Petroleum). Both moves were designed to reflect the company’s newly stated dedication to environmental stewardship. The campaign launched with a $200 million public relations and advertising budget and won a prestigious advertising award from the American Marketing Association. These efforts appeared to have an effect on the public as BP’s brand awareness rose from below 10 percent to more than 60 percent during the 2000s (Environmental Leader News, 2008). BP also consistently appeared as the most environmentally friendly oil company in U.S. consumer surveys and press reviews (Landor Associates, Cohn & Wolfe, and Penn, Schoen, & Berland Associates 2007, 2008).

In April 2010, an oil well blowout caused multiple explosions and led to the eventual sinking of the Deepwater Horizon oil drilling rig. An estimated 205.8 million gallons of oil flowed from the well in

[1] These results also relate to the applied theory literature on advertising and quality in experience goods markets (e.g. Shapiro, 1983; Milgrom and Roberts, 1983; Cabral, 2005).

the ensuing weeks (National Commission, 2011). Despite containment efforts, the spill led to the world's largest accidental release of oil into marine waters (Robertson and Krauss, 2010).[2]

The Beyond Petroleum campaign and subsequent oil spill are a natural setting for measuring consumer response to news about environmental stewardship for a firm that invested to varying degrees in green advertising across markets. We combine detailed data on gasoline station prices and sales to fleet card holders (as a measure of sales volumes) from January 2009 to March 2011 with local measures of environmental preferences and metropolitan-level BP advertising data during the 2000s. We estimate the impact of the spill on retail demand for BP gasoline and examine how the measured impacts varied over time and across regions with different levels of green preferences, demographics, and pre-spill advertising exposure.

Our analysis reveals several findings. First, there was a significant consumer response to the BP oil spill. BP retail prices declined 4.2 cents per gallon relative to non-BP stations in neighboring markets. This represents a 25 percent decrease in margins relative to industry standards. In addition, BP volumes declined by 3.6 percent among fleet card holders. We further find that, over the course of the spill, BP prices and volumes fell with increasing intensity: the negative impact of the spill peaked at a 6.1 cents per gallon price decrease and a 6.7 percent volume loss in August 2010.

Second, the estimated impact is significantly stronger in areas where consumers exhibit greener preferences. Following List and Sturm (2006), Kahn (2007), and Kahn and Vaughn (2009), we create a green index based on local demand for green products, as well as memberships in and contributions to environmental organizations. We find the impact was more intense in areas with stronger green preferences and less intense in higher-income areas, all else equal. The positive correlation between green preferences and income mitigated the impact on BP retail performance in "green" markets.

Third, we find that the consumer response to the spill was significantly reduced by pre-spill exposure to BP advertising. We measure advertising using data from Kantar Media (formerly known as CMR, TNS Media Intelligence, and KMR Group).[3] The data include BP's monthly advertising units and expenditures across newspaper, billboard, radio, television, and internet by metropolitan area. Our core ad spending measure focuses on advertisements most likely to contain Beyond Petroleum messaging (e.g., ads related to the BP Corporation, BP fuels, and environmental issues). To address the potential endogeneity of advertising expenditures, we use market-level TV spot prices as an instrument for variation in BP advertising across cities. We find that the impact of the oil spill on BP prices was

[2] Robertson and Clifford Krauss (2010). On November 5, 2012, BP formally pled guilty to charges of *environmental crimes*, and agreed to pay $4 billion to settle its criminal case with the United States government (United States of America v. BP Exploration & Production, Inc. CDN: 2:12-cr-00292-SSV-DEK).

[3] TNS Media Intelligence acquired Competitive Media Research (CMR) in 2003. Kantar acquired both TNS and KMR group in 2008 (Chou et al. 2008, Clark et al. 2009).

significantly less severe in areas with more BP advertising in the pre-spill environmental campaign. These results are robust to a variety of specification checks such as varying our measure of advertising and controlling for BP's advertising during the spill.

Overall, our results suggest that investment by BP in environmental advertising cushioned the impact of the spill on demand. There are several possible explanations for this result. Minor and Morgan (2011) argue that expenditures on corporate social responsibility can provide insurance against reputational costs after product recalls by shifting beliefs about whether the event was due to negligence or bad luck. In this sense, green advertising plays more of a persuasive role (Schmalensee, 1976; Becker and Murphy, 1993) than an informative role (Butters, 1977; Grossman and Shapiro, 1984), shifting beliefs rather than providing information about and commitment to environmental quality. Alternatively, this effect could also be generated by positive brand recognition or non-environmental brand value (such as habit formation) that buoyed demand despite revelations of lower-than-advertised environmental quality (Clark et al., 2009).

We test if the cushioning effect of advertising is attributable to green advertising per se by adding measures of non-green advertising to our main regression specification, where non-green advertising includes ads for individual service station and ancillary product services such as convenience store brands. Though our results are imprecise, the point estimates suggest that both types of advertising have similar impacts overall, but the effect of each type of advertising interacts with the green preferences of the local market. Specifically, we find that the impact of green ad spending is concentrated at stations in high-green-preference markets (as measured by our green index), whereas the impact of non-green ad spending is prominent in low-green-preference markets. This suggests that green advertising may play more of a persuasive role in markets where customers value green product attributes which creates "green-washing" instead of "green-investing" incentives for firms.

Finally, we find two long-term effects of the oil spill. First, the impact on BP prices and quantities changed sharply after the leak was sealed in September 2010. BP prices increased to slightly higher than pre-spill averages relative to stations in comparison markets; however, fleet card volume sales remained significantly lower.[4] Second, markets with low pre-spill environmental advertising suffered greater losses in BP retail outlet share. We find significant losses in BP's share of stations beginning around the time of the largest price impacts. The losses represent a five percent decline relative to the mean and occur only in areas with low pre-spill advertising, suggesting that in these areas, during-spill profit losses may have been large enough to cause station owners to switch to alternative brands.

[4] We provide a more detailed discussion of the interpretation of price versus quantity effects in Section 4.

Coupled together, our short-run and long-run findings suggests a role for government (or other organizations) to monitor environmental stewardship claims and to provide additional regulatory incentives for firms to internalize externalities.

2 Corporate Social Responsibility: Theory and Practice

In July 2000, BP launched a $200 million public relations campaign focused on aligning the BP brand with environmental issues (PR Watch, 2010). The company introduced a new slogan, "Beyond Petroleum," and redesigned its logo to a green and yellow Helios sun. Ad campaigns focused on environmental stewardship[5] and emphasized how BP was making its operations more efficient and working to reduce environmental impacts (Cherry and Sneirson, 2011). The campaign won two PR Week "Campaign of the Year" awards and received the prestigious Gold Effie Award from the American Marketing Association in 2007 (Solman, 2008).[6]

Anecdotally, consumers appeared to retain this environmental messaging. In 2008, the marketing firm Landor Associates surveyed consumers, asking "How green do you consider [BP] to be?" Survey results showed that 33 percent believed BP was a "green" brand, and respondents ranked BP as the greenest of the major petroleum companies (Landor Associates, Cohn & Wolfe, and Penn, Schoen, & Berland Associates, 2007, 2008). A 2008 poll of 1,000 U.K. marketers ranked BP as third when asked which company made the greatest commitment to environmental issues (Marketing Week, 2008). At the same time, several environmental and advocacy groups, such as Greenpeace and Corpwatch, criticized BP's re-branding as "greenwashing" (Corpwatch, 2000).

An emerging applied theory literature has set out to explain the economic forces behind private provision of public goods, motivated in part by the recent popularity of CSR and environmental branding (the Beyond Petroleum campaign being but one example). . One strand in this research examines how strategic market interactions between firms and activists – "private politics" – can result in CSR provision (see, e.g., Baron, 2003; Baron and Diermeier, 2007). Another set of papers analyze markets for "impure public goods" which bundle private products with public good creation or the abatement of public "bads" (Besley and Ghatak, 2001, 2007; Kotchen, 2006).[7]

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[5] For example, one TV ad featured a narrator asking "Is it possible to drive a car and still have a clean environment?" and "Can business go further and be a force for good?" Speaking on the behalf of BP, the narrator affirms: "We think so" (BBC News, 2000).

[6] PR Week, Brand Development Campaign of the Year (winner), International Campaign of the Year (honorable mention), Internal Communications Campaign of the Year (winner) for "Taking BP Beyond" (PR Week, 2010)

[7] Kitzmueller and Shimsack (2012) discuss these papers in a broader review on the CSR literature.

