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ADVERTISING AS INSURANCE OR COMMITMENT? EVIDENCE FROM THE BP OIL SPILL

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ABSTRACT

This paper explores whether private markets can incentivize environmental stewardship. We examine the consumer response to the 2010 BP oil spill and test how BP's investment in the 2000-2008 "Beyond Petroleum" green advertising campaign affected this response. We find evidence consistent with consumer punishment: BP station margins and volumes declined by 2.9 cents per gallon and 4.2 percent, respectively, in the month after the spill. However, pre-spill advertising significantly dampened the price response, and may have reduced brand switching by BP stations. These results indicate that firms may have incentives to engage in green advertising without investments in environmental stewardship.

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1 Introduction

How does advertising shape consumer behavior and firm incentives to undertake costly and hidden investment in product quality? The answer to this question informs a debate over whether private markets can provide incentives for public goods such as environmental stewardship in production of goods and services. One view holds that advertising can provide valuable information to consumers who seek to support firms that base production decisions on environmental and sustainability concerns. Another view suggests firms may use advertising as a means of creating spurious product differentiation and brand loyalty in green markets.[1]

This paper provides novel evidence on the role of advertising in green markets by studying the consumer response to the British Petroleum (BP) Deepwater Horizon Oil Spill in 2010, one of the largest oil-related environmental disasters to date.[2] Prior to the spill, BP undertook one of the most successful corporate advertising campaigns entitled "Beyond Petroleum." Between 2000 and 2008, BP debuted a new logo – a Helios (sun) symbol – and rebranded the BP acronym (i.e., the slogan "Beyond Petroleum" replaced the name British Petroleum). These actions reflected a newly stated dedication to environmental stewardship and commitment to production methods that mitigated environmental degradation. Consumers appeared to have internalized this message as surveys fielded during the campaign consistently rated BP as the most environmentally friendly oil company during the mid-2000s (Landor Associates and Cohn and Wolfe and Penn, Schoen and Berland Associates,

[1] This discussion of advertising relates to two types of models of the economics of advertising (Bagwell, 2007). One type of model suggests that advertising provides information that can enhance market efficiency when there is imperfect consumer information and costly search. A second type of model holds that advertising is persuasive, thus potentially protecting firms even in the event of negative product news (Minor and Morgan, 2011).

[2] 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 the ensuing weeks (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Despite containment efforts, the spill led to the world's largest accidental release of oil into marine waters. 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, 2013).

2007, 2008).

The Beyond Petroleum campaign and subsequent BP oil spill provide a natural setting to study how advertising affects firm incentives to provide public goods. Absent third-party certification, advertising is the main mechanism through which firms make environmental quality claims to consumers. Whether consumer valuation of environmental stewardship can successfully incentivize its provision in equilibrium depends critically on whether consumers punish firms for deviating from advertised product attributes (Besley and Ghatak, 2007).

Our analysis proceeds in two steps. First, we estimate the consumer response to the BP oil spill using detailed data on gasoline station prices and a select measure of sales from January 2009 to December 2010. We identify impacts by comparing outcomes for BP and a comparison group of stations in periods before and after the spill. This difference-in-differences approach indicates that there was an economically and statistically significant consumer response to the oil spill. Retail prices at BP stations declined by 2.9 cents per gallon relative to the comparison stations in the first month after the spill (May 2010). This impact represents up to an 18 percent decline in profit margin relative to industry standards. In addition, BP sales declined on average by 4.2 percent among our sample of station customers (Wright Express fleet card holders). For the entire period before BP capped the oil leak (May-September 2010), there was an average price decline of 1.1 cents per gallon.

The second step in our analysis studies how advertising modified the consumer response to the spill by combining station-level data with metropolitan-level data on BP advertising during the 2000s. Our core measure focuses on corporate advertisements (i.e., ads related to the BP Corporation, BP fuels, and environmental issues) during the Beyond Petroleum campaign (2000-2008). To address the potential endogeneity of advertising expenditures, we construct a novel instrumental variable (IV) based on the number of elections for mayors, U.S. Senators, and Governors in each metropolitan statistical area (MSA) during the period of the Beyond Petroleum campaign. Electoral calendars are legally preset and should be exogenous to any unobserved area characteristics correlated with demand responses to the BP oil spill. At the same time, this instrument should be relevant because political advertising displaces other forms of advertising. This idea stems from (Sinkinson and Starc, 2018) who study pharmaceutical advertising using a similar IV strategy based on the primary calendar for the 2008 national election.

Our advertising results show that the negative impact of the oil spill on BP prices was significantly less severe in areas with more pre-spill advertising. Moreover, this protective effect on prices was significantly stronger in areas where consumers have "green preferences" as captured by an index measure based the local area share of hybrid vehicles and support for environmental organizations.[3] We also find suggestive evidence that advertising appeared to mitigate longer-run effects of the oil spill. Utilizing an event study framework, we find that markets with low pre-spill advertising suffered significantly greater losses in BP retail outlet share after the spill. The losses amount to a six percent decline relative to the mean in areas with low pre-spill advertising. Though subject to the limitations of event studies, these results are consistent with the possibility that during-spill profit losses may have been large enough to induce station owners to switch to alternative brands, whereas BP investments in green advertising mitigated those impacts in other markets.

The evidence of a mitigating effect of the Beyond Petroleum campaign suggests that advertising provides insurance against reputational costs. This may occur because advertising and other types of corporate social responsibility shift beliefs about whether an adverse event was due to negligence or bad luck (Minor and Morgan, 2011).[4] This interpretation is consistent with the idea that advertising plays more of a persuasive rather than an informative role.[5]

[3]The index measure that we construct follows similar approaches by List and Sturm (2006); Kahn (2007); Kahn and Vaughn (2009).

[4]One alternative explanation is that positive brand recognition or non-environmental brand value (such as habit formation) buoyed demand (Clark, Doraszelski and Draganska, 2009). While we only observe one history of BP advertising, we compare the effects of core corporate and environmental advertising during the Beyond Petroleum campaign against the effects of local and ancillary BP station product ads. We find significantly larger protective effects of environmentally-themed corporate advertisements in areas where consumers exhibit "green" preferences.

[5]Recent empirical evidence supports the idea that persuasive advertising is effective.

In terms of contribution, this paper broadly stands at the intersection of three literatures. First, we add to studies of the causal impact of advertising on consumer behavior. Recent work has studied the impact of advertising using price and expenditure related instruments (Dube and Manchanda, 2005; Iizuka and Jin, 2005; Chou, Rashad and Grossman, 2008; Liu and Gupta, 2011; Dinner, Van Heerde and Neslin, 2014) and experimental methods (Bertrand et al., 2010; Lewis and Reiley, 2014; Lewis and Rao, 2015). Most closely related to our analysis is Sinkinson and Starc (2018) who pioneered the use of an instrumental variable approach based political campaigns and found positive impacts of advertising on pharmaceutical sales. Our paper complements prior studies by examining how advertising affects consumer behavior in the aftermath of a negative event. In this sense, our analysis secondly relates to a literature that shows accidents, regulatory violations and product recalls have negative impacts on firm performance (Jarrell and Peltzman, 1985; Hoffer, Pruitt and Reilly, 1988; Barber and Darrough, 1996; Borenstein and Zimmerman, 1988; Karpoff, Lott and Wehrly, 2005; Dranove and Jin, 2010; Minor and Morgan, 2011; Freedman, Kearney and Lederman, 2010). We add to this literature by examining consumer responses to a large environmental disaster.

Third, we contribute to studies of consumer information and deception. A growing number of empirical studies find that advertising may induce consumers to make less informed purchasing decisions. This could weaken demand responses as a market disciplining mechanism to sustain firms' commitment to product quality. For example, Jin and Kato (2006) find that online sellers can earn price premiums for unverified product quality claims even when those are misleading. Similarly, Zinman and Zitzewitz (2016) document deceptive advertising in the context of snowfall and ski reports. Bronnenberg et al. (2015) find that misinformation accounts for a sizable portion of brand premiums for health products such as pain relievers. Finally, Rao and Wang (2017) find that firms gained significant revenues by making false claims about

Bertrand et al. (2010) find that non-informative advertising – such as an attractive woman's photo – can affect demand significantly even when consumers had previously purchased the advertised product.

the health attributes of consumer products. They find significant declines in demand when the Federal Trade Commission (FTC) ordered termination of misleading claims. However, this effect is heterogeneous with large responses by newcomers and more muted effects for existing customers. Our results are consistent with the idea that advertising may provide protective benefits to firms that make unsubstantiated product claims.

Overall, our findings relate to public policy debates over consumer protection and regulation. A concern is that persuasive advertising affects consumer demand and weakens incentives for firms to invest in product quality. Misleading advertising is especially policy-relevant in the environmental realm, where there are concerns about a "greenwashing" equilibrium.[6] With this in mind, several policies could enhance efficiency in markets where consumers seek to purchase environmentally friendly goods and services. For example, both truth-in-advertising regulations and third-party evaluations of product claims have been effective in other contexts.[7] Yet, a concern is that these policies may be difficult to apply to broad environmental campaigns or marketing that includes nature-based imagery.[8] These considerations suggest that price-based regulations (e.g., pollution taxes or penalties) likely remain a first-best policy solution to environmental externalities. We present a detailed discussion of policy options in Section 5.

[6]See Laufer (2003) and references therein. Ramus and Montiel (2005) contrast firms' environmental policy statements and implementation. Non-governmental organizations such as TerraChoice evaluate greenwashing at the product-level. Empirical evidence for the potential success of greenwashing has been documented based on survey perceptions, web experiments, and media accounts (Parguel, Benot-Moreau and Larceneux, 2011; Nyilasy, Gangadharbatla and Paladino, 2014; Berrone, Fosfuri and Gelabert, 2017).

[7]For example, Jin and Leslie (2003) provide evidence on the impact of third-party evaluations by studying restaurant hygiene ratings. For truth-in-advertising rules in the environmental realm, see Rohmer (2007).

[8]For example, Parguel, Benoit-Moreau and Russell (2015) provide experimental evidence that evoking nature in advertising misleads consumers in their evaluation of a brand's ecological image.

2 Background

From 2000 to 2008, BP conducted a public relations and marketing campaign that sought to align the company with environmental issues. BP introduced a new slogan, "Beyond Petroleum," and redesigned the company logo to a green and yellow Helios sun. BP advertisements emphasized that the company was investing to make operations more efficient and reduce environmental impacts (Cherry and Sneirson, 2010).[9]

This marketing appeared to impact industry and consumer stakeholders. The Beyond Petroleum campaign won two PR Week "Campaign of the Year" awards and received the Gold Effie Award from the American Marketing Association in 2007 (Solman, 2008).[10] Survey data suggests consumers were aware of the environmental messaging. In 2008, Landor Associates, a marketing firm, found that 33 percent of survey respondents believed BP was a "green" brand. Respondents also ranked BP as the greenest of the major petroleum companies (Landor Associates and Cohn and Wolfe and Penn, Schoen and Berland Associates, 2007, 2008). A poll by Marketing Week also ranked BP third in terms of companies that made the greatest commitment to environmental issues (Marketing Week, 2008).[11]

Why did BP invest in environmental branding? Prior research shows that consumers are willing to pay for environmental stewardship as a product attribute (Nimon and Beghin, 1999; Forsyth, Haley and Kozak, 1999; Goett, Hudson and Train, 2000; Loureiro, McCluskey and Mittelhammer, 2001; Roe et al., 2001; Teisl, Roe and Hicks, 2002; Pelsmacker et al., 2006; Kahn, 2007; Kahn and Vaughn, 2009; Kiesel and Villas-Boas, 2013). In addition, the literature has found that advertising increases demand for advertised products (Ackerberg, 2001; Dube and Manchanda, 2005; Bagwell, 2007; Sorensen, 2007;

[9]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).

