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ABSTRACT

This paper explores whether and how environmental stewardship can be provided by private markets through green advertising. We examine the period surrounding the BP oil spill and estimate how BP's pre-spill investment in "green advertising" affected the spill's impact on retail prices and demand at BP gasoline stations. We use station-level prices and sales from a large sample of U.S. retail gasoline stations, and market-level advertising expenditures during BP's 2000-2008 "Beyond Petroleum" advertising campaign. We find evidence consistent with consumer punishment of BP in the months following the spill; overall BP margins declined significantly by 4.2 cents per gallon, and volumes declined by 3.6 percent during the spill. We examine how pre-spill environmental advertising affected the spill's impact on margins and sales, testing whether expenditures on green reputation act as a commitment to green production or as insurance against environmental damage. We find evidence in support of the latter: pre-spill exposure to BP advertising significantly softened the impact of the spill on BP retail margins, and abated losses to station share from stations switching to alternative gasoline brands.

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1 Introduction

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

The growth in CSR suggests that public goods could be provided through the private market if consumers are willing to pay for green product characteristics. A recent and growing theoretical literature examines conditions under which private markets can provide environmental protection through green-product-quality (e.g. Baron, 2003; Kotchen, 2006; Besley and Ghatak, 2007) extending the applied theory literature on advertising and quality in experience goods markets (e.g. Shapiro, 1983; Cabral, 2005). In these models, a consumer response to evidence contradicting green advertising claims is needed to incentivize firms to advertise truthfully about green production rather than "greenwash." Corporate provision of public goods is only possible if the marketplace financially punishes firms for deviating from advertised CSR promises (Besley and Gathak, 2007).

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

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

from the well (National Commission, 2011). Despite containment efforts, the spill led to the world's largest accidental release of oil into marine waters.[1]

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

We find the following. First, there was a significant consumer response to the BP oil spill. During the spill, BP retail prices declined by 4.2 cents per gallon relative to non-BP stations in neighboring markets, representing a 25 percent decline in margins relative to industry standards. In addition, BP volumes sold declined by 3.6 percent among fleet card holders. We further find that, over the course of the spill, BP prices and volumes fell with increasing intensity, peaking at a 6.1 cents per gallon decrease in price and a 6.7 percent decrease in volume in August 2010.

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

Third, we find that the consumer response to the spill was significantly reduced by pre-spill exposure to BP advertising during the "Beyond Petroleum" campaign years (2000-2008). We use advertising data from Kantar Media (formerly known as CMR, TNS Media Intelligence, and KMR Group).[2] The data include BP's monthly advertising units and expenditures across newspaper, billboard, radio, television, and internet by metropolitan area. We compute industry-wide advertising market TV spot prices and use them as an instrument for variation in BP advertising across markets in the Beyond Petroleum campaign period. We find that the impact of the oil spill on BP prices was significantly *less*

[1] Robertson, Campbell, and Clifford Krauss, "Gulf Spill Is the Largest of Its Kind, Scientists Say" *New York Times*, August 2, 2010. On November 5, 2012, BP formally pled guilty to charges of *environmental crimes*, and agreed to pay $4 billion to settle its criminal case with the United States government (United States of America v. BP Exploration & Production, Inc. CDN: 2:12-cr-00292-SSV-DEK).

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

severe in areas with more BP advertising in the pre-spill environmental campaign years. Our results are robust to a variety of specification checks, including varying our measure of advertising, instrumenting for advertising expenditures, and including during-spill advertising by BP.

Finally, we find two long-term effects. First, the impact of the spill on BP prices and quantities changed sharply once the leak was sealed on September 19, 2010. BP prices increased to slightly higher than pre-spill averages relative to stations in comparison markets, though fleet card volume sales remained significantly lower. This suggests a "bootstrap mechanism" of quality provision (Cabral, 2005), where consumers punish firms for deviations from promises for a limited period of time. Second, although prices returned to normal once the leak was capped, markets with low pre-spill environmental advertising suffered losses to BP retail outlet share. We find significant losses in BP's share of stations beginning around the time of the largest price impacts and totaling of five percent of mean outlet share. The losses occur only in areas with low pre-spill advertising. In regions of heavy pre-spill advertising, during-spill profit losses may have been low enough to prevent station owners from switching to alternative brands.