In the latter set of models, there are three key features relevant to the provision of environmental stewardship. First, consumers must be willing to pay for (environmental) public goods as product characteristics. Such willingness to pay has been demonstrated using both revealed preference methods (e.g., Kiesel and Villas-Boas, 2013; Kahn and Vaughn, 2009; Kahn, 2007; Teisl et al., 2002; Roe et al., 2001; Nimon and Beghin, 1999) and stated preference methods (e.g., Goett et al., 2000; Forsyth et al., 1999; De Pelsmacker et al., 2006; Loureiro et al., 2001).

Second, environmental attributes must be credibly communicated to consumers. In the absence of third-party certification, advertising is one such mechanism. Models of markets for "experience goods" – where consumers do not know the true product quality at the time of purchase – have shown that advertising can act as a sunk cost to signal high product quality (Shapiro, 1983; Milgrom and Roberts, 1983; Cabral, 2005). Empirical work has often found that advertising increases demand for advertised products (e.g., Ackerberg, 2001; Bagwell, 2007; Dube and Manchanda, 2005; Bertrand et al., 2010; Clark et al., 2009; Simester et al., 2009; Lewis and Reiley, 2008; Hastings et al., 2013; Gurun et al. 2013).

Finally, firms must face financial sanctions for making false claims of public goods provision (e.g., "greenwashing") (Besley and Gathak, 2007).[8] This punishment ensures firms have the necessary incentives to undertake costly investment in environmental quality after advertising themselves as "green" (Cabral, 2005). Punishment may be more difficult if deviation is hard to detect. For example in traditional models of product quality, consumers experience actual quality immediately after purchase. With environmental stewardship, consumers may only observe negative events that occur probabilistically. They must infer if events are an accident (bad luck) or the result of shirking on environmental quality promises. If advertising makes the "bad luck" interpretation more likely, then advertising can insure against consumer punishment, decreasing incentives to follow through with green promises (Morgan and Minor, 2011).[9]

This paper explores the empirical validity of these conditions for CSR provision in the context of the Beyond Petroleum campaign and the subsequent BP oil spill which plausibly caused consumers to updated their beliefs about BP. Two years after the Beyond Petroleum campaign, an oil well blowout in April 2010 led to multiple explosions and the eventual sinking of the Deepwater Horizon rig. Afterward,

[8] Several studies have analyzed the impacts of negative product news on demand, such as recalls of consumer products (e.g., Crafton et al., 1981; Reilly and Hoffer, 1983; Minor and Morgan, 2011; Freedman et al., 2012), airplane crashes (e.g., Borenstein and Zimmerman, 1988) and lawsuits involving medical services (Dranove et al., 2012). They do not examine advertising and baseline claims of product quality.

[9] Other empirical evidence linking CSR investments and social bads include Kotchen and Moon (2011), who provide backward-looking evidence that firms with past "social irresponsibility" subsequently invest in CSR. They regress combinations of companies' current Kinder, Lydenberg, Domini Research & Analytics social responsibility indices on lagged values to test if past poor ratings (as measures of corporate social "irresponsibility") predict future good ratings (as measures of corporate social "responsibility"). Relatedly, Eichholtz et al. (2009) find that firms in certain 'dirty' industries, such as oil and mining, are more likely to lease green office space.

robotic monitoring devices discovered that oil was leaking from the damaged well.[10] Over the next few months BP engineers sought to contain the oil leak, but were unsuccessful until a “containment dome” was placed over the leaking well in July 2010.[11] With the capping of the well, government-appointed scientists estimated that nearly 205.8 million gallons of oil had leaked from the well (Department of Interior, 2010). On September 19, 2010, BP completed the relief well, and officials declared that the damaged well was “effectively dead.” Subsequent investigations confirmed the cause of the spill to be attributable active management decisions on behalf of BP.[12]

Hence, the BP case provides a natural setting to empirically examine how consumers respond to a deviation from advertised CSR commitments First, we examine the response to the BP oil spill by analyzing retail gasoline station-level impacts on prices and volumes of fleet purchases, how the impacts changed with events during and after the spill, and the long-term impact on BP station market share. We then examine how consumer response to the spill varied across markets with measures of willingness to pay for environmental goods. Finally, we examine the effect of BP’s green advertising on the oil spill response, testing whether advertising serves as a commitment to product quality. Specifically, we test whether BP stations suffered greater losses in markets which received high levels of green advertising, and whether these markets had a smaller or larger long-run change in the share of stations affiliated with the BP brand.

3 Data

3.1 Gasoline data

We use data on retail gasoline prices, sales to fleet-card customers, and station brand affiliations to estimate the impact of the BP oil spill on gasoline prices, sales, and long-run branding decisions. The data come from the Oil Price Information Service (OPIS), which collects information on gasoline station prices and sales from two sources. First, OPIS records information on prices and volumes from Wright Express fleet fuel card “swipes.” Wright Express reports the last transaction of the day at each station to

[10] Aigner et al. (2010).
[11] Ibid.
[12] A non-partisan commission found that “the immediate cause of the blowout could be traced to a series of identifiable mistakes made by BP” and its contractors, further concluding that “(w)hether purposeful or not, many of the decisions that BP, Halliburton and Transocean made that increased the risk of the Macondo blowout clearly saved those companies significant time (and money)” (National Commission, 2011). The U.S. Department of Justice (DOJ) concluded that “the explosion of the rig was a disaster that resulted from BP’s culture of privileging profit over prudence” (DOJ, 2011).

OPIS and calculates a price based on that transaction's total sales amount and gallons sold.[13] This information is available only for stations that accept this fleet card and available only on days when fleet card transactions happen (i.e., an individual must use their fleet card for a price to be recorded for a particular station on a particular day).[14] The fleet card is widely accepted across the U.S. Second, since 2009, OPIS has expanded their data collection to include reporting agreements with several gasoline refiner-marketers which provide retail prices for some stations that do not accept the fleet card.[15]

Between these two sources, the OPIS data have a price observation for over 100,000 stations in the United States. However, most stations are available only for a portion of the years 2009-2011 or have sporadically reported prices. Given our interest in station-level variation in prices and sales over time, we focus on zip codes in which OPIS reporting meets minimum density criteria.[16] Each zip must have at least five gasoline stations with at least three price observations per week for our entire sample period. We keep data for all stations located in this list of zip codes.

In our empirical results, we compare prices at BP stations to a control group of stores in zip codes without any BP stations present. To be clear, this control group excludes non-BP stations in close proximity to BP stores as their prices were likely impacted by the spill as well. This leaves us with a sample of 7,503 stations. As a robustness check, we reproduce our main analysis using all of the OPIS data, regardless of whether stations are missing large portions of data or whether most competitors in the station's area are not in the OPIS data. The results for this unfiltered sample are very similar and can be found in Online Appendix Section II.

For stations in our sample that accept fleet cards (as opposed to stations whose parent company only report prices to OPIS), we observe weekly total gasoline sold through fleet cards. Although fleet card customer preferences may be different than the population average, these data provide a glimpse into the consumer response to the events of interest. While limited, these data represent, to our knowledge, the only station-level volume data currently available.[17] We follow an analogous procedure to select zip codes with sufficient fleet sales coverage (see Online Appendix). For the volumes data, we are left with 6,735 stations of which 6,709 of these stations are also in our price sample. Again robustness checks

[13] As with all scanner data, this can result in errors in prices. Because only the last purchase of the day is reported, it is more difficult to clean out errors than in scanner data for which many purchases are recorded for the same product each day. Prices are more accurate in recent years as more purchases are recorded for more stations each week and the data become easier for Wright Express and OPIS to clean. We drop only one percent of price observations based on large one-day changes in prices indicative of an error in data. Note that for gasoline stations that offer personalized discounts (e.g. grocery store chains), variation in OPIS retail prices may reflect both changes in street price as well as differences in per-gallon discounts available to the customer who post the last purchase of the day.

[14] See also Busse et al. (2013) for another description of these data.

[15] For a list of stations that accept the fleet card see www.wrightexpress.com.

[16] For further details on how we clean the OPIS data and define our sample, see the Online Appendix.

[17] The alternative panel data on gasoline sales volumes of which we are aware are state-aggregated (over all brands and suppliers) sales volumes reported to the Energy Information Administration (EIA) by oil companies through survey responses (Hastings and Shapiro, 2013).

using the entire sample of treatment and control stations produce very similar results and are reported in the Online Appendix.

In addition to prices and fleet sales, each observation also includes a station's location, brand of gasoline, and brand of convenience store in each week. Our main analysis uses each station's initial brand in our sample (from January 2009) to categorize it as BP or non-BP station in order to avoid potential brand endogeneity due to stations switching away from the BP brand after the spill. We analyze such switching behavior in a separate analysis in Section 4.3.