[10]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, 2001).

[11]At the same time, several environmental and advocacy groups, such as Greenpeace and Corpwatch, already criticized BP's re-branding as "greenwashing" (Bruno, 2000).

Bertrand et al., 2010; Clark, Doraszelski and Draganska, 2009; Simester et al., 2009; Friberg and Grnqvist, 2012; Hastings, Hortasu and Syverson, 2017; Gurun, Matvos and Seru, 2016; Lewis and Reiley, 2014; Garthwaite, 2014).

While there may be demand for environmental quality, consumers do not know whether a product has this attribute (in the absence of third party certification). This suggests at least two motivations for green themed advertising. First, one class of model shows that firms can use advertising as a sunk cost to signal their investment in product quality (Grossman and Shapiro, 1984; Milgrom and Roberts, 1986; Cabral, 2005). Second, advertising could play a persuasive role that convinces consumers that negative events are accidental and due to "bad luck" (Minor and Morgan, 2011). In this sense, advertising changes customer beliefs about firm behavior and acts as insurance. Such beliefs could mitigate consumer punishment and thereby decrease the incentives for firms to invest in hard-to-observe product characteristics.[12]

The period after the Beyond Petroleum marketing campaign provides a unique opportunity to study environmental advertising due to the BP Deepwater Horizon oil spill. In April 2010, an oil well blowout sunk the Deepwater Horizon rig, and robotic monitoring devices soon discovered that oil was leaking from the damaged well. BP sought to contain the leak, but their efforts were unsuccessful until engineers installed a "containment dome" in July 2010 (Aigner et al., 2010). Officials declared that the damaged well was "effectively dead" after a relief well was completed in September 2010. Scientific experts estimated that 205.8 million gallons of oil had leaked before containment (Department of Interior, 2010). Subsequent investigations found that the cause of the spill was attributable to active management decisions on behalf of BP.[13]

[12]More broadly, models of ex-ante unobservable product quality provision have found that firms must face financial sanctions for false product quality claims (such as advertising) as incentives for equilibrium quality provision (see Cabral (2005) for a survey of this literature). Models of private provision of public goods have similarly formalized this point (Besley and Ghatak, 2007). In addition, punishment may be more difficult if deviation is hard to detect. In our setting, negative news about environmental stewardship may only occur probabilistically. Consumers must infer events are the result of shirking on quality promises, and decrease demand accordingly.

[13]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. In addition,

3 Data Sources and Sample Construction

We use several proprietary data sources to study the impact of the BP oil spill and advertising. This section provides a detailed summary of our sample construction and key variables. A brief overview is as follows. We begin by creating a sample of BP and comparison group stations using data from the Oil Price Information Service (OPIS) (2009-2010). The OPIS data contain station-level information on regular grade retail gasoline prices, a select measure of sales volumes based on fleet card holders (further detailed below) and brand affiliation. Next, we match the sample of stations to wholesale gasoline prices from OPIS based on distribution terminal ("rack") prices aggregated at the state-week level. The linked data allow us to compute net prices as a measure of retail margins. In addition, we link the sample of stations to Designated Market Area (DMA) measures of BP advertising obtained from Kantar Media.[14] Finally, we link the sample of stations to local area proxies of consumer preference for environmental protection, demographics, and elections. These measures vary at the state or zip code level.

3.1 Station-Level Sample

We create a sample gasoline stations using data from OPIS, which collects information from two sources. First, OPIS observes stations over time based on Wright Express fleet fuel card "swipes."[15] This information is available

the commission concluded 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 on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Officials at the Department of Justice concluded that "the explosion of the rig was a disaster that resulted from BP's culture of privileging profit over prudence" (Brewer, 2012).

[14] A DMA is a geographic area that represents a specific television market as defined by and updated annually by Nielsen.

[15] Wright Express uses fleet card swipes and reports the last daily transaction at each station to OPIS. The price is based on the transaction total sales amount and the volume of gallons sold. As with all scanner data, the process can result in errors. 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 because there are more purchases recorded for stations each week and the data is easier for Wright Express and OPIS to clean. We drop only one percent of

for stations that accept this fleet card on days when fleet card transactions happen (i.e., an individual must use their fleet card for a particular station on a particular day).[16] The fleet card is widely accepted across the U.S. Second, since 2009, OPIS has expanded its data collection to include reporting agreements with several gasoline refiner-marketers that provide data for additional stations that do not accept the fleet card.[17] Between these two sources, OPIS has data for over 100,000 stations across the United States.

We define the sample for our analysis based on two considerations. First 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 fleet sales over time, we focus on zip codes where OPIS reporting meets minimum density criteria.[18] Each zip must have at least five 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.

The second consideration is to ensure sufficient geographic congruity between treatment and control stations. Our empirical analysis compares prices at BP branded stations (the treatment group) to a comparison group of stations in zip codes without any BP stations. Note that the data contains information on a station's brand over time, and we identify BP stations based on the brand observed in January 2009. Our preferred control group excludes non-BP stations in close proximity to BP stores as their prices were likely impacted by the spill as well. In the United States, the BP brand has a broad presence east of the Mississippi River, but becomes more selectively concentrated toward the West. To ensure that our empirical analysis compares treatment and comparison stations in comparable regions, we restrict the analyses to EIA areas where BP has a sufficient brand presence: the East Coast (PADD 1), the Midwest (PADD 2), and the Gulf Coast (PADD 3). Based on these criteria, we create a sample that contains 5,526 and 4,997 stations for the (separate)

price observations based on sudden and large one-day changes in prices.

[16]See also Busse, Knittel and Zettelmeyer (2013) for another description of these data.

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

[18]Further details on how we clean the data and define our sample are in the Online Appendix Section A2.

analyses of station-level prices and fleet sales, respectively.[19] Note that we test the robustness of the results for prices and fleet sales to changes in the sample inclusion criteria.[20]

3.2 Net Price, Fleet Card Sales and Brand Outcomes

For stations in the sample, the OPIS data contain station-level information on retail prices for regular grade gasoline, sales to fleet card holders and brand affiliation. The retail prices for each station are at the daily level, which we aggregate to a weekly measure because most stations do not report a price every day. We construct a net price measure (an estimate of retail price margin) after linking the sample to additional data from OPIS on wholesale prices. The wholesale prices stem from local gasoline distribution terminals ("racks"). We use state-level averages of minimum rack prices, averaged over the relevant retail gasoline formulations sold in a given state-week (e.g., 10 percent ethanol reformulated gasoline where applicable or locally relevant Reid Vapor Pressure formulations). This is a regionally appropriate measure of wholesale prices that accounts for supply shocks at a high temporal frequency that matches the retail price data.[21] Formally, we construct the weekly station-level net price of station i in state j during week t as:

$$netprice_{i,t} \equiv AvgRetailPrice_{i,t} - AvgWholesalePrice_{j,t} \tag{1}$$

As mentioned, we focus on weekly net prices 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 (detailed in Section 4), we

[19] The number of stations with price observations is larger since some OPIS sources only report prices, and OPIS obtains volume information solely from fleet card swipes. There are 4,975 stations in the sample that have data on both prices and fleet card sales.

[20] Online Appendix Table A2 replicates the main results in a sample that includes direct BP competitors in the sample. Online Appendix Tables A3 and A4 present specifications using all 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. Finally, the main results are similar or larger in the full U.S. sample (see Barrage, Chyn and Hastings (2014)).

[21] In contrast, alternative wholesale price data such as from the EIA are based on surveys of gasoline refiners, which are conducted at a monthly level.

weight weekly price and quantity observations by the underlying number of daily observations within the station-week.

For stations that accept fleet cards (as opposed to stations whose parent companies only report prices to OPIS), total gasoline sales to fleet cards is recorded at the weekly level. While limited, these data represent, to our knowledge, the only station-level volume data currently available.[22] Fleet card drivers range from professional drivers to employees and members of small business or other entities (e.g., municipalities). Although these customers' preferences may differ from the broader population, these data provide a glimpse into consumer behavior.

Finally, we also use the OPIS data to create a measure of BP's share of stations within each zip code at the monthly level. The underlying data contain information on each station's brand of gasoline at the weekly level. We aggregate this information into a monthly measure to explore longer-run brand switching behavior. (Our main analysis uses the station's initial brand in January 2009 to define treatment and comparison group indicators that do not vary over time.)

3.3 Advertising Measures

We link each station in the sample to measures of advertising from Kantar Media's Ad$pender database.[23] Kantar uses tracking technologies and services to monitor advertising on television (cable and network), online, or in print publications such as business-to-business magazines, consumer magazines and news publications, and on internet sites. Kantar also collects outdoor and local radio advertising information from other marketing subscription services and directly from media providers (e.g., radio stations or billboard plant op-

[22]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).

[23]Kantar collects information on advertising expenditures on the following 18 types of media: 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.

erators).[24]

We use data on BP advertising for the years 2000-2011. The underlying observations are at the monthly level and provide information on the media type and market (DMA). The data also identify the parent company (e.g., BP), distinguish between brands (e.g., BP service station vs. Amoco service station) and differentiate between the specific products advertised (e.g., BP energy utilities vs. BP gasoline).

Our main advertising measure is pre-spill BP advertising expenditures during the years of the Beyond Petroleum campaign (2000-2008) at the DMA level. This measure includes all advertising that focused on the BP Corporation, BP fuel products, and environmental issues. We aggregate 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). For the robustness analysis, we also construct a measure of all advertising during the BP oil spill period (March to September 2010). We also construct a detailed measure of advertising for ancillary products and convenience stores at BP stations.

3.4 Elections Measure

We also link each station in the sample to a measure of local area elections. This measure allows us to construct an instrumental variable to address the concern that BP advertising may be endogenous to each area's unobserved preferences for the BP brand. Electoral calendars are plausibly exogenous to spill impacts because they are preset by law. In other words, there should be no correlation between population preferences or other unobserved characteristics that are correlated with demand responses to the BP oil spill.[25] The relevance of this instrument stems from the effect of political campaigns on the costs of advertising. There is cross-sectional variation in the cost of advertising due

[24]For more details, see Ad$pender manual (Kantar Media, 2011). See also other papers that have used these data: Saffer and Dave (2006); Chou, Rashad and Grossman (2008); Clark, Doraszelski and Draganska (2009); Gurun, Matvos and Seru (2016).