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

2 Background

2.1 The "Beyond Petroleum" Campaign and the Deepwater Horizon Oil Spill

In July 2000, BP launched a $200 million public relations campaign focused on aligning the BP brand with environmental issues (PR Watch, 2010). The company introduced a new slogan, "Beyond Petroleum," and redesigned its 70-year-old logo to a green and yellow Helios (sun) logo. The rebranding effort targeted consumers' environmental sensibilities through television and print media advertising. 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). The campaign emphasized how BP was making its operations more efficient and working to reduce environmental impact (Cherry and Sneirson, 2011). That is, the advertising highlighted that BP was a company that actively reduced the environmental consequences of production.

The campaign received the prestigious Gold Effie Award from the American Marketing Association in 2007, establishing the campaign as one of the most effective advertising efforts of the year. The AMA wrote that Beyond Petroleum was "…a landmark platform for a company trying to change the way the world uses and thinks about, the fuels that are vital to human progress" (Solman, 2008). The campaign won two PR Week "Campaign of the Year" awards for Ogilvy and Mather Worldwide, the public relations firm in charge of the campaign.[3]

Consumers appeared to retain this environmental message from BP's marketing. In 2008, the marketing firm Landor Associates surveyed consumers, asking "How green do you consider [BP] to be?" Survey results showed that 33 percent believed BP was a "green" brand, with "green" being the most positive response option. The company was also recognized as being the greenest of the major petroleum companies in this survey in 2007 and 2008 (Landor Associates, Cohn & Wolfe, and Penn, Schoen, & Berland Associates 2007, 2008). Additionally, a 2008 poll of 1,000 U.K. marketers ranked BP third when asked which company made the greatest commitment to environmental issues (Marketing Week, 2008).

At the same time, the campaign was not without detractors. Several environmental groups criticized BP's branding decision. Greenpeace commented: "This is a triumph of style over substance. BP

[3] 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". See Ogilvy and Mather's official website at http://www.ogilvypr.com/about/awards.

spent more on their logo this year than they did on renewable energy last year" (BBC News, 2000). Another NGO, Corpwatch, awarded BP its "Greenwash Award" for being "beyond preposterous" (Corpwatch, 2000).

Ten years after the inception of the Beyond Petroleum campaign, multiple explosions ripped apart the Deepwater Horizon oil drilling rig, consuming it in a firestorm. Eleven rig workers died in the accident. In the subsequent days, the remains of the Deepwater Horizon sank into the Gulf of Mexico on April 22 – the 30th anniversary of Earth Day.[4] This catastrophe stemmed from an oil well blowout. On April 24, robotic monitoring devices discovered that oil was leaking from the damaged well.[5] After initial efforts to stem the oil leak failed, BP's primary plan to control the spill was to drill a relief well to pump cement into the original well. An oil rig commissioned by BP began drilling a primary relief well on May 2.[6]At the same time, BP engineers also considered other, more immediate, ways to mitigate the oil spill. On May 7, BP deployed a "containment dome" over the leaking well, but this solution ultimately failed.[7] Further efforts to plug the oil leak also failed before a new sealing cap was placed on the well on July 12. By July 15, it was determined that the oil flow had stopped.[8] With the capping of the well, government-appointed scientists estimated that nearly 205.8 million gallons of oil had leaked from the well (Department of Interior, 2010). On September 19, 2010, BP completed the relief well, and officials declared that the damaged well was "effectively dead."[9]

2.2 Related literature

Motivated in part by the increasing prevalence of CSR in the marketplace, several applied-theory models explore private provision of public goods through corporate responsibility and environmental stewardship. One branch of this literature studies how strategic market interactions between firms and activists – 'private politics' – can result in CSR provision (see, e.g., Baron, 2003; Baron and Diermeier,

[4] Fisk, Margaret Cronin, and Laurel Brubaker Calkins, "BP Gulf of Mexico Spill, From Disaster to Trial: Timeline," Bloomberg, February 24, 2013, URL: http://www.bloomberg.com/news/2013-02-25/bp-gulf-of-mexico-spill-from-disaster-to-trial-timeline.htm [Accessed: 3/15/2013].
[5] Aigner, Erin, Joe Burgess, Shan Carter, Joanne Nurse, Haeyoun Park, Amy Schoenfeld, and Archie Tse, "Tracking the Oil Spill in the Gulf," *New York Times*, Updated August 2, 2010. URL: http://www.nytimes.com/interactive/2010/05/01/us/20100501-oil-spill-tracker.html [Accessed: 03/10/2013]
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] A non-partisan commission investigating the tragedy found that "the immediate cause of the blowout could be traced to a series of identifiable mistakes made by BP" and its contractors, further concluding that "(w)hether purposeful or not, many of the decisions that BP, Halliburton and Transocean made that increased the risk of the Macondo blowout clearly saved those companies significant time (and money)" (National Commission, 2011). The U.S. Department of Justice (DOJ) concluded that "the explosion of the rig was a disaster that resulted from BP's culture of privileging profit over prudence" (DOJ, 2011).