Finally, we use weekly gasoline spot prices from the Energy Information Administration (EIA) to compute a measure of retail margins (EIA, 2011). Specifically, we define a weekly station-level net price as the average price for station *i* in week *t* less the average New York spot price in week *t*:[18]

$$netprice_{it} = AveRetailPrice_{it} - EIANewYorkSpot_{t} \quad (1)$$

We focus on weekly net prices to abstract from daily variation and because most stations do not post prices for every day during a week (data are typically available up to six days per week). In our regression specifications, we weight weekly price and quantity observations by the underlying number of daily observations within the week.

3.2 Advertising data

We measure advertising using Kantar Media Ad$pender data which report expenditures by date and marketplace for more than three million brands across 18 media formats.[19] Kantar uses tracking technologies and services to monitor television advertising on both cable and network stations, print media expenditures from over a thousand business-to-business and consumer magazine and news publications, and internet sites. They collect outdoor and local radio advertising information from other marketing subscription services and directly from media providers (e.g., radio stations or billboard plant operators).[20] Given a fixed combination of time period, market, and media type, advertising expenditure data are hierarchically categorized through product levels that identify the parent company (e.g., BP vs.

[18] We use the NY spot price instead of the Gulf spot price because several hurricanes hit this area during our sample period, causing a few instances of spot price spikes that were not reflected in our NY spot or retail price series.

[19] The 18 media types provided by Kantar Media include network television, spot television, cable television, Spanish language network television, syndication, magazines, business-to-business magazines, Sunday magazines, Hispanic magazines, local magazines, national newspapers, local newspapers, Hispanic newspapers, network radio, national spot radio, local radio, U.S. Internet and outdoor activities.

[20] For more details, seeAd$pender manual (Kantar Media, 2011). See also other papers that have used these data, including Saffer and Dave (2006), Reuter and Zitzewitz, (2006), Chou et al., (2008), Clark et al. (2009) and Gurun et al. (2013).

Shell), distinguish between brands (e.g., BP service station vs. Amoco service station) and differentiate between products to which a brand is attached (e.g., BP energy utilities vs. BP gasoline).

Our data set tracks BP advertising from 2000 through 2011 and all other advertising from 2007 through the 2011.[21] In our main specification we use advertisements during the years of the Beyond Petroleum campaign (2000-2008) that focused on the BP Corporation, BP fuel products, and on environmental issues. Our main analysis aggregates all advertising expenditures across all media as our measure of advertising exposure. This specification assumes there are stock effects of advertising on demand (Dube and Manchanda, 2005).

BP advertising may be endogenous to each area's unobserved preference for the BP brand. We instrument for BP's advertising using television advertising spot prices across all industries and product categories. We focus specifically on the quantity-weighted average spot television advertising price from 2007-2008. This price provides a measure of advertising cost differences across metropolitan areas.[22] Our identifying assumption is that cross-sectional differences in demand and supply for general spot television advertising do not lead to differences in the consumer response to the BP oil spill other than through their impact on BP advertising levels. Note that previous studies in advertising use this type of instrument. We further discuss the plausibility of the identifying assumption in section 4.2.1.

3.3 Measures of Green Preferences

The literature characterizes green preferences in a variety of ways. For example, List and Sturm (2006) use per capita membership in environmental organizations at the state level. Kahn (2007) uses California Green Party registrations and shows that they are a significant predictor of demand for green products, such as hybrid vehicle registrations. Kahn and Vaughn (2009) create a green index based on California referendum voting outcomes and Green Party registrations; they document that hybrid vehicles as well as LEED-certified ("green") buildings cluster in politically green communities. Building on this literature, we compile and combine the following measures to create a green index:[23]

[21] Ad$pender data licenses cover a rolling five year period; historic data must be purchased separately and at a significant premium.

[22] We match the Kantar data, which are at the Designated Market Area (DMA) level, to zip codes using the county-DMA correspondence provided by Gentzkow and Shapiro (2008), in conjunction with a county-zip correspondence from the U.S. Department of Housing and Urban Development.

[23] We also experimented with including measures of Democratic Party committee contributions and Barack Obama's vote share from the 2008 presidential election. However, these measures appeared to decrease the explanatory power of the green index.

1) Hybrids: Share of hybrid-electric vehicle registrations in 2007 in each zip code obtained from R.L. Polk automotive data. We chose the year 2007 to exclude hybrid car purchases caused by the 2008 spike in gasoline prices.
2) Sierra: Per capita Sierra Club membership in 2010 at the state level created using data from the Sierra Club and the U.S. Census Bureau.
3) LEED: The number of LEED-registered buildings per capita in each zip code, obtained from the U.S. Green Building Council (data accessed in June 2011).
4) Green Party Contributions: Average per-capita contributions to Green Party committees in 2003/04 and 2007/08 at the zip code level, computed using individual level data from the Federal Election Commission.[24,25]

We aggregate these variables into a single "Green Index" by computing Z-scores for each of the measures and summing them into a single value. We also consider each zip code's hybrid vehicle share as an alternative measure of green preferences.

4 Empirical Analysis

4.1 Pooled results

We begin by examining the impact of the BP oil spill on station prices and fleet card sales. We regress station net price or fleet sales on station fixed effects, indictors for during- and post- spill periods, and interactions of those time period dummies with an indicator of whether a station sells BP-branded gasoline:

$$y_{it} = \alpha_i + \beta^1 during_t + \beta^2 post_t + \theta^1 during_t * BP_i + \theta^2 post_t BP_i + \varepsilon_{it} \quad (2)$$

Here, y_{it} is either average net price or the log average fleet sales for station i in period t, α_i is a station-level fixed-effect, $during_t$ is an indicator if period t is during the oil spill, $post_t$ is an indicator if period t is after the spill, and BP_i is an indicator of whether station i sells BP-branded gasoline.

We aggregate daily prices and quantities at two levels. First, a concern is that autocorrelation in net prices or fleet sales data might bias the standard errors (Bertrand et al., 2004). To address this, we

[24] The Federal Election Commission data cover all individual contributions over $200.
[25] To maintain comparability with income data, contributions are converted to 1999 dollars using the Bureau of Labor Statistics' CPI inflation calculator.

collapse all weekly net price and fleet sales data into averages within three time periods: a *pre-spill* period (January 01, 2009, through April 16, 2010), a *during-spill* period (April 23, 2010, through September 17, 2010), and a *post-spill* period (through March 2011). Results from this aggregation are presented in Table 1, columns 1 and 2. Second, we use weekly net price and fleet sales data for comparison in Table 1, columns 3 and 4.[26]

Across specifications we find that there is a negative, economically and statistically significant effect of the oil spill on both prices and sales at BP stations relative to the control group. BP stations experienced a relative price decrease of 4.2 cents per gallon and a 3.6 percent drop in sales from fleet customers.[27] This decrease in net price is substantial, given that the National Association of Convenience Stores estimates that the average retail mark-up was 16.3 cents per gallon in 2010 (NACS, 2011). Using this statistic, the point estimate represents a 26 percent decline in retail margins. These effects are, however, temporary: in the post-spill period, retail station prices at BP stations rebound although quantities remain depressed.

Figure 1 displays the mean weekly price (level) for the BP and control stations in our sample. The vertical lines denote the beginning and sealing of the oil spill, respectively. For much of the period prior to the spill, our sample of BP stations has higher prices, on average, compared to the control group. Almost immediately following the oil spill, the mean price for BP falls below the control price until the spill is capped. Several months following the spill, BP's prices rise above control station prices. This pattern is consistent with the following interpretation: advertising increased demand from marginal consumers pre-spill, those consumers decreased demand during and after the spill. BP re-optimized post-spill to their new demand curve to sell to the most loyal, but smaller subset of consumers. If these consumers were less price elastic, BP's new equilibrium price should increase and quantity sold should fall.

Table 2 estimates the month-by-month change in BP prices and fleet sales relative to control stations. After the spill, BP stations experienced a small, immediate drop in net price (of one cent per gallon) with no discernible impact on fleet sales. Net prices continued to fall, bottoming out in August at -6.1 cents per gallon. During the same month, BP stations experienced a 6.7 percent reduction in fleet sales compared to control stations. At this point, nearly 205.8 million gallons of oil had spilled into the Gulf and only 17 percent had been captured by BP's containment efforts (New York Times, 2010).[28] By

[26] In both specifications, the aggregate observations for each station in each time period are weighted by the number of underlying observations from the disaggregated (daily) data.

[27] Because our measure of volume comes from fleet sales, we prefer the reduced-form regressions for price and quantity. Using our data to estimate structural demand parameters of the change in preferences resulting from the spill would require an assumption that fle et sale demand is the same as non-fleet sale demand (which we do not observe). In addition, because prices and sales are not available at all stations, estimating a demand system based on a random utility model is problematic.

[28] Among the rest, eight percent had been burned or skimmed, 25 percent evaporated or dissolved, 24 percent dispersed either naturally or chemically and 26 percent still at sea or on shore.