[25]For example, state assignment to different electoral calendars of the U.S. Senate Classes 1, 2, or 3 were randomly determined by a coin toss or lot drawing (U.S. Senate, 2018).

to the differences in the number of elections each city experienced during the Beyond Petroleum campaign. This logic follows (Sinkinson and Starc, 2018), who utilized variation in primary election dates in 2008 to instrument for pharmaceutical advertising exposure across states. Our specific instrument is the total number of elections for U.S. Senators, Governors, and mayors that each MSA experienced during the Beyond Petroleum campaign years (2000-2008).[26]

3.5 Local Area Characteristics and Measures of Green Preferences

Finally, we link each station to measures of local area characteristics and green preferences. Specifically, we use the 2000 U.S. Census to obtain measures of zip code level median household income. We follow prior studies to study green preferences. 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 and LEED-certified buildings cluster in politically green communities. Similar to these prior studies, we collect the following measures and aggregate them into a "Green Index" score:[27]

- Hybrids Cars: 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.

- Sierra Club Membership: Per-capita Sierra Club membership in 2010

[26] 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.

[27] 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.

at the state level created using data from the Sierra Club and the U.S. Census Bureau.

- LEED Buildings: The number of LEED-registered buildings per-capita in each zip, obtained from the U.S. Green Building Council (accessed in June 2011).

- Green Party Contributions: Average per-capita contributions to Green Party committees in 2003-2004 and 2007-2008 at the zip code level, computed using individual level data from the Federal Election Commission.[28,29]

We first aggregate these variables by computing z-scores for each measure and taking the sum. We then create an indicator variable "Green Zip" to classify zip codes based on whether they have above or below median Green Index scores.

3.6 Summary Statistics

Online Appendix Table A1 provides summary statistics for all measures used for our main analysis. Station-level weekly net prices were $0.55 on average during our sample period (2009-2010). For the analysis, we rely on the station-level price difference between the pre- and post-spill period averages. The mean change in price is 5 cents in our sample, which reflects the fact that retail gas prices generally increased between 2009 and 2010. For the 645 unique zips covered by our sample of stations, the average median household income (based on the 2000 Census) is approximately $48,000, which was slightly higher than the national median income of $42,000 (US Census Bureau, 2001). Online Appendix Table A1 also shows that the average DMA in our sample received about $1.8 million of BP advertising during the Beyond Petroleum campaign years (2000-2008). For this set of DMAs, there was an average of 7.63 elections during this same period.

[28] The Federal Election Commission data cover all individual contributions over $200.

[29] To maintain comparability with the income data, contributions are converted to 1999 dollars using the CPI inflation calculator from the Bureau of Labor Statistics.

Online Appendix Figure A2 provides aggregate summary statistics for the states covered by our sample of stations. Panel (c) shows that BP advertising prior to the spill was highest in several Midwestern (Illinois, Indiana, Ohio) and Southeastern (Florida and Georgia) states. Panel (d) shows that the states with the highest number of elections during the Beyond Petroleum years were Texas, Missouri, North Carolina and Michigan. As expected, there is no apparent pattern of geographic clustering in our measure of elections.[30]

4 Empirical Analysis

4.1 The Consumer Response to the BP Oil Spill

We begin by examining the impact of the BP oil spill on station prices and fleet card sales using a difference-in-difference style approach. Our approach designates BP stations as the treatment group, and we use non-BP stations that are not in the same zip code as a BP station as the comparison group. As mentioned, this definition excludes non-BP stations in close proximity because the oil spill may have had an impact on these stations as well.[31]

Formally, the model is a regression of station net price or fleet sales on station fixed effects, indicators for the during- and post-spill periods, and interactions of those time period dummies with an indicator of whether a station sells BP-branded gasoline:

$$y_{i,t} = \alpha_i + \beta_1 during_t + \beta_2 post_t + \theta_1(during_t \times BP_i) + \theta_2(post_i \times BP_i) + \epsilon_{i,t} \quad (2)$$

where $y_{i,t}$ is an outcome for station i in period t, α_i is a station-level fixed effect, $during_t$ is an indicator equal to one if period t is during the oil spill, $post_t$ is an indicator equal to one if period t is after the spill (defined by the official capping of the leak in September 2010), and BP_i is an indicator of whether station i sells BP branded gasoline. We cluster standard errors at the

[30] In addition, Online Appendix Table A9 shows that there are no significant correlations between the total number of elections during 2000-2008 and MSA-level characteristics.

[31] In Section 4.2, we discuss results based on including non-BP stations within BP markets as part of the comparison group.

zip code level.[32]

Our preferred specification aggregates net prices and quantities sold at the time period level. This approach addresses the possibility that autocorrelation in weekly measures of net prices or fleet sales might bias standard errors (Bertrand, Duflo and Mullainathan, 2004). Specifically, we address this concern by collapsing the 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 (September 18, 2010 to December 31, 2010). Columns 1 and 2 of Table 1 report results from this level of aggregation. For comparison, Columns 3 and 4 of Table 1 provide results using the disaggregated weekly net price and fleet sales data.[33]

All specifications show a negative and statistically significant effect of the oil spill on both prices and fleet sales at BP stations relative to the comparison group. BP stations experienced a relative price decrease of 1.1 cents per gallon and a 4.2 percent drop in sales from fleet customers on average in the five months after the spill.[34] Table 2 estimates the month-by-month change in BP prices and fleet sales relative to control stations. In the month after the spill (May 2010), BP stations experienced a peak price decline of 2.9 cents per gallon relative to comparison stations. Fleet sales impacts reached their peak in June 2010 at a 7.5 percent loss (relative to the comparison group). To put these effects in context, the National Association of Convenience Stores

[32]The literature on retail gasoline competition typically defines market measures within a one-to-two mile radius around a given station (Barron, Taylor and Umbeck, 2004; Eckert and West, 2004; Hastings, 2004; Hosken, McMillan and Taylor, 2008; Chandra and Tappata, 2011). As the average zip code in the United States comprises approximately 86 square miles, clustering at the zip level is appropriate given the localized nature of retail gasoline competition.

[33]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.

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

(NACS) estimates that the average retail mark-up was 16.3 cents per gallon in 2010 (NACS, 2011). Using this statistic, the largest monthly point estimate represents an 18 percent decline in retail margins. However, we also see that these effects are temporary. In the post-spill period, BP retail station prices rebound, although quantities remain depressed.

Figure 1 illustrates our main results by displaying the mean weekly price (level) for the BP and control stations.[35] The vertical lines denote the beginning and capping of the oil spill, respectively. 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, this BP premium collapses, consistent with the estimated relative price decline. Over the ensuing months, the BP premium begins to recover.

We also compare these estimated impacts with a measure of public interest in the BP oil spill. Figure 2 plots estimates from Table 2 against Google search intensity for the phrase "oil spill." In a given month, the Google search intensity is the ratio of searches relative to a baseline month of January 2004. (For example, a value of 50 indicates that searches in a 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 4, which was one day after a BP apology campaign began airing. The results suggest that public interest in the spill was significant around the time of the spill, and the evolution of public interest coincides with the peak price and fleet sales impacts.

4.2 Basic Robustness Checks

We conduct three exercises to examine the robustness of our main results to alternative sample definitions. First, Online Appendix Table A2 shows that the results are robust to including non-BP stations within the same zip code as BP stations in the comparison group. The estimated average price impact is attenuated slightly (from −1.1 cents to −0.7 cents per gallon), suggesting

[35] Figure 1 "zooms in" on the 2010 period. Online Appendix Figure A1 shows the same information for the full sample time frame January 2009-2010.

that nearby BP competitor stations partially matched the reduction in prices at BP stations.

Second, Online Appendix Tables A3 and A4 repeat the main analysis on the unfiltered sample of stations in the OPIS data (located in PADD 1, 2 and 3). Recall that we define the sample to include only stations that are located in zips where there at least five stations with three prices per week for our entire sample period. In the unrestricted OPIS sample, we obtain results that are very similar in magnitude to the results in Tables 1 and 2.

Third, we also conduct additional analysis of stations located in areas not subject to summertime gasoline Reid Vapor Pressure (RVP) standard regulations. Such gasoline content regulations can cause local seasonal increases in gasoline prices.[36] This is not necessarily a threat to our analysis of net prices because state wholesale prices incorporate all relevant gasoline formulations sold in a given state-week. That is, this measure of cost captures state average price increases due to seasonal gasoline content regulations. At the same time, it is possible that, within each state, BP stations are more likely to be located in zip codes subject to RVP requirements than comparison group stations.

Panels (a) and (b) of Figure A3 show the evolution of BP and comparison group station price levels over time for stations located in areas that are and are not subject to summertime RVP regulations, respectively. Both series show similar pre-spill trends with higher average prices at BP stations. After the spill, this premium disappears in both regulated and non-regulated areas, with an even stronger decline in the latter. Online Appendix Table A5 expands on these results by providing difference-in-difference results on the subset of zip codes which are not subject to RVP regulation.[37] For the net price variable, we also compute this measure after excluding restricted (RVP of 7 or 7.8) gasoline formulations in the wholesale price computation. These results are less precise, but the pattern of the estimates continues to show a significant decline in BP station margins and fleet card sales after the BP oil spill. In

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

[37]The restriction to stations in areas without RVP regulations decrease the sample size by around 75 percent.

sum, our first set of results thus suggest that, on average, BP stations suffered losses to revenues as a result of the BP oil spill, consistent with consumer punishment of BP.[38]

4.3 The Impact of Beyond Petroleum Advertising

To study the impact of past advertising on the consumer response to the oil spill, we augment our regression model from Equation 2 with measures of (demeaned) Beyond Petroleum campaign advertising expenditures. On the one hand, we might expect steeper losses at BP stations in areas with heavier advertising if consumers believed this was a signal of BP's commitment to environment stewardship. On the other hand, such advertised claims could have swayed consumer beliefs about whether the disaster was due to bad luck or bad management, thereby mitigating price and fleet sale impacts (Minor and Morgan, 2011).

To ease the interpretation of our results, we restrict the sample to the immediate pre-spill (starting in January 2009) and during-spill periods. This regression reduces to a standard two-period, two-group difference-in-difference model. In our analysis, we use the station-level difference in net price or total fleet sales during the spill versus the pre-spill period as the dependent variable. We also include main effect and interaction terms for the Green Index and zip code household income as control variables in this advertising analysis. We demean each of these interaction variables and interact them with an indicator for BP brand affiliation.

Columns 1 and 2 of Table 3 report ordinary least squares (OLS) results. The results suggest that greater exposure to BP advertising in 2000-2008 mitigated the impact of the oil spill on BP station prices significantly (p-value$<$ 0.05). We fail to detect a corresponding impact of pre-spill advertising on BP

[38]This response may be surprising given that punishment is not individually rational for consumers whose demand is not sufficient to affect aggregate outcomes or incentives. In this way, boycott behavior is analogous to voting (Downs, 1957; Olson, 1965; Palfrey and Rosenthal, 1985; Feddersen, 2004). Peer pressure models have been put forward as social mechanisms to overcome voting paradoxes (Gerber and Green, 2000; Green and Gruber, 2015; Coate and Conlin, 2004). Alternatively, Fehr and Gchter (2000) study laboratory experiments where the findings suggest that punishment may have intrinsic value.

station fleet quantity sales. There are at least two interpretations of this pattern of results. First, a negative demand shock accompanied by an outward supply shift (due to BP lowering prices) could result in an equilibrium with lower prices but unchanged quantities. Second, sales to fleet card customers may not be representative of the population segment relevant for station price setting.