2007). Others analyze the production of "impure public goods," which bundle public good creation or the abatement of public "bads" with private products (Besley and Ghatak, 2001, 2007; Kotchen, 2006).[10]

Several key mechanisms are relevant to the sustainable provision of environmental stewardship in these models. First, consumers must be willing to pay for (environmental) public goods as product characteristics. Willingness to pay for environmental product characteristics has been demonstrated, using both revealed-preference methods (e.g., Kiesel and Villas-Boas, 2013; Kahn and Vaughn, 2009; Kahn, 2007; Teisl et al., 2002; Roe et al., 2001; Nimon and Beghin, 1999) and stated preference methods (e.g., Goett et al., 2000; Forsyth et al., 1999; De Pelsmacker et al., 2006; Loureiro et al., 2001). These studies focus on markets where environmental attributes are either easily measured or officially certified (e.g., hybrid vehicles and USDA organic certification). We study a common setting where corporate investments in environmental protection are both difficult for consumers to measure and are not certified.

Second, environmental attributes must be credibly communicated to consumers. In the absence of third-party certification, advertising presents one such mechanism. In multi-period models, initial advertising can act as a sunk cost to signal high product quality that consumers observe only after purchase (Shapiro, 1983; Cabral, 2005). In line with these predictions, empirical work has often found that advertising increases demand for advertised products (e.g., Ackerberg, 2001; Bagwell, 2007; Dube and Manchanda, 2005; Bertrand et al., 2010; Clark et al. 2009; Simester et al., 2009; Lewis and Reiley, 2011; Hastings et al., 2013; Gurun et al. 2013).

Equilibrium provision of CSR (and unobserved product quality in general) also requires that firms face financial sanctions for making false claims of public goods provision, i.e. "greenwashing" (see, e.g., Besley and Gathak, 2007).[11] Consumer response to news contrary to advertising claims can be short-lived, following a "bootstrap" model of punishment followed by restoration to equilibrium (Cabral 2005), or a permanent change in environmental quality beliefs and willingness-to-pay.

Irrespective of punishment mechanisms, how advertising influences consumers' beliefs about actual environmentally conscious production decisions and how they interpret news to the contrary is central to private provision of CSR. Advertising can be informative and signal environmental quality, providing a commitment device for actual production decisions. On the other hand, advertising could affect consumer's *ex-post* assessment of a firm's environmental stewardship after a negative event. Morgan and Minor (2011) argue that investment in a socially responsible image provides insurance against reputational costs after accidents or recalls by shifting beliefs about the cause of the accident away

[10] Kitzmueller and Shimsack (2012) discuss these papers in a broader review article on the burgeoning corporate social responsibility literature.

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

from negligence and towards bad luck (Minor and Morgan, 2011). Here, advertising plays a persuasive role, shifting preferences or beliefs about the underlying cause of the observed outcomes. Kotchen and Moon (2011) provide backward-looking evidence that firms with past "social irresponsibility" subsequently invest in CSR. They regress combinations of companies' current Kinder, Lydenberg, Domini Research & Analytics (KLD) social responsibility indices on lagged values to test if past poor ratings (as measures of corporate social "irresponsibility") predict future good ratings (as measures of corporate social "responsibility"). Relatedly, Eichholtz et al. (2009) find that firms in certain 'dirty' industries, such as oil and mining, are more likely to lease green office space. In the present context, we are the first to link baseline advertising investment to outcomes following an environmental disaster, directly testing the models above.