October, the price impact had declined to 0.5 cents per gallon, with quantities remaining lowered by 2.4 percent.

Figure 2 plots the point estimates from Table 2 against Google search intensity relative to January 2004 for the phrase "oil spill." For a given month, the Google search intensity is measured as the ratio of searches in that month to searches during a baseline month. Here, the baseline month is January 2004, so a value of 50 indicates that searches in a baseline month were 50 times greater than they were in January 2004. The number of searches for the term "oil spill" intensified dramatically in early May 2010 and peaked on June 4th, one day after a BP apology campaign began airing. The results suggest that public interest in the spill was significant and that the relative magnitude of the price response appears to lag the spike in online searches.

Our identifying assumption is that, aside from the oil spill, there was no shock to gasoline prices (and quantity sold to fleet vehicles) that affected BP and competitor stations differentially from non-BP/non-BP competitor stations in the aftermath of the oil spill. Although plausible, this assumption could be violated if, for example, BP stations are more likely to be in zip codes that are less (more) likely to be subject to summertime gasoline Reid Vapor Pressure (RVP) standard regulations than markets in which our control group stations lie.[29] This could disproportionately drive down (up) the relative price of gasoline in markets with BP stations in the summer, as content regulations can cause local seasonal increases in gasoline prices through increased production costs. Because the BP spill occurred during the spring and summer of 2010, differential regulations could be a confounding factor.

Table 3 restricts the sample to zip codes with no seasonal gasoline content regulation (uniform RVP of 9.0). The results show a *stronger* overall BP price decrease of 7.5 cents per gallon. Fleet sales impacts cease to be significant, although the point estimate remains negative. It should be noted that the Table 3 specification reduces our sample size by over 70 percent. Indeed, when considering a larger sample of standard RVP zip codes from the unfiltered OPIS data (i.e., not restricted to our list of "good" sample zip codes), the quantity impacts are stronger and remain highly significant in this specification as well (see Online Appendix Section II). Overall, seasonal changes in RVP gasoline content requirements do not appear to be driving our results.

These findings suggest that, on average, BP stations suffered losses to revenues as a result of environmental damage from the BP oil spill. Our results are consistent with both short-run punishment and a more permanent loss of some customers post-spill. They are consistent with models of trust, where a consumer expects a firm to behave a certain way, and punishes it for deviating from that behavior for a period of time, and with reputation models, where consumers expect firms to be a particular type (e.g., high quality) and update their beliefs permanently in response to an experience sufficiently different from

[29] See Brown et al. (2008) and Auffhammer and Kellogg (2011) for detailed descriptions of gasoline content regulations.

their expectation. Trust models primarily address moral hazard (e.g., shirking on promised quality effort), whereas reputation models primarily deal with adverse selection (e.g., low quality types pretending to be high quality types). Both may have happened and for different customers, generating the observed changes in prices and sales during and after the spill.

Note that trust models that involve many consumers suffer from a similar problem to voting; punishment is not individually rational as each individual consumer's demand is not sufficiently large enough to affect aggregate outcomes or incentives.[30] This may explain why consumers organize boycotts as a coordinated response to firm behavior, as many did during the BP spill.[31,32] Alternatively, Fehr and Gaechter (2000) find in laboratory experiments that subjects are willing to expend resources to punish deviating players even in a single-shot trust game, where such punishment cannot incentivize better future behavior. Punishment of bad behavior may have intrinsic value, and punishment is necessary for provision of CSR in private goods markets.

4.2 Interaction effects and advertising exposure

Table 4 examines how the price and sales impacts vary with measures of local green preferences and income. We merge onto our base data zip code level income data from the 2000 U.S. Census, the share of all registered cars in a zip code that are hybrid vehicles, and our Green Index as described in Section 3. We focus on the pre-spill versus during-spill periods to facilitate interpretation of interaction terms. Our regression reduces to a pure difference-in-difference estimation, with the difference in net price or total sales during the spill versus the pre-spill period at each station *i* as the dependent variable. We demean each of our interaction variables (income in 2000 U.S. thousands of dollars, hybrid share of registered vehicles) and interact them with an indicator for BP brand affiliation.

The first two columns repeat the results in Table 1 on the subsample of stations for which the Green Index, hybrid car shares, and income data are all available. The results are essentially unchanged. Columns 3 and 4 add controls and interactions for income and hybrid shares. Income has a positive and significant association with the price changes at BP stations, indicating that the negative impact of the spill was abated in high-income areas. A one standard deviation increase in income (of $15,563) implies a 1.55 cents per gallon ($0.001*$15.563) smaller price decrease than the average. This difference

[30] See the literature on the paradox of not voting (e.g., Downs, 1957; Olson, 1965; Palfrey and Rosenthal, 1985; Feddersen, 2004).
[31] Calls for boycotting BP stations were issued by voices including Public Citizen, Jesse Jackson, and the Backstreet Boys, who reportedly completed their 2010 tour without stopping at BP stations to refuel their tourbus (Backstreet Boys, 2010).
[32] Models of civic duty, peer pressure and group voting have been put forward as social mechanisms to overcome the paradox of not voting. See for example Gerber and Green (2000), Green and Gerber (2004) and Coate and Conlin (2004).

represents an approximately 39 percent reduction in the price decrease relative to the overall impact of -4 cents per gallon. The smaller price effects seen in high income areas may be driven by gasoline station selection and by higher valuation of convenience. We find a negative and significant association between income and quantity sold through fleet cards. A one standard deviation increase income at the zip code level reduces BP volumes during the spill period by an additional 3 percentage points (0.002*$15.563) relative to our sample mean of -3.6 percent. Thus, while BP prices drop less in high-income areas, BP fleet card customer sales drop more, though we note that fleet card sales may not be reflective of overall demand relevant for price setting.

Price effects were larger in areas with larger shares of hybrid vehicles. The results imply that a one-standard deviation increase in hybrid vehicle share is associated with an additional 0.6 cent per gallon (0.012*0.5%) drop in BP retail gasoline prices in the aftermath of the spill. However, the hybrid vehicle share interaction term is not a significant predictor of changes in BP sales after the spill. Columns 5 and 6 of Table 4 substitute our Green Index for percentage of hybrid vehicles, as described in Section 3, compiling measures of green preferences used by List and Sturm (2000), Kahn (2007) and Kahn and Vaughn (2009). Using this measure, we again find that greener areas responded more strongly to the BP oil spill. The coefficient on Green Index implies that a one standard deviation increase in the Index intensifies price decreases by 0.94 cents per gallon (-0.006*1.56), or a 23.4 percent further decrease relative to a mean decrease of four cents per gallon. We do not find a significant interaction effect between the Green Index and changes in fleet-card volume sold at BP stations, however fleet card sales may not be reflective of overall demand relevant for price setting.

Table 5 adds interactions with demeaned BP advertising expenditures to test if advertising during the Beyond Petroleum campaign is associated with higher or lower price and sales impacts. Our main specification measures advertising as total expenditures aggregated over all forms of advertising in our Kantar data, which includes television, newspapers, magazines, radio, billboards and Internet spending (Clark et al., 2009) for ads that focused on the BP Corporation, BP fuel products, and environmental issues during the Beyond Petroleum campaign years (2000-2008). If green advertising convinced consumers of BP's commitment to the environment through investments in production processes that provide an environmental public good (or reduce negative externalities), one might expect to see steeper losses at BP stations in areas with heavier Beyond Petroleum advertising. On the other hand, in the early days of the spill, such green ad claims could have swayed consumers' beliefs about whether the disaster was due to bad luck or bad management, leading to softer price and sales impacts (Minor and Morgan, 2011).

The first two columns of Table 5 replicate the benchmark results from Table 1 for the sample of stations that have income, green preference, and advertising data available. The average impact of the spill is slightly smaller in this sample, but remains economically and statistically significant. Columns 3 and 4 add demeaned advertising and its interactions with an indicator if the station was a BP station and an indicator for the post-spill period. The results suggest that pre-spill exposure to BP advertising significantly dampened the impact of the oil spill. The point estimate on the interaction term BP*Advertising suggests that a one standard deviation increase in advertising expenditure softened the price impact of the spill by about 1 cent per gallon (0.003*3.4), resulting in a 24 percent decline in the price impact of the spill. The effects of the spill on BP station prices in high income and high Green Index areas remain unchanged; the coefficients on these interaction terms are similar to those in Table 4. We find no significantly different effect of the spill on quantities sold in areas exposed to more versus less advertising. On the one hand, a negative demand shock accompanied by an outward supply shift (i.e., BP lowering prices sufficiently) may result in an equilibrium with lower prices but unchanged quantities. On the other hand, sales to fleet card customers may not be representative of the population segment relevant for station price-setting, as discussed previously.