One concern with these OLS estimates is that advertising may be endogenous to factors that are correlated with local demand response to the BP spill. While we control for confounders such as income and environmental preferences (as proxied by the Green Index), this may not be sufficient. To address this endogeneity concern, we instrument for advertising expenditures with a novel election calendar-based instrument: a *count* of the number of elections scheduled in each MSA during the Beyond Petroleum campaign years (2000-2008).

Our approach stems from the idea that the number of elections is a relevant instrument because political advertising displaces other types of advertising. Using a similar IV approach, Sinkinson and Starc (2018) showed that the political advertising during the lead up to the 2008 national election resulted in significant displacement on advertising for pharmaceuticals. The exclusion restriction in our context is that cross-sectional variation in elections during the Beyond Petroleum campaign years is not correlated with unobserved factors that determine the consumer response to the BP oil spill. This assumption is plausible since the political calendars are legally preset and should be independent of retail gasoline market factors. (Online Appendix Table A9 shows that we fail to detect significant correlations between our election measure and MSA-level characteristics such as BP station share, median household income or the Green Index.)

The remaining columns in Table 3 report the election-based IV results. The first stage estimates in Columns 3 and 6 show a highly significant negative effect of scheduled elections on BP ad spending. These results are consistent with the displacement effects detected in Sinkinson and Starc (2017). The performance of our first stage is strong in that the relevant F-statistics (i.e., 26.23 and 27.47 in the price and fleet sale first-stages, respectively) compare favorably with recommended critical values.[39]

The second stage results in Columns 5 show that pre-spill advertising significantly decreased the negative impact of the oil spill on net prices at BP stations (p-value < 0.05). Relative to the OLS estimate, the IV estimate for this interaction is even larger. The results imply that a one standard deviation increase in pre-spill ad spending (+\$1.64 million) reduced the oil spill's price impact by 0.656 cents per gallon, amounting to approximately half of the total impact of the spill.

4.4 Robustness Checks for Advertising IV Results

We conduct two exercises to examine the robustness of our advertising results. First, Online Appendix Table A6 presents results where the endogenous variable is BP spot TV advertising units as a measure of pre-spill campaign exposure. The results are similar, namely that a one standard deviation increase in units of spot TV advertising (+11.4 ads) is predicted to mitigate the price effect of the BP oil spill by 1.14 cents per gallon (OLS) and 2.28 cents per gallon (IV). Note that this measure counts all spot TV advertising units as equal whereas the expenditure measure counts advertising dollars as equal.

Second, we address the concern that there is a correlation between pre-spill (2000-2008) and during-spill (March to September 2010) advertising. This is an important concern given that the Kantar data show an increase in BP advertising during the spill months. Moreover, this during spill marketing could have affected the consumer response given that it included information about relief and mitigation efforts (Tracy, 2010).

The results in Online Appendix Table A7 show that controlling for during spill advertising does not affect our main results. We obtain similar estimates for the impact of pre-spill advertising after we control for BP during

[39]Specifically, the Kleibergen-Paap Wald F-statistic (relevant here due to the potential correlation and clustering of the standard errors at the zip code level) of 26.23 exceeds the relevant critical value for a 10 percent Wald test size distortion proposed by Stock and Yogo (2005) of 7.03, or the general rule-of-thumb value of 10. While these critical values are not derived in a non-i.i.d. error term setting, they remain the recommended references in this setting since such critical values are unavailable Baum, Schaffer and Stillman (2007).

spill advertising in the IV specification. Interestingly, Column 6 of Table A7 also suggests a marginally significant positive association between during-spill advertising and fleet card sales during the spill (p-value < 0.10).

4.5 Impacts on Station Brand Affiliation

As a final analysis, we examine BP brand affiliation in the period after the Deepwater Horizon oil spill. Depending on the severity of the impact on station profits, we might expect to see a change in BP station shares. Most gasoline stations are owned or leased by independent dealers who sign long-term contracts with upstream refines to sell and market a particular brand. If expected returns to the BP brand fall sufficiently low, station owners may switch affiliations. To explore this idea, we measure changes in BP's share of stations in a zip code before and after the oil spill.

Formally, we estimate the following event study specification:

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

where the dependent variable is BP's station share in zip code z in month t. The γ_m terms are coefficients on dummy variables for each of the pre-spill months (before April 2010) and the τ_m terms are coefficients on dummies for each month after the spill (that is, after April 2010). The term μ_z is a zip code fixed effect. 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.

To examine the impact of advertising, we estimate Equation 3 separately for zip codes in metropolitan areas with above or below median pre-spill advertising. Panels (a) and (b) of Figure 3 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, respectively. Online Appendix Table A8 provides the corresponding regression results.

While there is a statistically significant loss in market share in below-median advertising areas, there is no detectable decline in areas with higher levels of advertising. The loss in station share is economically meaningful, representing a roughly six percent decline (about 0.7 percent relative to the mean BP station share of 11 percent). While our estimates only pertain to a relatively short period after the spill, these results are consistent with the possibility that advertising may have dampened longer-term losses to the BP brand outside of the short-run effects on prices and fleet sales. At the same time, it is important to note that this evidence is only suggestive given that we have limited ability to control for additional marketing activities that BP (and competitors) may have undertaken in the longer-run period after the spill.

4.6 Interpretation

Table 3 provides evidence that pre-spill exposure to the Beyond Petroleum advertising campaign softened the negative impact of the BP oil spill. This suggests that firms who provide (unobserved) low levels of environmental quality in production may benefit from green advertising. This is consistent with a broader hypothesis that investments in corporate social responsibility provide reputational insurance in case of adverse events Minor and Morgan (2011).

One concern for the interpretation of our estimates is whether the observed effects are due to environmental messaging *or* other advertising (e.g., local marketing by individual service stations) that also occurred during the Beyond Petroleum campaign.[40] We address this concern by relying on detailed information on the corporate entity of the advertiser and the product advertised in the Kantar data. Our core advertising measure focuses on corporate branding ads for the BP Corporation, BP fuels, and environmental issues during the Beyond Petroleum campaign years (2000-2008), which are likely to contain green messaging. To explore the underlying mechanisms further, we create a second measure that contains advertising only for local BP service stations, BP convenience stores or ancillary products.[41]

[40] That is, we are concerned that the Beyond Petroleum campaign is positively correlated with non-environmental advertising.

[41] The ad measures are constructed as follows: First, we use all Kantar advertising data for 2000-2008 for which BP is listed as "Ultimate Owner." Second, we drop all advertisements for which the advertiser (i.e., entity paying for the ad) is clearly not related to BP or

We study the direct and interaction effects of both measures of advertising. Specifically, we interact each advertising measure with the Green Zip indicator to explore whether the effects varied with environmental preferences. A caveat for this analysis is that both types of advertising may be endogenous, but we have one IV. Given this limitation, we report OLS results. One reassurance for these exploratory results is that the OLS estimates in Table 3 appear to be biased toward zero relative to the IV estimates.

Table 4 shows that the protective benefit of pre-spill BP corporate advertising (i.e., likely to contain green marketing) appears to be higher in "greener" zip codes. Column 3 shows that interaction term between the BP indicator, the likely green advertising measure and the Green Zip indicator is positive and marginally significant (p-value < 0.10). Column 4 expands on these results by including the main and interaction terms for local and ancillary product advertising. In this specification, the point estimate for the three-way interaction term that includes green advertising (which reflects the protective benefits of core corporate advertising in green areas) is larger and magnitude and significant (p-value < 0.01). In contrast, the three-way interaction term that includes local and ancillary product advertising is opposite signed and marginally significant (p-value < 0.10).

5 Policy Implications

The role of private firms and markets in providing public goods has been a subject of debate going back at least to works such as Coase (1960) and Friedman (1970). Kitzmueller and Shimshack (2012) note that the literature has broadly moved from asking whether private markets *should* provide corporate

BP gas stations (i.e., ARCO and individual ARCO stations as well as Amoco and individual Amoco stations (as these are excluded from the analysis), Castrol and Castrol brands (Lube Express), and a handful of other entities mainly related to BP chemicals manufacturing. Third, our core corporate advertising measure includes all ads for the BP Corporation, BP fuels and oils, and explicitly environmental advertisements such as for solar systems or explicit "Beyond Petroleum" announcements run during 2000-2008. Fourth, all remaining ads are included in the "Local/Ancillary Ad Spending" measure, consisting of advertisements related to BP-affiliated convenience stores and products, individual service stations, ancillary product services, and miscellaneous items such as BP credit cards.

social responsibility (CSR) to whether the market *can* provide incentives for CSR.[42] One strand in this research examines how strategic market interactions between firms and activists – "private politics" – can result in CSR provision (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). In these models, private provision of public goods requires that consumers value environmental stewardship and punish firms for deviating from promised (advertised) product attributes.[43]

While consumers appear to be willing to punish BP in the aftermath of an environmental disaster, we find that pre-spill corporate advertising softened this response. These results provide large-scale and revealed preference evidence that consumers respond to green advertising in a way that may give firms an incentive to "greenwash" by exaggerating the environmental benefits or qualities of its products (or operations). This interpretation implies that the market's ability to effectively reward corporate social responsibility and provide public goods may be limited if CSR is communicated through advertising.

There are at least three policies to address greenwashing. First, governments increasingly use truth-in-advertising regulations to reduce misleading environmental product claims (Rohmer, 2007). For example, the U.S. Federal Trade Commission (FTC) publishes a "Green Guide" on environmental friendliness claims. Second, third parties can evaluate environmental claims. Third, governments can use price-based mechanisms such as penalties and taxes.

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[42] The majority of Americans now expect companies to engage in socially responsible practices such as environmental stewardship in production (Fleishman-Hillard and 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).

[43] 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. Similarly, Eichholtz, Kok and Quigley (2010) find that firms in certain "dirty" industries, such as oil and mining, are more likely to lease green office space.

A few considerations suggest that price-based policies may be most effective in encouraging firms to uphold CSR promises or provide environmental stewardship in production. Truth-in-advertising policies may have limited effectiveness because authorities often fail to punish violations (Delmas and Burbano, 2011). In addition, marketing survey experiments have found that simply including nature-based images, symbols, or sounds in product advertising can promote a "green" brand image (Parguel, Benoit-Moreau and Russell, 2015). Indeed, the Beyond Petroleum campaign included elements such as changing the corporate logo to feature a helios sun and airing commercials that featured nature-based imagery and statement about environmental ideals. This type of "executional greenwashing" is likely more difficult to regulate than "claim greenwashing" which is based on explicit claims about product attributes (Parguel, Benoit-Moreau and Russell, 2015). In addition, another concern is that consumers may have heterogeneous responses to truth-in-advertising or third party information. For example, Rao and Wang (2017) find that new consumers are the ones who respond most to an FTC order to terminate false ads.

Price-based mechanisms may be a first-best policy solution since penalties or taxes force firms to internalize the costs of externalities. While third party information and truth-in-advertising regulation can mitigate greenwashing in certain contexts, they may not address the issue comprehensively. Indeed, our results indicate that green advertising can be effective in muting the kind of "punishment" response that is theoretically necessary to incentivize firm investment in practices that support environmental sustainability.

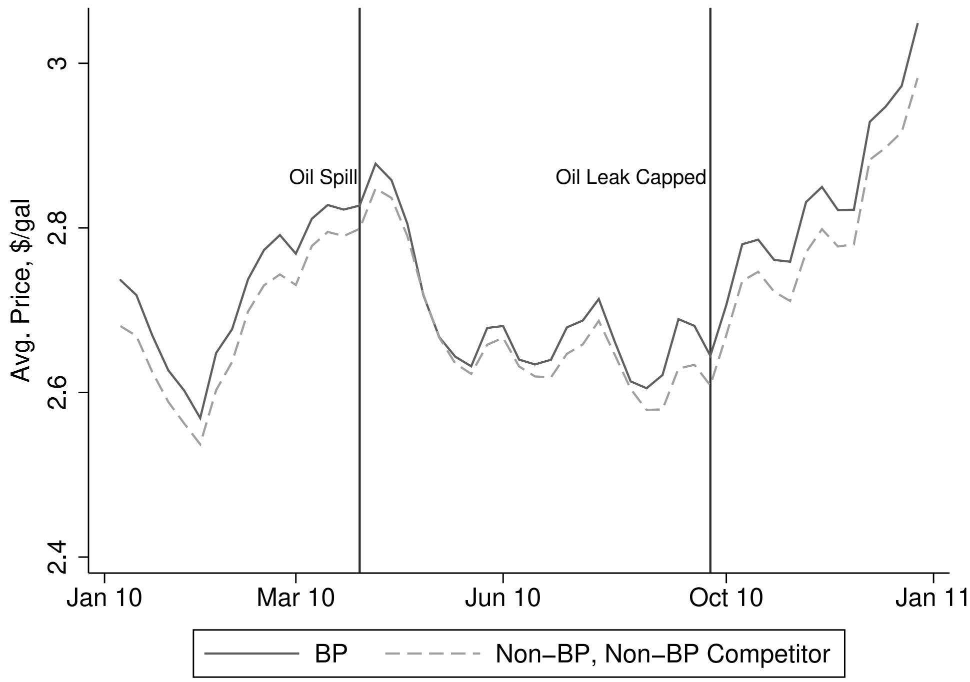
6 Conclusion

We study how environmental advertising affects consumer behavior in retail gasoline markets. After the BP Deepwater Horizon oil spill in 2010, we show that there were significant and large declines in BP station prices and gasoline sales to fleet card customers. During the decade preceding the spill, BP embarked on a large green marketing campaign, and we find that greater exposure to this advertising significantly dampened the negative impacts on retail station prices. We also find suggestive evidence that past advertising cushioned BP from longer-run negative impacts on gasoline market share.

Our results are consistent with the hypothesis that advertising led consumers to believe that the spill was due to bad luck rather than to negligent practices. This supports the idea that firm expenditures on CSR function more as insurance (Minor and Morgan, 2011). This suggests that advertising may fail to provide incentives for firms to undertake investments in hidden product attributes such as environmental stewardship in production. One implication of our findings is that price-based mechanisms such as penalties may be necessary to enhance efficiency in markets where consumer seek environmentally friendly products or services.

7 Figures and Tables

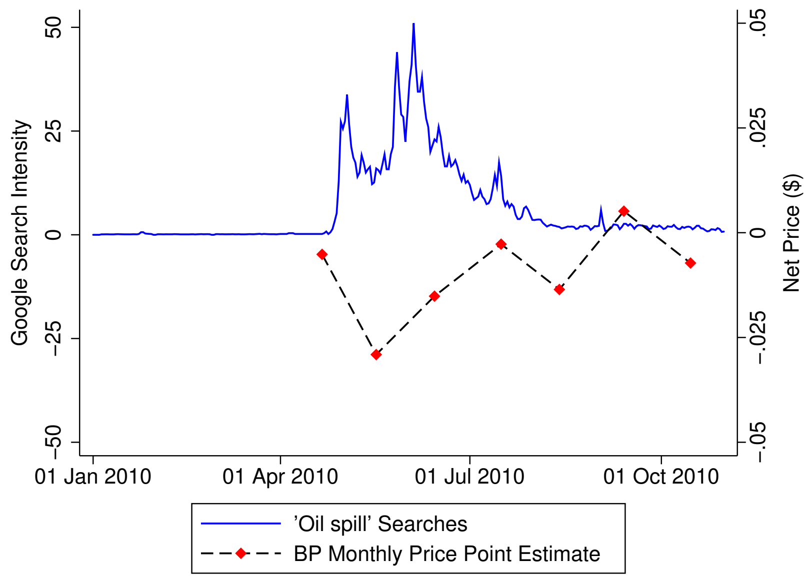
Figure 1: Average Weekly Retail Price for BP and Comparison Group Stations



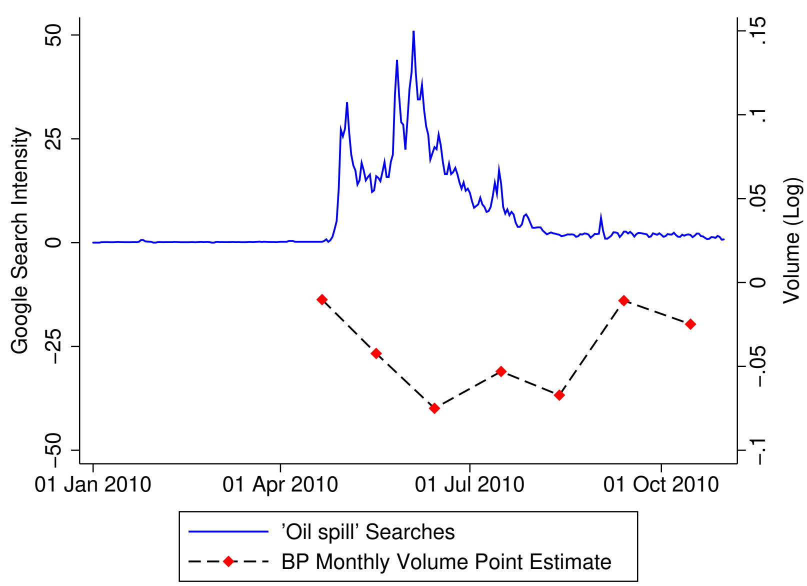
Notes: The figure illustrates average weekly prices for BP and non-BP competitor stations in the main analysis sample. See Section 3 and the Online Appendix for details on the sample construction, and for a zoomed out version of the graph starting at the beginning of our sample in 2009. Source: OPIS.

Figure 2: Google Search Intensity for BP Oil Spill Searches and Retail Impacts

(a) Google Intensity and Price Results



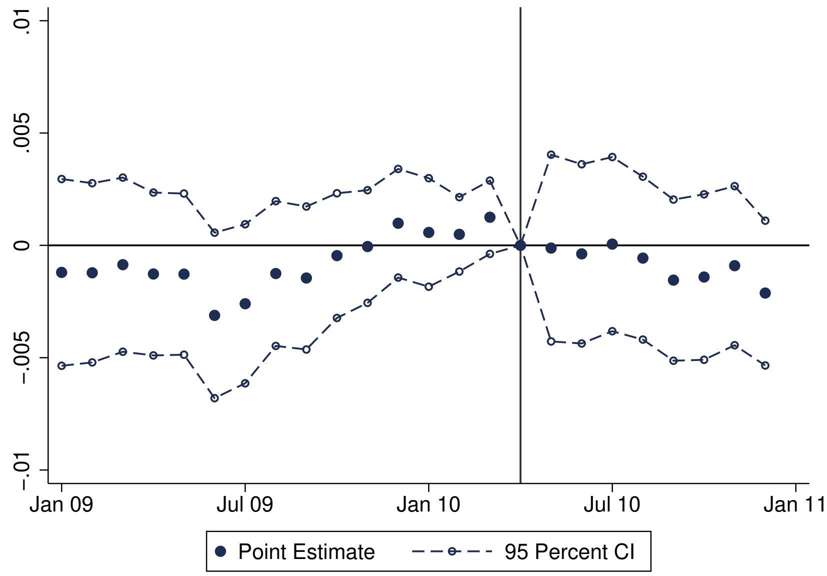
(b) Google Intensity and Sales Results



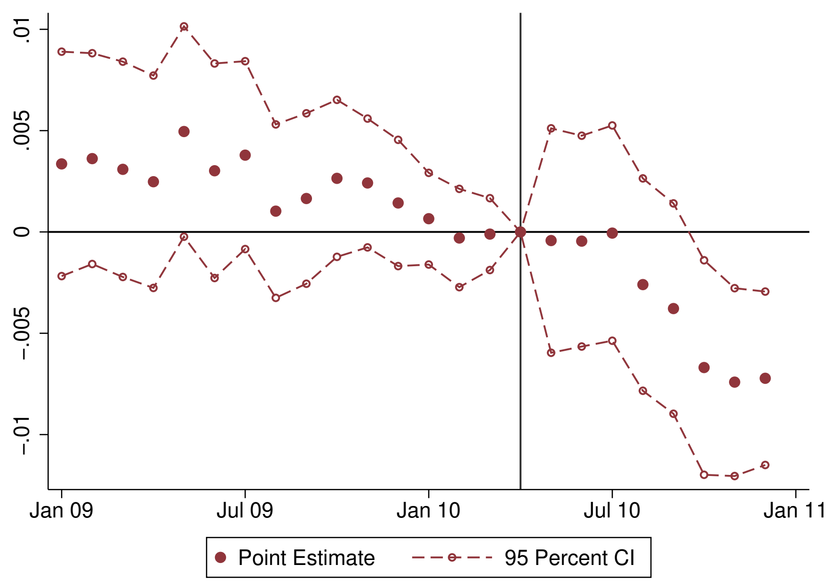
Notes: The figures display the Google search intensity (blue) for the phrase "oil spill" relative to January 2004. For a given month, the Google search intensity measures the ratio of searches in that month to searches during January 2004 (the baseline). A value of 50 indicates that searches in a month were 50 times greater than in January 2004. The dots (red) 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. Sources: OPIS and Google Insights (accessed 8/16/2011).

Figure 3: Impacts of the Oil Spill on BP Station Market Share

(a) Above Median Pre-spill Advertising Zips



(b) Below Median Pre-spill Advertising Zips



Notes: This figure displays the coefficients on month indicators from a regression of the share of BP stations in each zip code-month indicators, an indicator for BP station status, the interaction of BP station status and month indicators, and zip code fixed effects. The full specification is provided in Equation 3 in the text. The omitted month is April 2010, the first month of the oil spill. Results above are provided for zip codes with above and below median BP ad spending during the Beyond Petroleum campaign years of 2000-2008. All point estimates and standard errors are reported in Online Appendix Table A8. Source: OPIS and Kantar Media.