4.2.1 Instrumental Variables and Identification of Advertising Effects

Advertising may be potentially endogenous to other factors that are correlated with local demand response to the BP spill. For example, advertising may be correlated with BP station market share, which may also be correlated with customer perceptions of BP brand quality or with the set of alternative non-BP brand stations they could substitute towards. For example, suppose that advertising prices were correlated with BP's share of gasoline stations in a metropolitan area or with the number of gasoline station options consumers had. In this case, advertising may be correlated with consumer response to the oil spill as BP customers would have fewer non-BP gasoline options nearby, and would therefore be less responsive to the spill in their choice of station.

To address this endogeneity concern, we instrument for advertising expenditures using spot television advertising prices. Note that several papers in the literature develop similar instruments for advertising (Dube and Manchanda 2005; Izuka and Jin 2005; Choi, Shin-Yi, and Grossman, 2008; Liu and Gupta 2011; Dinner, Van Heerde, and Neslin 2014).[33] We use the quantity-weighted average spot price in the late Beyond Petroleum campaign years (2007-2008), when we have advertising data for all

[33] Most similarly, Dube and Manchanda (2005) use the list price of gross rating points (an advertising measure), Choi, Shin-Yi, and Grossman (2008) use the price of advertising computed as dollars per seconds of messages aired (as well as the number of households in a DMA with a television set), and Izuka and Jin (2005) compute average wages in advertising-related occupations to capture advertising costs. Also relying on broad advertising market measures are Liu and Gupta (2011), who instrument for statin drug advertising with average advertising expenditures across all pharmaceutical firms and other drugs, and Dinner, Van Heerde, and Neslin (2014), who use non-direct competitor firm's advertising expenditures as instrument for firm's advertising expenditures.

brands and all products in all product categories and industries (e.g., automobiles, clothing, etc.). First stage results are reported in full in the Online Appendix Table A0. To summarize, spot TV advertising prices are a highly significant predictor of advertising expenditures. The Shea's partial R-squared value is 0.69 in the first stage. Formal tests of instrument relevance strongly reject the null that the first stage coefficients on the excluded instruments are equal to zero (e.g., the Angrist-Pischke F-statistic leads to a rejection of the null with a p-value<0.0000).

The instrumental variables results in columns 5 and 6 of Table 5 are very similar in magnitude to the OLS results in columns 3 and 4. That is, our IV results confirm that the price effects of the spill were softer in areas where BP advertised more heavily during the Beyond Petroleum Campaign years. Indeed, the coefficient on price is stronger in the IV specification (0.4 cents per gallon spill impact protection per $1 million additional advertising expenditure), suggesting, if anything, that BP advertising was potentially higher in areas where it would have been punished more.

The instrument is valid under the assumption that spot prices are determined by the broad advertising market rather than factors endogenous to the demand elasticity at BP gasoline stations *per se*, and would therefore dampen the demand response to the oil spill in the absence of increased advertising. In the Online Appendix we investigate correlations between our instrument and other local area characteristics that could affect the demand response to the spill. Table A5 shows that spot TV prices vary positively and significantly with population density, but there is no detectable relationship with retail gasoline market concentration (HHI), BP station share, or gasoline station density. This suggests that spot advertising prices are orthogonal to key factors that might impact demand response at BP stations to the BP spill, such as BP market share and retail gasoline brand market concentration.

We also conduct several specification checks which directly control for the characteristics of local markets that could affect the demand elasticity of BP gasoline stations. Columns 3 and 6 in Table A6 report results from specifications which adds our measure of BP's market share in the metropolitan area to our main advertising IV specification. Reassuringly, the results further confirm that BP station share is uncorrelated with our instrument since the point estimates on advertising's interaction with BP are very similar to our results in columns 5 and 6 of Table 5. Similarly, Table A7 also tests the robustness of our IV results by adding interactions with measures of the number of gas stations per square mile at the zip code level to our IV specifications. Adding these measures to our IV estimation has no impact on our advertising results, further confirming that our IV results are not driven by station density or concentration through more or fewer stations to substitute towards in response to the spill.

Since our instrument is specific to TV expenditures, we also conduct a final robustness check for our analysis by focusing on BP's spot TV advertising only (the excluded media are billboards, newspaper, radio and online spending). Online Appendix Tables A8-A9 show that focusing only on BP's spot TV advertising yields very similar results to our main analysis based on all media expenditures: a one standard deviation increase in BP's spot TV expenditures (+$2.2 mil) reduces the oil spill's impact on BP prices by 0.9 (OLS) and 1.3 (IV) cents per gallon. The instrument yields slightly higher Shea's partial R-squared values in the first stage regression as spot TV market prices are stronger determinants of Spot TV advertising for BP than they are for all-media advertising for BP. As before, we find no statistically significant advertising effect on quantities. Lastly, when we measure TV advertising in units of advertising we get similar results to using expenditures, namely that a one standard deviation increase in units of spot TV advertising (+1,080 ads) is predicted to mitigate the price effect of the BP oil spill by 1.1 (OLS) and 3.2 (IV) cents per gallon. Note that this measure counts all spot TV advertising units as equal whereas the expenditure measure counts advertising dollars as equal.

4.2.2 Interpretation

In summary, the positive and significant impact of green advertising suggests that, rather than punishing BP more for the spill, consumers in high-advertising metropolitan areas were less likely to punish BP, lowering the impact of the spill on BP station prices. This result suggests that firms which cause environmental damage may benefit from green advertising. Hence, the consumer response to the BP oil spill provides further empirical support for the notion that corporate social responsibility may provide reputational insurance in case of adverse events as suggested by Minor and Morgan (2011).

Two main issues arise in interpreting these results. First, it may be the case that during-spill advertising is correlated with pre-spill advertising. Indeed, our data show an increase in BP advertising during the spill. These marketing efforts included informational advertising about relief and mitigation efforts (Tracy, 2010). Hence, the concern is that during-spill advertisements could have stemmed the impact of the spill on demand rather than previous expenditures during the Beyond Petroleum campaign. We thus control for BP advertising *during* the oil spill in an augmented version of the main specification in Table 5. Table A10 shows that our estimates are robust to including during-spill advertising. Interestingly, column 2 shows that the price impact of during-spill advertising is also precisely estimated and has a slightly larger positive effect (per dollar of advertising) on reducing the consumer response to the oil spill.

A second issue for our interpretation is whether the same impact would have resulted if BP had simply engaged in any sort of advertising, environmentally related or not. Ideally, we would observe the impacts of two separate advertising campaigns pre-spill, one with green messaging and one without. However, we only observe one history of BP advertising. To overcome this limitation, we exploit the fact that the Kantar data contain information on the corporate entity of the advertiser and the product advertised. Recall that our main green advertising measure includes only ads most likely to have contained Beyond Petroleum messaging (ads for the BP Corporation, BP fuels, and environmental issues). For our supplementary analysis, we create a second measure of likely "non-green" ads, such as those specific to local BP service stations, BP convenience stores and ancillary products. See the Online Appendix for further details on the classification of green and non-green advertising.

Using these data, we test if the protective effect of advertising in Table 5 is due to green advertising per se by controlling for non-green advertising in our specification. One caveat for this analysis is that both advertising categories may be endogenous, but we have only one instrument. Given this limitation, we report OLS results only. One reassurance for these results is that the similarity between the OLS and IV estimates in our main specification may imply that the endogeneity bias in these advertising estimates is minimal.

Table A11 shows that the estimated effect of green advertising is robust to including non-green advertising. Column 2 shows that the point estimate for the impact of green advertising is only slightly smaller than our main specification estimate (which includes only green advertising) re-produced in Column 1. Specifically, the point estimate shrinks from 0.3 to 0.2 cents per gallon per $1 mil of green advertising. Although imprecise, the point estimate for non-green advertising is positive which suggests that non-green ads also cushioned the consumer response to the oil spill at BP stations. This may have occurred through other channels such as habit formation or consumer loyalty (to a local station owners).[34]

Finally, we also test whether the response to these different types of advertising varies across markets with different green preferences (as measured by our green index). Column 4 presents results where we include additional interactions between the indicator for BP stations, each measure of advertising and an indicator for whether a station is located in a zip code that has an above median green index score. While the estimates for these additional interaction terms are noisy, they suggest that the impact of green ad spending is concentrated at BP stations in high-green-preference markets (as measured by our green index) while the impact of non-green ad spending is prominent in low-green-preference markets.

[34] Prior literature suggests that advertising may operate through these additional channels. For example, Clark et al. (2009) also use Kantar advertising data linked to survey data on quality and brand awareness for firms across many sectors. They find that advertising has a larger impact on brand awareness than on quality perception (they do not, however, distinguish between advertising campaigns targeted at communicating quality versus brand awareness).