Table 1: Oil Spill Impacts, Difference-in-Difference Estimates

	(1) Average Net Price	(2) Ln(Avg. Fleet Sales)	(3) Weekly Net Price	(4) Ln(Weekly Fleet Sales)
During Spill	0.056***	0.026***	0.056***	0.039***
	(0.003)	(0.007)	(0.002)	(0.006)
Post Spill	0.006**	-0.019**	0.006***	-0.011
	(0.003)	(0.009)	(0.002)	(0.007)
BP*(During Spill)	-0.011***	-0.042***	-0.011***	-0.047***
	(0.003)	(0.011)	(0.003)	(0.009)
BP*(Post Spill)	-0.004	-0.033**	-0.004	-0.037**
	(0.004)	(0.013)	(0.003)	(0.012)
Obs.	15,807	14,400	502,094	456,244
Adjusted R-squared	0.946	0.970	0.608	0.855
S.E. Cluster	Zip	Zip	Zip	Zip
Weight	Price obs.	Quantity obs.	Price obs.	Quantity obs.
# of zips	847	836	847	836
# of stations	5,526	4,997	5,526	4,997

Notes: The price and quantity data span January 2009 to December 2010. 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. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table 2: Oil Spill Impacts by Month

	(1) Weekly Net Price	(2) Ln(Weekly Fleet Sales)
BP*(Late Apr'10)	-0.005*	-0.010
	(0.003)	(0.011)
BP*(May'10)	-0.029***	-0.042***
	(0.005)	(0.010)
BP*(Jun'10)	-0.015***	-0.075***
	(0.004)	(0.011)
BP*(Jul'10)	-0.003	-0.053***
	(0.003)	(0.011)
BP*(Aug'10)	-0.014***	-0.067***
	(0.003)	(0.012)
BP*(Sep'10)	0.005	-0.011
	(0.004)	(0.013)
BP*(Oct'10)	-0.007**	-0.025**
	(0.003)	(0.012)
BP*(Nov'10)	0.001	-0.039***
	(0.004)	(0.012)
BP*(Dec'10)	-0.007**	-0.048***
	(0.003)	(0.013)
Obs.	502,094	456,244
Adjusted R-squared	0.863	0.863
Fixed Effects	Station	Station
S.E. Cluster	Zip	Zip
Weight	Price obs.	Quantity obs.
# of zips	847	836
# of stations	5,526	4,997

Notes: The price and quantity data cover the period from January 2009 to December 2010. 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. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table 3: OLS and IV Estimates of the Impact of Pre-spill Advertising on Oil Spill Impacts

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS Estimates		Election IV Estimates					
			First Stage		Second Stage	First Stage		Second Stage
	Price Diff.	Sales Diff.	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Price Diff.	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Sales Diff.
BP	-0.012***	-0.035***	-2.340	14.028***	-0.015***	-2.161	14.145***	-0.032*
	(0.003)	(0.012)	(3.041)	(1.765)	(0.004)	(3.025)	(1.740)	(0.019)
Green Index	0.001	-0.005*	-0.069	0.000***	0.001	-0.079	0.000**	-0.005
	(0.001)	(0.003)	(0.106)	(0.000)	(0.001)	(0.109)	(0.000)	(0.003)
BP*(Green Index)	-0.001	0.010**	0.249*	0.180*	-0.002	0.274*	0.194**	0.010**
	(0.001)	(0.004)	(0.143)	(0.095)	(0.001)	(0.145)	(0.096)	(0.004)
Income, Demeaned	0.000***	0.000	0.119***	-0.000***	0.001***	0.123***	-0.000*	0.001*
	(0.000)	(0.000)	(0.025)	(0.000)	(0.000)	(0.024)	(0.000)	(0.001)
BP*(Income, Demeaned)	-0.000	-0.002**	-0.020	0.099***	-0.001**	-0.022	0.101***	-0.002*
	(0.000)	(0.001)	(0.033)	(0.021)	(0.000)	(0.032)	(0.021)	(0.001)
Ad Spend., Demeaned	0.003***	-0.000			-0.001			-0.004
	(0.000)	(0.001)			(0.001)			(0.003)
BP*(Ad Spend., Demeaned)	0.001**	0.001			0.004**			0.000
	(0.001)	(0.002)			(0.002)			(0.007)
# Elections, 2000-2008			-1.951***	0.000***		-1.932***	-0.000	
			(0.303)	(0.000)		(0.302)	(0.000)	
BP*(# Elections, 2000-2008)			0.414	-1.538***		0.376	-1.557***	
			(0.370)	(0.212)		(0.368)	(0.210)	
Constant	0.052***	0.017**	16.367***	-0.000***	0.056***	16.306***	0.000	0.022***
	(0.002)	(0.007)	(2.476)	(0.000)	(0.003)	(2.475)	(0.000)	(0.008)
Obs.	3,748	3,424	3,748	3,748	3,748	3,424	3,424	3,424
S.E. Cluster	Zip	Zip	Zip	Zip	Zip	Zip	Zip	Zip
# of zips	645	637	645	645	645	637	637	637
# of stations	3,748	3,424	3,748	3,748	3748	3,424	3,424	3,424
Kleibergen-Paap Wald F-stat.			26.23	26.23		27.47	27.47	

The sample is restricted to stations with available data on Green Index and household income. The dependent variable is the station's price difference or log of quantity difference between the "pre" and "during" spill periods. 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 year 2000 U.S. thousand dollars. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media.

Table 4: Green (Core) and Ancillary Advertising Effects

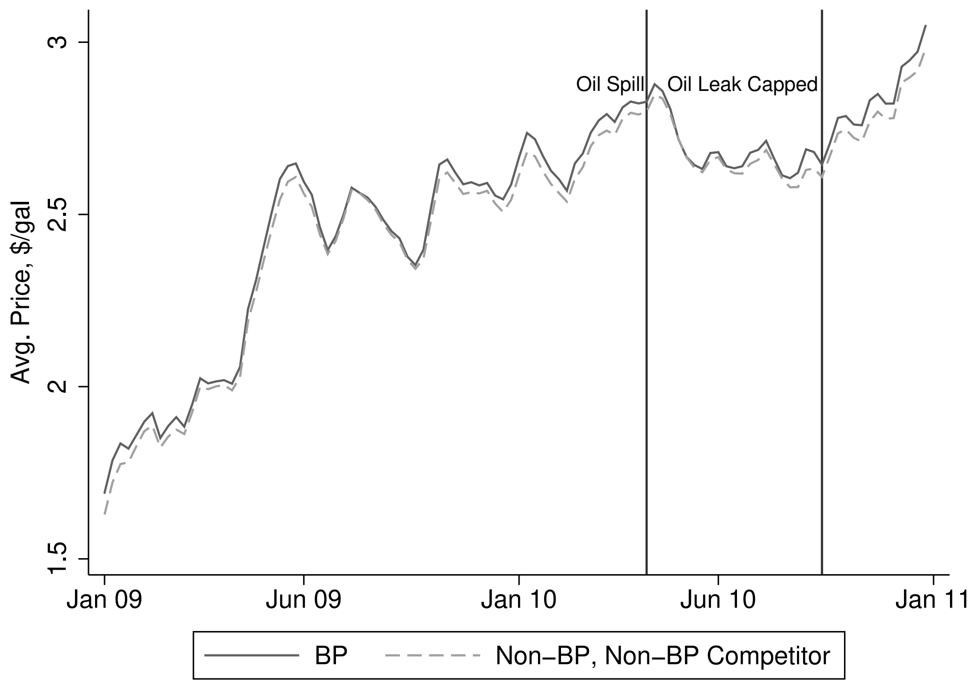
	(1) Price Diff.	(2) Price Diff.	(3) Price Diff.	(4) Price Diff.
BP	-0.012***	-0.012***	-0.009**	-0.010**
	(0.003)	(0.003)	(0.004)	(0.004)
Green Index	0.001	0.001		
	(0.001)	(0.001)		
BP*(Green Index)	-0.001	-0.001		
	(0.001)	(0.001)		
Green Zip Dummy			-0.003	-0.003
			(0.004)	(0.004)
BP*(Green Zip Dummy)			-0.006	-0.004
			(0.005)	(0.005)
Income, Demeaned	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
BP*(Income, Demeaned)	-0.000	-0.000	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Green Ad. Spending	0.003***	0.003***	0.002***	0.002**
	(0.000)	(0.001)	(0.000)	(0.001)
BP*(Green Ad. Spend.)	0.001**	0.001	-0.001	-0.004*
	(0.001)	(0.001)	(0.001)	(0.002)
BP*(Green Ad. Spend.)*(Green Zip)			0.002*	0.006***
			(0.001)	(0.002)
Local/Ancillary Ad. Spend.		-0.001		0.000
		(0.003)		(0.003)
BP*(Local/Ancillary Ad. Spend.)		0.002		0.007
		(0.003)		(0.004)
BP*(Local/Ancil. Ad. Spend.)*(Green Zip)				-0.007*
				(0.004)
Constant	0.052***	0.053***	0.052***	0.053***
	(0.002)	(0.003)	(0.002)	(0.003)
Obs.	3,748	3,748	3,748	3,748
S.E. Cluster	Zip	Zip	Zip	Zip
# of zips	645	645	692	692
# of stations	3,748	3,748	4,020	4,020

Notes: The dependent variable is the station-level price difference (the average net price over the during-spill period minus the average net price during the pre-spill period). The advertising measures control for demeaned BP advertising expenditures during the Beyond Petroleum campaign years (2000-2008). “Green Ad.” includes advertising related to the BP Corporation, BP fuels, and environmental issues. “Local/Ancillary Ad. Spend” includes other BP service station related ads such as for convenience stores and products and individual service stations. The indicator “Green Zip” equals one for stations in zip codes whose Green Index measure is above the median. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media.

8 Online Appendix

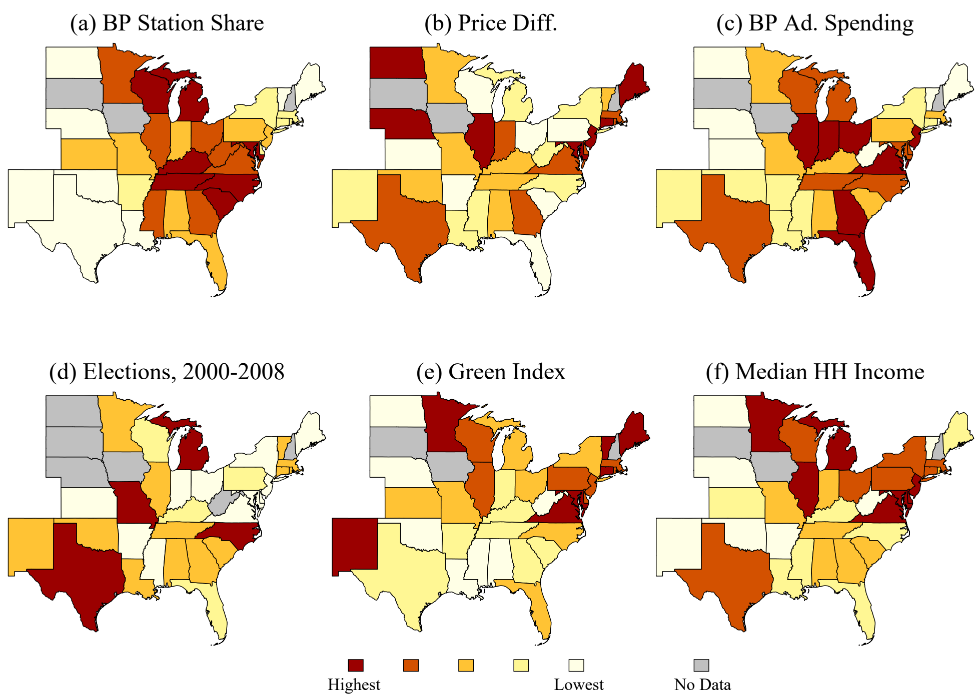
A1 Appendix Figures and Tables

Figure A1: Average Weekly Retail Price for BP and Comparison Stations, Jan. 2009 to Dec. 2010



Notes: The figure displays average weekly prices for BP and non-BP competitor stations in the main analysis sample of stores Source: OPIS.