4.3 Long-run impact on station brand affiliation

Depending on the severity of the impact on station owners' profits, we might expect to see a long-run impact on BP through loss of station share as retailers switch affiliations to other brands. Most gasoline stations are owned or leased by independent dealers who sign long-term contracts with upstream refiners to sell and market a particular brand of gasoline.[35] If expected returns to the BP brand fall low enough, station owners may switch brand affiliations. This is a second, longer-term measure of the spill's impact on demand and long-run supply. We measure changes in BP's *share of stations* across zip codes before and after the oil spill, as well as how these patterns differ with BP advertising.

Specifically, we estimate the following specification:

$$MarketShare_{z,t} = \mu_z + \sum_{-15}^{-1} \gamma_m \, 1(m = t) + \sum_{1}^{15} \tau_m \, 1(m = t) + \epsilon_{z,t} \quad (3)$$

where the dependent variable is BP's station share in zip code *z* in month *t*, γ_m are coefficients on dummy variables for each of the pre-spill months (before April 2010), τ_m are coefficients on dummies for each month after the spill (that is, after April 2010) and μ_z are zip code fixed effects. The omitted month is thus April 2010. The regression coefficients measure the change in station share relative to April 2010 controlling for zip code fixed effects. We estimate (3) separately for zip codes in metropolitan areas with above or below median BP ad spending during the Beyond Petroleum campaign years of 2000-2008. Figures 3A and 3B display the resulting coefficient estimates on the monthly time dummies with 95 percent confidence intervals for zip codes in above and below median advertising areas. Table A1 in the Online Appendix provides the corresponding regression tables.

The figures show no significant decline in station share in zip codes in high-Beyond Petroleum advertising areas, but a significant loss in below-median areas. The losses appear about six months after the oil spill, coinciding with the largest monthly drop in prices and sales volumes according to Figure 2. The loss in station share is sizeable, representing a five percent decline (-0.5% relative to a sample mean station share of 9.67%). The comparison of outlet share changes between areas with high and low pre-spill advertising suggests that advertising dampened longer term losses to BP in addition to softening the short-run negative impact of the spill on prices and sales.

[35] Although many stations are not convenience stores, the National Association of Convenience Stores describes contracting and pricing generally among its members (NACS, 2012)

4.4 Additional Evidence from Survey Data

Finally, we acquired consumer survey data on firms' environmental responsibility reputations to bring additional evidence on how negative environmental events and advertising affect consumers' stated valuations. The data are an annual online survey conducted by a major survey company which focuses on firm reputation and product quality perception. We focus on survey responses for major integrated oil companies from 2005 to 2013 (the earliest and latest waves available).[36] The survey is a repeated cross-section taken online around February each year by about 450 individuals. We report regression results on changes in consumer sentiment and ad spending in the Online Appendix Section III. The survey results generally support the view that environmental advertising is associated with higher environmental reputation and cushions the fall of reputation subsequent to an environmentally negative event.

5 Conclusion

This paper studies the ability of private markets to provide environmental stewardship through corporate social responsibility (CSR). We specifically explore the empirical validity of key requirements for such CSR provision in the context of the Beyond Petroleum campaign and 2010 BP Deepwater Horizon oil spill. We study the effect of the oil spill on BP gasoline prices and sales, and how the impact of the spill varied over time and across areas with different levels of green preferences, demographics, and investment by BP in green advertising prior to the spill. We find a statistically and economically significant (relative) decline in BP stations' prices and gasoline sales (for fleet card customers) that is consistent with a demand shift away from BP-branded gasoline in response to the oil spill. We find that station revenues suffered significantly larger losses in areas that exhibit stronger green preferences as measured by proxies such as hybrid vehicle ownership or Green Party donations. This finding relates to a growing literature linking political green preferences with consumers' retail purchasing behavior (e.g., Kahn, 2007; Kahn and Vaughn, 2009). Evidence that consumers may be voting with their wallets is essential for the ability of private markets to incentivize any degree of environmental protection.

We also show that pre-spill exposure to BP advertising significantly dampened the spill's impacts on BP stations' prices. During the decade preceding the oil spill, BP embarked on a large and celebrated marketing campaign to brand itself as an environmentally friendly company. In the absence of formal

[36] We present graphical and regression analysis using the survey firm's data in the Online Appendix. Due to restrictions on data use under our agreement with the survey company, we are unable to refer to specific company names in our analysis. However, the patterns in consumer opinion generally reflect our empirical analysis using gasoline data.

certification schemes, advertising is a way for firms to signal and commit to environmental stewardship. However, our results suggest that green advertising may have led consumers to attribute the oil spill to bad luck rather than to negligent practices, playing a persuasive rather than an informative role about environmental practices. We interpret this as evidence that expenditures on CSR may function more as insurance (Minor and Morgan, 2011) and less as investment in signaling unobserved environmental product quality. Finally, we also find that advertising cushioned BP from long-run, negative impacts on sales as it decreased the fraction of gasoline stations who re-branded to other brands in the aftermath of the spill.

Overall, our results suggest that consumers value environmental stewardship, but their response to green advertising gives firms an incentive to greenwash. This hampers the market's ability to effectively reward corporate social responsibility and efficiently provide public goods. These findings support the need for public or private environmental certification to monitor green product claims and suggest that regulation may be necessary to provide the incentives for firms to internalize the environmental repercussions of their production decisions.

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TABLE 1: OIL SPILL IMPACT: BASIC DIFFERENCE ESTIMATES

VARIABLES	(1) Average Net Price	(2) Ln (Ave. Fleet Sales)	(3) Weekly Net Price	(4) Ln(Weekly Fleet Sales)
During-spill	0.072**	0.019**	0.071**	0.032**
	(0.001)	(0.004)	(0.001)	(0.003)
Post-spill	-0.062**	-0.025**	-0.062**	-0.021**
	(0.001)	(0.005)	(0.001)	(0.004)
BP*During-spill	-0.042**	-0.036**	-0.042**	-0.040**
	(0.002)	(0.009)	(0.002)	(0.008)
BP*Post-spill	0.025**	-0.027*	0.025**	-0.027**
	(0.002)	(0.011)	(0.001)	(0.009)
Observations	21,421	19,430	763,985	695,166
Adjusted R-squared	0.933	0.965	0.741	0.852
S.E.cluster	station	Station	station	station
Weight	price observation	quantity observation	price observation	quantity observation
# stations	7,503	6,735	7,503	6,735

Notes: Source: OPIS. The price and quantity data cover the period from January 2009 to March 2011. Columns (1) and (2) report estimates where the dependent variable is the station's average net price and average log-quantity computed over the entire "pre-," "during-" and "post-" spill periods. Columns (3) and (4) report estimates when the dependent variable is the station's weekly net price and log-quantity. Each specification regresses the dependent variable on dummies for the during-spill period, a dummy for the post-spill period, and their interactions with a dummy for BP gas station. All models control for station fixed effects. Standard errors are clustered by station. Significance at 1%**, 5%*.

TABLE 2: OIL SPILL IMPACT BY MONTH

VARIABLE	Weekly Net Price	Ln(Weekly Fleet Sales)
	(1)	(2)
BP*late_Apr'10	-0.011**	0.003
	(0.002)	(0.010)
BP*May'10	-0.041**	-0.030**
	(0.002)	(0.009)
BP*Jun'10	-0.049**	-0.063**
	(0.002)	(0.010)
BP*Jul'10	-0.044**	-0.049**
	(0.002)	(0.009)
BP*Aug'10	-0.061**	-0.067**
	(0.002)	(0.010)
BP*Sep'10	-0.029**	-0.010
	(0.002)	(0.010)
BP*Oct'10	-0.005**	-0.024*
	(0.002)	(0.010)
BP*Nov'10	0.021**	-0.040**
	(0.002)	(0.010)
BP*Dec'10	0.052**	-0.044**
	(0.002)	(0.011)
BP*Jan'11	0.049**	-0.031**
	(0.002)	(0.011)
BP*Feb'11	0.022**	0.012
	(0.002)	(0.011)
BP*Mar'11	0.028**	-0.033**
	(0.002)	(0.011)
Observations	763,985	695,166
Adjusted R-squared	0.839	0.860
Fixed Effects	station	Station
S.E.cluster	station	Station
Weight	price observation	quantity observation
# stations	7,503	6,735

Notes: Source: OPIS. The price and quantity data cover the period from January 2009 to March 2011. The dependent variables in Columns (1) and (2) are weekly net price and log-quantity, respectively. Each of these dependent variables is regressed on post-spill month dummies and their interactions with a dummy for BP gas station. All models control for station fixed effects. Standard errors are clustered by station. Significance at 1%**, 5%*.