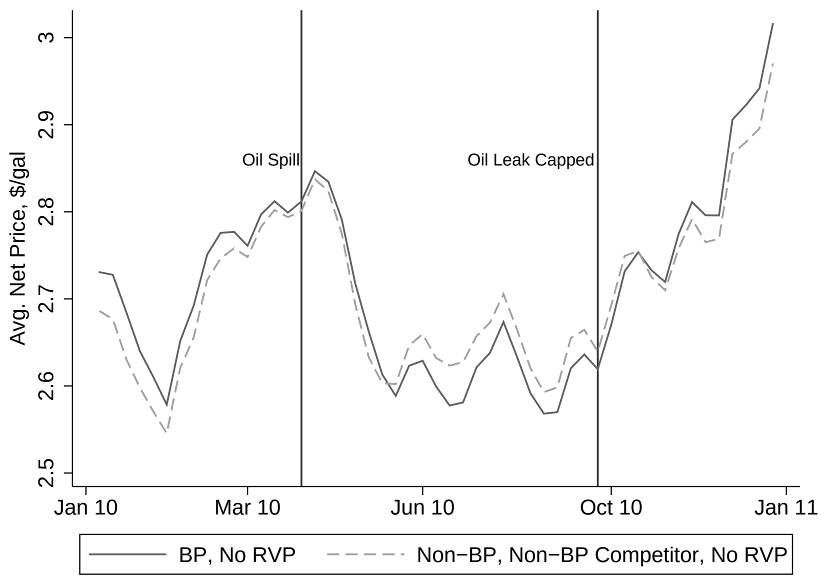
Figure A2: Maps with Sample Descriptive Statistics at the State Level



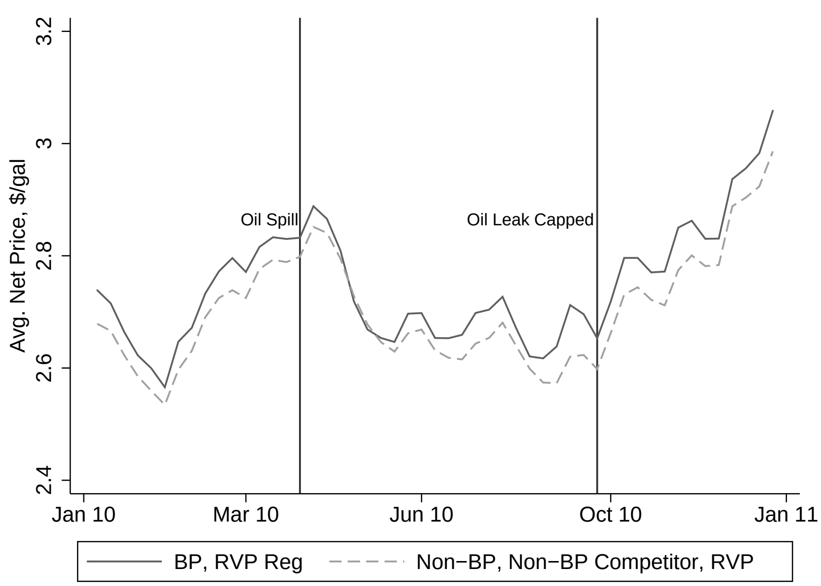
Notes: The term "Price Diff." refers to the difference between pre- and post-spill average prices at the station level. We compute the average price difference at the state level using the main analysis sample of stations. We compute the share of BP stations using the main analysis sample of stations. We construct state level averages for BP Ad. Spending and Elections using one observation per MSA. We construct state level averages for the Green Index and Median HH Income using one observation per zip in the main analysis sample. Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media.

Figure A3: Average Weekly Price for BP and Comparison Stations, By RVP Status

(a) No Summer RVP Regulation Areas



(b) Summer RVP Regulation Areas



Notes: The top panel displays average weekly price levels for BP and non-BP competitor stations in areas not subject to summertime Reid Vapor Pressure (RVP) requirements. The bottom panel display average weekly price levels for BP and non-BP competitor stations in areas which are subject to summertime RVP requirements. Source: OPIS.

Table A1: Main Sample Summary Statistics

	(1) Mean	(2) Min.	(3) Max	(4) Median	(5) Obs.	(6) Obs. Level
Weekly Net Price ($/gal)	0.55	-1.08	1.97	0.54	502,094	Station, Week
Ln(Weekly Fleet Sales)	5.87	-4.61	8.75	6.01	456,244	Station, Week
Average Net Price ($/gal)	0.56	-0.89	1.91	0.55	15,807	Station, Pre/Post
Ln(Avg. Fleet Sales)	5.83	-1.17	8.38	5.98	14,400	Station, Pre/Post
Price Diff.	0.05	-0.27	0.41	0.05	3,748	Station
Green Index	0.00	-3.71	16.42	-0.55	645	Zip
Median HH Inc. ($1000)	48.39	20.09	110.47	45.92	645	Zip
BP Ad. Spending ($ Millions)	1.64	0.00	20.89	0.27	78	DMA
# Elections (2000-2008)	7.63	4.00	10.00	7.00	78	DMA

Notes: This table provides summary statistics for the main analysis sample. Sources: OPIS, Sierra Club, R.L. Polk, the U.S. Green Building Council, and the U.S. Census.

Table A2: Oil Spill Impacts, Sample Including Non-BP, Within Zip Competitors

	(1) Average Net Price	(2) Ln(Avg. Fleet Sales)	(3) Weekly Net Price	(4) Ln(Weekly Fleet Sales)
During Spill	0.051***	0.026***	0.052***	0.038***
	(0.002)	(0.004)	(0.001)	(0.003)
Post Spill	0.005***	-0.022***	0.005***	-0.014***
	(0.002)	(0.005)	(0.001)	(0.004)
BP*(During Spill)	-0.007***	-0.042***	-0.007***	-0.046***
	(0.002)	(0.009)	(0.001)	(0.008)
BP*(Post Spill)	-0.002	-0.030***	-0.002	-0.033***
	(0.002)	(0.011)	(0.002)	(0.009)
Obs.	34,305	31,129	1,081,561	983,677
Adjusted R-squared	0.938	0.972	0.580	0.862
S.E. cluster	Zip	Zip	Zip	Zip
Weight	Price obs.	Quantity obs.	Price obs.	Quantity obs.
# of zips	847	851	847	851
# of stations	11,994	10,809	11,994	10,809

Notes: The price and quantity data span January 2009 to December 2010. 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. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table A3: Oil Spill Impacts, Unfiltered Sample

	(1)	(2)	(3)	(4)
	Average Net Price	Ln(Avg. Fleet Sales)	Weekly Net Price	Ln(Weekly Fleet Sales)
During Spill	0.054***	0.032***	0.053***	0.050***
	(0.001)	(0.002)	(0.001)	(0.002)
Post Spill	0.001*	-0.002	0.001**	0.012***
	(0.001)	(0.002)	(0.001)	(0.002)
BP*(During Spill)	-0.008***	-0.039***	-0.007***	-0.046***
	(0.001)	(0.004)	(0.001)	(0.003)
BP*(Post Spill)	0.003**	-0.034***	0.003***	-0.040***
	(0.001)	(0.005)	(0.001)	(0.004)
Obs.	188,528	173,534	5,692,926	5,339,617
Adjusted R-squared	0.943	0.970	0.601	0.856
S.E. Cluster	Zip	Zip	Zip	Zip
Weight	Price obs.	Quantity obs.	Price obs.	Quantity obs.
# of zips	19,549	19,085	19,550	19,086
# of stations	66,868	60,606	66,869	60,607

Notes: The price and quantity data span January 2009 to December 2010. 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. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table A4: Oil Spill Impacts by Month, Unfiltered Sample

	(1) Weekly Net Price	(2) Ln(Weekly Fleet Sales)
BP*(Late_Apr'10)	0.002**	-0.007*
	(0.001)	(0.004)
BP*(May'10)	-0.023***	-0.038***
	(0.001)	(0.004)
BP*(Jun'10)	-0.012***	-0.069***
	(0.001)	(0.004)
BP*(Jul'10)	-0.002*	-0.055***
	(0.001)	(0.004)
BP*(Aug'10)	-0.012***	-0.062***
	(0.001)	(0.004)
BP*(Sep'10)	0.008***	-0.020***
	(0.001)	(0.004)
BP*(Oct'10)	0.000	-0.031***
	(0.001)	(0.004)
BP*(Nov'10)	0.009***	-0.052***
	(0.001)	(0.005)
BP*(Dec'10)	-0.003***	-0.040***
	(0.001)	(0.005)
Obs.	5,692,926	5,339,617
Adjusted R-squared	0.855	0.861
Fixed Effects	Station	Station
S.E. Cluster	Zip	Zip
Weight	Price obs.	Quantity obs.
# of zips	19,550	19,086
# of stations	66,869	60,607

Notes: The price and quantity data cover the period from January 2009 to December 2010. 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. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table A5: Oil Spill Impacts by Month, No RVP Sample

	(1)	(2)
	Weekly Net Price	Ln(Weekly Fleet Sales)
BP*(Late Apr'10)	-0.0047	0.0053
	(0.004)	(0.023)
BP*(May'10)	0.0107	-0.0292
	(0.007)	(0.021)
BP*(Jun'10)	-0.0005	-0.1060***
	(0.006)	(0.021)
BP*(Jul'10)	-0.0192***	-0.0634**
	(0.005)	(0.027)
BP*(Aug'10)	-0.0111*	-0.0737***
	(0.006)	(0.027)
BP*(Sep'10)	-0.0175***	-0.0032
	(0.005)	(0.026)
BP*(Oct'10)	-0.0336***	-0.0451*
	(0.006)	(0.027)
BP*(Nov'10)	-0.0192***	-0.0721**
	(0.005)	(0.029)
BP*(Dec'10)	-0.0139***	-0.1039***
	(0.004)	(0.029)
Obs.	127,600	113,164
Adjusted R-squared	0.881	0.859
Fixed Effects	Station	Station
S.E. Cluster	Zip	Zip
Weight	Price obs.	Quantity obs.
# of zips	227	226
# of stations	1,458	1,280

Notes: The price and quantity data cover the period from January 2009 to December 2010. The dependent variables in Columns (1) and (2) are weekly net price and log-quantity, respectively. Sample is restricted to areas without summertime RVP regulations. State-level wholesale prices used in net price computation are minimum average rack prices excluding RVP 7 and 7.8 fuels. Each of these dependent variables is regressed on post-spill month dummies and their interactions with a dummy for BP gas station. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS.