TABLE 3: OIL SPILL IMPACT AND REID VAPOR PRESSURE REGULATION

VARIABLE	Average Net Price (1)	Ln(Ave. Fleet Sales) (2)	Weekly Net Price (3)	Ln(Weekly Fleet Sales) (4)
During-spill	0.075**	0.013	0.075**	0.024**
	(0.003)	(0.009)	(0.002)	(0.007)
Post-spill	-0.076**	-0.040**	-0.076**	-0.039**
	(0.001)	(0.011)	(0.001)	(0.009)
BP*During-spill	-0.075**	-0.028	-0.075**	-0.028
	(0.004)	(0.020)	(0.003)	(0.017)
BP*Post-spill	0.021**	-0.041	0.021**	-0.037
	(0.003)	(0.024)	(0.002)	(0.020)
Observations	5,878	5,195	211,285	184,665
Adjusted R-squared	0.886	0.959	0.645	0.850
Fixed Effects	station	Station	Station	Station
S.E.cluster	station	Station	Station	Station
Weight	price observation	quantity observation	price observation	quantity observation
# stations	2,107	1,853	2,122	1,864

Notes: Source: OPIS. The sample covers the period from January 2009 to March 2011. Sample restricted to states meeting the standard summertime Reid Vapor Pressure (RVP) 9.0 psi limit. The coefficients reported are from regressions of BP retail price and log-quantity on the during-spill dummy, the dummy for post-spill period, and their interactions with a dummy for BP gas station. Columns (1) and (2) report estimates where the dependent variable is the station's average net price and average log-quantity computed over the entire “pre-,” "during-," and "post-" spill periods. Columns (3) and (4) report estimates where the dependent variable is the individual station's weekly net price and log-quantity. All models control for station fixed effects. Standard errors are clustered by station. Significance at 1%**, 5%*.

TABLE 4: IMPACT OF OIL SPILL AS A FUNCTION OF GREEN PREFERENCES

	(1)	(2)	(3)	(4)	(5)	(6)
DEP. VARIABLE:	Price Diff	Sales Diff	Price Diff	Sales Diff	Price Diff	Sales Diff
BP	-0.043**	-0.036**	-0.041**	-0.036**	-0.041**	-0.033**
	(0.002)	(0.009)	(0.002)	(0.010)	(0.003)	(0.010)
Pct hybrid, Demeaned			0.008**	-0.003		
			(0.002)	(0.009)		
BP*(Pct hybrid, Demeaned)			-0.012*	0.039		
			(0.005)	(0.021)		
Income, Demeaned			-0.000	0.000	-0.000	0.000
			(0.000)	(0.000)	(0.000)	(0.000)
BP*(Income, Demeaned)			0.001**	-0.002*	0.001**	-0.001
			(0.000)	(0.001)	(0.000)	(0.001)
Green Index					0.006**	-0.002
					(0.001)	(0.002)
BP*(Green Index)					-0.006**	0.013
					(0.002)	(0.008)
Constant	0.073**	0.016**	0.073**	0.017**	0.074**	0.016**
	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)
Observations	6,388	5,868	6,388	5,868	6,388	5,868
Adjusted R-squared	0.050	0.002	0.057	0.003	0.070	0.002
# stations	6,388	5,868	6,388	5,868	6,388	5,868

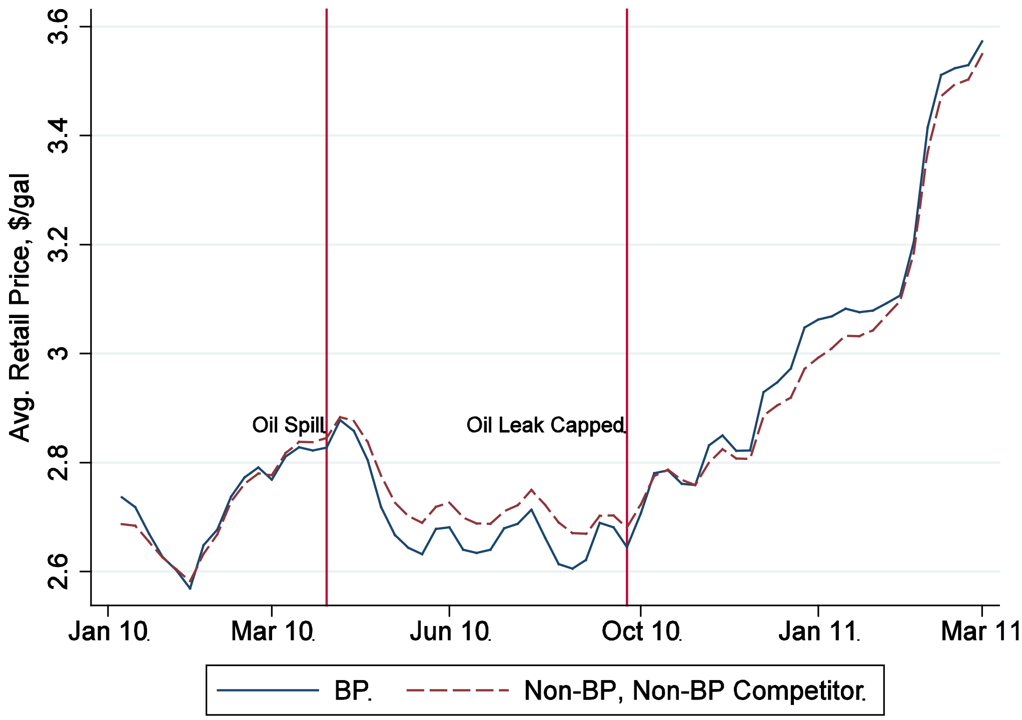
Notes: Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media. The sample is restricted to stations with available data on Green Index and household income. Columns (1) and (2) report the benchmark estimates from Table 1 for the sample of stations that has income, green index, and hybrid car share data available. The dependent variable is the station's price difference or log-quantity difference between the "pre" and "during" spill periods. Columns (3) and (4) add median household income and hybrid vehicle shares as control variables. Columns (5) and (6) add income and the Green Index. The Green Index is the sum of z scores for four variables: the hybrid share of vehicle registrations at the zip-code level in 2007, Sierra Club membership, the number of LEED-registered buildings per capita, and contributions to Green Party committees. Zip-code income is in 2000 U.S. $thousands. Significance at 1%**, 5%*.

TABLE 5: OLS AND IV ESTIMATES OF OIL SPILL IMPACT INCLUDING INTERACTIONS WITH GREEN PREFERENCES AND PRE-SPILL ADVERTISING

	OLS ESTIMATES		OLS ESTIMATES		2SLS ESTIMATES	
DEPENDENT VARIABLE:	Price Diff	Sales Diff	Price Diff	Sales Diff	Price Diff	Sales Diff
	(1)	(2)	(3)	(4)	(5)	(6)
BP	-0.035**	-0.031**	-0.042**	-0.029*	-0.044**	-0.025*
	(0.002)	(0.010)	(0.003)	(0.011)	(0.003)	(0.012)
Green Index			0.006**	-0.001	0.005**	-0.002
			(0.001)	(0.003)	(0.001)	(0.003)
BP*(Green Index)			-0.007**	0.010	-0.007**	0.010
			(0.002)	(0.008)	(0.002)	(0.009)
Income, Demeaned			0.000	0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)	(0.000)
BP*(Income, Demeaned)			0.001**	-0.002*	0.000*	-0.002*
			(0.000)	(0.001)	(0.000)	(0.001)
Ad spending, Demeaned			-0.000	0.000	-0.001**	-0.000
			(0.000)	(0.001)	(0.000)	(0.001)
BP*(Ad spending, Demeaned)			0.003**	0.000	0.004**	-0.001
			(0.000)	(0.002)	(0.001)	(0.002)
Constant	0.067**	0.013**	0.067**	0.013**	0.062**	0.014**
	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)	(0.005)
# observations	5,088	4,662	5,088	4,662	5,002	4,582
# stations	5088	4662	5088	4662	5,002	4,582
R-squared	0.039	0.002	0.074	0.002	0.075	0.003

Notes: Source: OPIS, Sierra Club, R.L. Polk, the U.S. Green Building Council, and U.S. Census. The sample is restricted to stations with available data on Green Index, household income, and BP advertising expenditures. Columns (1) and (2) report the benchmark estimates from Table 1 for the stations that have income, Green Index, and advertising data available. The dependent variable is the station's price difference or log-quantity difference. Columns (3) and (4) report results with added controls for Green Index, demeaned median household income, and demeaned cumulative BP advertising expenditures during the 'Beyond Petroleum' campaign years for the BP Corporation, BP fuels, and environmental issues. Expenditures are in $millions, with mean $1.5 and std. $3.4 mil. The regressors of interests are the interactions of these variables with the BP gas station dummy. The price difference is the average net price in the during-spill period minus the pre-spill period. The log-quantity difference is the log average quantity in the during-spill period minus the pre-spill period. Columns (5) and (6) report 2SLS estimates instrumenting BP advertising expenditures with the DMA average spot TV ad price across all industries and products in 2007-2008. First stage results are in the Online Appendix. The Green Index is sum of z scores for four variables: the hybrid share of vehicle registrations at the zip-code level in 2007, Sierra Club membership, the number of LEED-registered buildings per capita, and contributions to Green Party committees. Zip-code income is in 2000 U.S. $thousands. Significance at 1%**, 5%*.