Table A6: OLS and IV Estimates of the Impact of Pre-spill Spot TV Units on Oil Spill Impacts

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS Estimates		Election IV Estimates					
			First Stage		Second Stage	First Stage		Second Stage
	Price Diff.	Sales Diff.	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Price Diff.	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Sales Diff.
BP	-0.014***	-0.036***	-4.162	32.232***	-0.019***	-3.860	31.795***	-0.023
	(0.003)	(0.013)	(8.175)	(4.495)	(0.005)	(8.076)	(4.435)	(0.027)
Green Index	0.001	-0.005*	-0.457*	0.000***	0.001	-0.494*	-0.000	-0.005*
	(0.001)	(0.003)	(0.274)	(0.000)	(0.001)	(0.280)	(.)	(0.003)
BP*(Green Index)	-0.001	0.010**	0.346	-0.111	-0.001	0.438	-0.057	0.010**
	(0.001)	(0.004)	(0.370)	(0.250)	(0.001)	(0.373)	(0.247)	(0.004)
Income, Demeaned	0.001***	0.000	0.217***	-0.000***	0.001***	0.226***	0.000	0.001*
	(0.000)	(0.000)	(0.058)	(0.000)	(0.000)	(0.056)	(0.000)	(0.000)
BP*(Income, Demeaned)	-0.000	-0.002**	0.033	0.250***	-0.001**	0.025	0.251***	-0.002
	(0.000)	(0.001)	(0.077)	(0.051)	(0.000)	(0.075)	(0.050)	(0.001)
Spot TV Ad Units, Dm.	0.001***	0.000			-0.000			-0.002
	(0.000)	(0.000)			(0.001)			(0.002)
BP*(Spot TV Ad Units, Dm.)	0.000	0.000			0.002**			-0.000
	(0.000)	(0.001)			(0.001)			(0.003)
# Elections, 2000-2008			-4.529***	0.000***		-4.407***	-0.000	
			(0.821)	(0.000)		(0.810)	(0.000)	
BP*(# Elections, 2000-2008)			1.328	-3.201***		1.256	-3.151***	
			(0.976)	(0.528)		(0.964)	(0.523)	
Constant	0.054***	0.016**	36.394***	-0.000***	0.056***	35.655***	0.000	0.019***
	(0.002)	(0.007)	(6.829)	(0.000)	(0.002)	(6.750)	(0.000)	(0.007)
Obs.	3,748	3,424	3,748	3,748	3,748	3,424	3,424	3,424
S.E. Cluster	Zip	Zip	Zip	Zip	Zip	Zip	Zip	Zip
# of zips	645	637	645	645	645	637	637	637
# of stations	3748	3424	3748	3748	3748	3424	3424	3424
Kleibergen-Paap Wald F-stat.			18.40	18.40		18.17	18.17	

Notes: The sample is restricted to stations with data for Green Index and household income. The dependent variable is the station's price difference or log of sales difference between the "pre" and "during" spill periods. 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 year 2000 U.S. thousand dollars. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media.

Table A7: OLS and IV Estimates of the Impact of Advertising, Controlling for During Spill Advertising

	(1)	(2)	(3)	(4)	(5)	(6)
	Election IV Estimates					
	First Stage		Second Stage	First Stage		Second Stage
	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Price Diff.	Ad. Spend. Demeaned	BP*(BP Ad. Spend. Demeaned)	Sales Diff.
BP	-2.867	12.853***	-0.016***	-2.748	12.913***	-0.021
	(3.931)	(2.317)	(0.005)	(3.936)	(2.308)	(0.023)
Green Index	-0.076	0.000***	0.001	-0.086	-0.000	-0.004
	(0.105)	(0.000)	(0.001)	(0.108)	(0.000)	(0.003)
BP*(Green Index)	0.235	0.160	-0.002	0.260*	0.174*	0.010**
	(0.143)	(0.097)	(0.001)	(0.146)	(0.098)	(0.005)
Income, Demeaned	0.118***	-0.000***	0.001***	0.123***	0.000*	0.001
	(0.025)	(0.000)	(0.000)	(0.025)	(0.000)	(0.001)
BP*(Income, Demeaned)	-0.018	0.100***	-0.001**	-0.021	0.102***	-0.001
	(0.033)	(0.021)	(0.000)	(0.032)	(0.021)	(0.001)
BP Ad. During Spill, Dm.	0.750	0.000***	-0.008	0.729	-0.000	-0.014
	(1.133)	(0.000)	(0.013)	(1.139)	(0.000)	(0.023)
BP*(BP Ad. During Spill, Dm.)	0.505	1.255	-0.005	0.546	1.274	0.078*
	(1.399)	(0.821)	(0.016)	(1.402)	(0.818)	(0.047)
# Elections, 2000-2008	-1.868***	0.000***		-1.850***	-0.000***	
	(0.389)	(0.000)		(0.389)	(0.000)	
BP*(# Elections, 2000-2008)	0.481	-1.388***		0.450	-1.399***	
	(0.478)	(0.279)		(0.479)	(0.279)	
Ad. Spending, Demeaned			-0.000			-0.004
			(0.002)			(0.004)
BP*(Ad. spending, Demeaned)			0.004*			-0.006
			(0.002)			(0.010)
Constant	15.720***	-0.000***	0.056***	15.660***	0.000	0.021**
	(3.175)	(0.000)	(0.003)	(3.188)	(0.000)	(0.009)
Observations	3,748	3,748	3,748	3,424	3,424	3,424
S.E. Cluster	Zip	Zip	Zip	Zip	Zip	Zip
# of zips	645	645	645	637	637	637
# of stations	3,748	3,748	3,748	3,424	3,424	3,424
Kleibergen-Paap Wald F-stat.	12.39	12.39		12.62	12.62	

Notes: The sample is restricted to stations with data for Green Index and household income. The "During Spill" measure is based on BP advertising during the oil spill (May-October 2010). We calculate the Green Index by summing 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 year 2000 U.S. thousand dollars. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media.

Table A8: BP Station Market Share Impact, By Advertising Level

	(1)	(2)
	BP Mkt. Share, Above Median Ad. Spend.	BP Mkt. Share, Below Median Ad. Spend.
Jan'09	-0.001	0.003
	(0.002)	(0.003)
Feb'09	-0.001	0.004
	(0.002)	(0.003)
Mar'09	-0.001	0.003
	(0.002)	(0.003)
Apr'09	-0.001	0.002
	(0.002)	(0.003)
May'09	-0.001	0.005
	(0.002)	(0.003)
Jun'09	-0.003	0.003
	(0.002)	(0.003)
Jul'09	-0.003	0.004
	(0.002)	(0.003)
Aug'09	-0.001	0.001
	(0.002)	(0.003)
Sep'09	-0.001	0.002
	(0.002)	(0.002)
Oct'09	-0.000	0.003
	(0.001)	(0.002)
Nov'09	-0.000	0.002
	(0.001)	(0.002)
Dec'09	0.001	0.001
	(0.001)	(0.002)
Jan'10	0.001	0.001
	(0.001)	(0.001)
Feb'10	0.000	-0.000
	(0.001)	(0.001)
Mar'10	0.001	-0.000
	(0.001)	(0.001)
May'10	-0.000	-0.000
	(0.001)	(0.001)
Jun'10	-0.000	-0.000
	(0.001)	(0.001)
Jul'10	0.000	-0.000
	(0.001)	(0.001)
Aug'10	-0.001	-0.003
	(0.001)	(0.002)
Sep'10	-0.002	-0.004
	(0.001)	(0.002)
Oct'10	-0.001	-0.007***
	(0.001)	(0.003)
Nov'10	-0.001	-0.007***
	(0.001)	(0.002)
Dec'10	-0.002*	-0.007***
	(0.001)	(0.002)
Obs.	12,408	4,800
Adjusted R-squared	0.964	0.960
S.E. Cluster	Zip	Zip
# of zips	517	200

Notes: The dependent variable is the BP share of gas stations in a zip code at the monthly level. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Source: OPIS and Kantar Media.

Table A9: 2000-2008 Total Elections and Area Characteristics

	(1)
	# Elections (2000-2008)
BP Station Share	0.442
	(1.218)
Gas Station Density	2.324
	(3.691)
HHI	0.761
	(2.043)
Green Index	-0.041
	(0.068)
Median HH Income	-0.005
	(0.017)
Obs.	78
R-squared	0.024

Notes: This table presents regressions results from a model where the dependent variable is the total number of elections between 2000-2008 calculated at the MSA level. The independent variables are measures of MSA characteristics such as the BP share of gasoline stations, overall gas station density, gasoline market Herfindahl index (HHI), average median household income (from the 2000 Census) and Green Index (averaged at the MSA level across zip codes in our sample). *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Sources: OPIS, Sierra Club, R.L. Polk, the U.S. Green Building Council, and the U.S. Census.

A2 OPIS Data Details and Sample Construction

We filter the price data at the zip code level according to the following criteria:

1. We begin with the daily price observations for each store from 2007 to October 2010. We remove store-weeks without at least five days of price observations. (This drop 10 percent of the observations from the raw data.)

2. We require that each store have at least 3 years of weekly observations. To ensure the consistency of our stores, we also flag large one-day changes in prices indicative of an error in data ("Twinkie effect") in the price data. We drop stores that are particularly affected by this error. Specifically, for each store we record the first and last day of operation in the data and require that each store have non-Twinkie price observations for at least 80 percent of these possible days.

3. With the remaining stores, we filter the data at the zip code level, keeping zips that have at least 5 distinct stores. We also require that each zip code have at least one observation (from at least one store) for every week from 2007-2010.

4. Finally, we retain data only from EIA Petroleum Administration Defense Districts (PADDs) that feature a sufficiently broad BP brand presence, namely the East Coast (PADD 1), the Midwest (PADD 2), and the Gulf Coast (PADD 3).

After conducting the above steps, we have a list zip codes from the pricing data. We have similar restrictions on the stores and zip codes used from the weekly quantity data as detailed below.

1. We begin with weekly quantity data from 2009 to December 2010. Within the weekly store quantity observations, we drop any store that is absent from the data for 3 months or more at some point in our data.

2. From this set of stores, we construct z-scores for each store's quantity by quarter. (We allow each store to have two extreme values by setting the two highest z-scores to missing). Next, we filter the data at the zip code level by removing any zip code and all its stores if that zip code has at least one store with a z-score below -3.0 or above 3.0 in any quarter of the data.

3. We drop any zip code that has fewer than 5 distinct stores.

4. We drop any zip code with implausibly high variation in quantity sold. We do this by computing the mean and standard deviation for quantity sold in each zip code. Next, we compute the ratio of the standard deviation over the mean. Calculating the mean of this ratio, we drop all zip codes above the mean.

5. Finally, we focus on zip codes located in the East Coast (PADD 1), the Midwest (PADD 2), and the Gulf Coast (PADD 3)

The remaining zip codes comprise our list of usable zip codes from the quantity data. For the proceeding analyses, we restrict the data to observations from zip codes that meet the above criteria for the price and quantity data. Note that we pick good zip codes and re-introduce the "bad" stations within those zip codes for the analysis presented in the paper. The table below provides statistics on the number of stations that have price or quantity data and satify various geographic criteria.

Number of Stations in OPIS Data

	(1)	(2)	(3)
	# Stores with Prices	# Stores with Sales	# Stores with Both
OPIS Raw Data	135,973	119,631	118,813
Located in "Good Zips"	15,825	13,865	13,795
+ Not ARCO	14,167	12,575	12,519
+ Not BP Competitor	7,503	6,735	6,709
+ Located in PADD 1, 2, or 3	5,526	4,997	4,975

Notes: Each row reports the number of stations with price or sales data during our sample period that satisfy various geographic criteria. Source: OPIS.

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