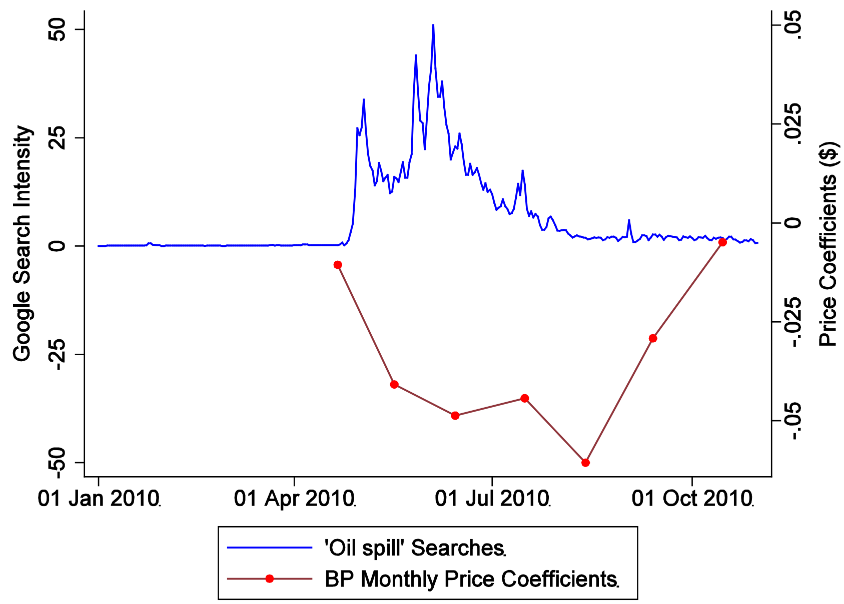
FIGURE 1
AVERAGE WEEKLY PRICE (LEVEL) FOR BP AND CONTROL STATIONS
JANUARY 2010 TO MARCH 2011



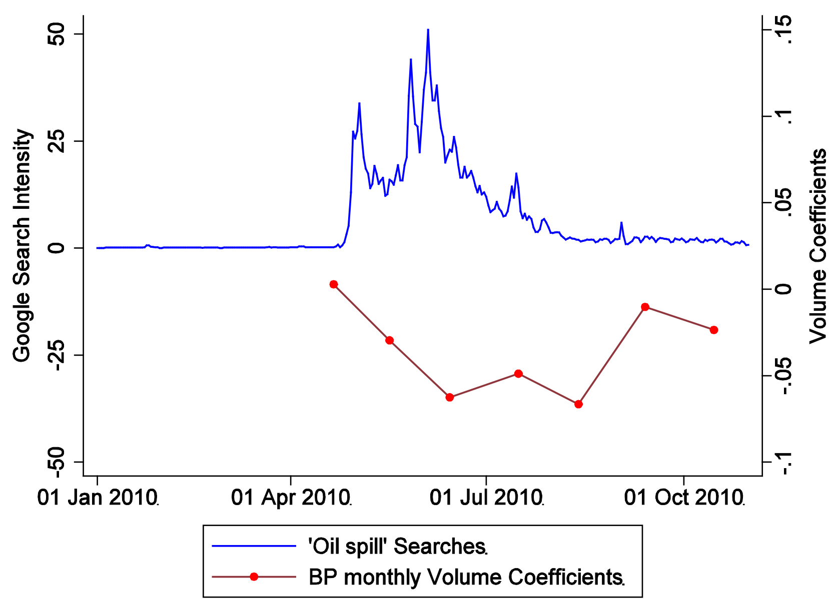
Notes: Source: OPIS. The figure displays average weekly prices for BP and non-BP competitor stations in our sample of 7,503 stores. See text and Online Appendix for details on our sample construction, and for a zoomed out version of the graph starting at the beginning of our sample in 2009.

FIGURE 2: GOOGLE SEARCH INTENSITY OF BP OIL SPILL RELATED SEARCHES

Panel A. Google Intensity and Price Coefficients



Panel B. Panel A. Google Intensity and Quantity Coefficients



Notes: Source: OPIS and Google Insights (accessed 8/16/2011). The figures display in blue the Google search intensity for the phrase "oil spill" relative to January 2004. For a given month, the Google search intensity measures the ratio of searches in that month to searches during the baseline month. A value of 50 thus indicates that searches in a month were 50 times greater than in January 2004. The red lines with markers plot the month-specific coefficients presented in Table 2. The dependent variables are station weekly net prices and log-quantity, respectively. Each dependent variable is regressed on post-spill month dummies and their interactions with a dummy for BP gas station. All models control for station fixed effects.

FIGURE 3A: BP MARKET SHARE TIME-DUMMY COEFFICIENTS, ABOVE MEDIAN ADVERTISING SPENDING

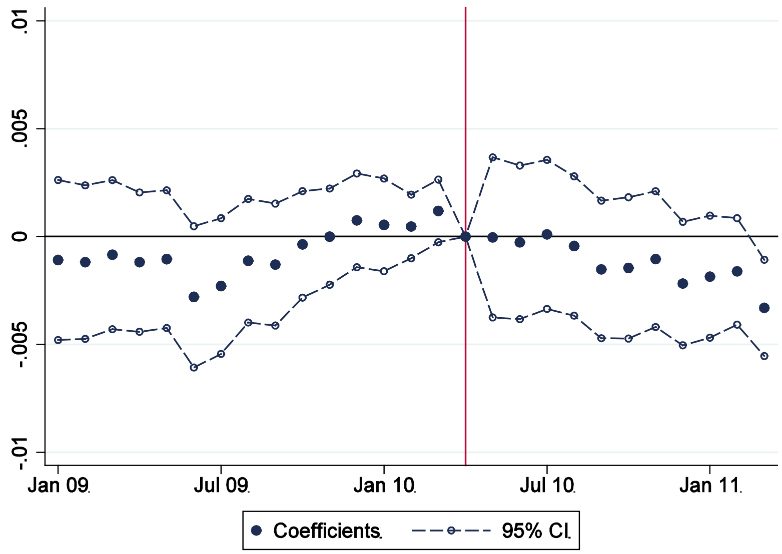
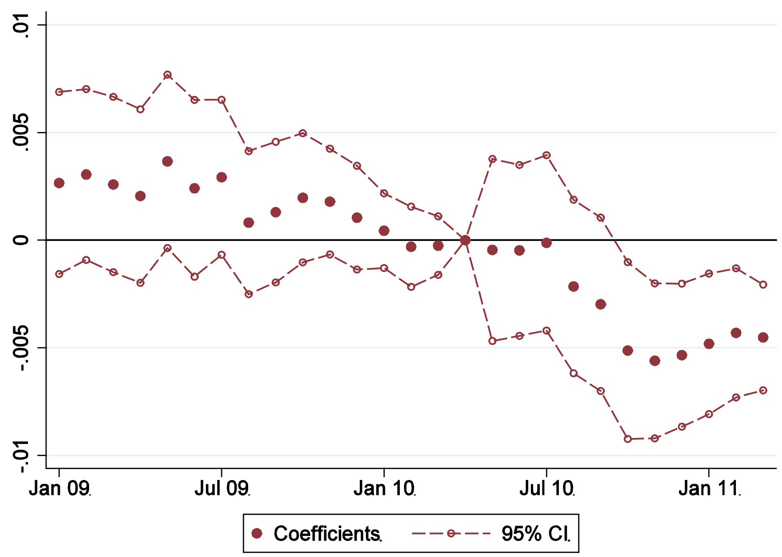


FIGURE 3B: BP MARKET SHARE TIME-DUMMY COEFFICIENTS, BELOW MEDIAN ADVERTISING SPENDING



Notes: Sources: OPIS and Kantar Ad$pender. This figure displays the coefficients on monthly time dummies –relative to the omitted April 2010 oil spill month – from a regression of the share of BP stations in each zip code-month on these time dummies as well as zip code fixed-effects (see specification (3) from the text). The regression was estimated separately for zip codes in metro areas with above and below median BP ad spending during the Beyond Petroleum campaign years of 2000-2008. The corresponding regression results can be found in the Online Appendix.