3 Data

3.1 Gasoline data

We use data on retail gasoline prices, sales to fleet-card customers, and station brand affiliations to estimate the impact of the BP oil spill on gasoline prices, sales, and long-run branding decisions. The data come from the Oil Price Information Service (OPIS), which collects information on gasoline station prices and sales from two sources. First, OPIS records information on prices and volumes from Wright Express fleet fuel card "swipes." Wright Express reports the last transaction of the day at each station to OPIS and calculates a price based on that transaction's total sales amount and gallons sold.[12] This information is only available for stations that accept this fleet card and is only available on days when fleet card transactions happen (i.e. an individual must use their fleet card for a price to be recorded for a particular station on a particular day).[13] The fleet card is widely accepted across the U.S., and since 2009, OPIS has expanded their data collection to include reporting agreements with several gasoline refiner-

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

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

marketers, which allows them report retail prices for some stations that do not accept the fleet card and to make the gasoline price series more complete among stations that do.[14]

Between these two sources, the OPIS data have at least one price observation for over 100,000 stations in the United States. However, most stations in the OPIS data only appear in the sample for a portion of the period, or appear during the entire period but only have sporadically reported prices on days when they attract a fleet card holder. Given our interest in station-level variation in prices and sales over time, we focus on regions in which OPIS reporting meets minimum density criteria.[15] We create a list of zip codes in which there is sufficient coverage of station prices for most stations (recall both stations and prices at a given station can be missing from the OPIS data). We define this as stations having at least five gasoline stations with at least three price observations per week for our entire sample period. We keep prices for all stations located in this list of zip codes.

We compare prices at BP stations to prices at stations in zip codes without any BP station present. We thus exclude from the comparison group prices of stations in close proximity to BP stations as their prices may be impacted by the BP spill as well. This leaves us with a sample of 7,503 stations we will focus on for our main analysis. Our main analysis is reproduced in Online Appendix Section II using all of the OPIS data, regardless of whether stations are missing large portions of price data or whether most competitors in the station's area are not in the OPIS data. The results are very similar.

For stations in our sample that accept fleet cards (as opposed to stations whose parent company reports prices to OPIS but does not accept fleet cards), we have a weekly total of gasoline sold through fleet cards. Although fleet card customer preferences may be different than the population average, these data provide a glimpse into the customer response to the events of interest. While limited, these data represent, to our knowledge, the only station-level volume data currently available.[16] We follow an analogous procedure to select zip codes with sufficient fleet sales coverage (see Online Appendix Section IV). For the volumes data, we are left with 6,735 stations for the basic difference analysis (6,709 of these stations are also in our price sample). Again robustness checks using the entire sample of treatment and control stations are in the Online Appendix and produce very similar results.

In addition to prices and fleet sales, each observation in the data also includes a station's location, brand of gasoline, and brand of convenience store in each week.[17] Our main analysis uses each station's *initial* brand in our sample (from January 2009) to categorize it as BP or non-BP station in order to avoid

[14] For a list of stations that accept the fleet card see www.wrightexpress.com.
[15] For details on how we clean the OPIS data and define our sample, see the Online Appendix available at: http://www.justinehastings.com/images/downloads/BCH_OnlineAppendix.
[16] The only 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).
[17] OPIS has tracked changes in station branding since 2007. Prior to that, the station's most current brand would be listed as the brand for its entire history.

potential brand endogeneity due to stations switching away from the BP brand after the spill. We analyze such switching behavior in a separate analysis in Section 4.3 as a long-run measure of the spill's impact.

Finally, we obtain weekly gasoline spot price information from the Energy Information Administration (EIA).[18] We use the spot price to compute a measure of retail margins used in most of our regression analysis. We define a weekly station-level net price as the average price for station *i* in week *t* less the average New York spot price in week *t*.[19]

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

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

3.2 Advertising data

To measure advertising we use Kantar Media Ad$pender data, which report advertising expenditures and occurrence information for more than three million brands across 18 media formats in major marketplaces.[20] Kantar uses tracking technologies and services to monitor television advertising on both cable and network stations, print media expenditures from over a thousand business-to-business and consumer magazine and news publications, and internet sites. They collect outdoor and local radio advertising information from other marketing subscription services and directly from media providers (e.g., radio stations or billboard plant operators).[21]

Given a fixed combination of time period, market, and media type, advertising expenditure data are hierarchically categorized through product levels that identify the parent company (e.g., BP vs. Shell), distinguish between brands (e.g., BP service station vs. Amoco service station) and differentiate between products to which a brand is attached (e.g., BP energy utilities vs. BP gasoline). Each advertised product is measured in both net total spending and units of advertisements.

[18] These data are publicly available at the URL: http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm
[19] We use the NY spot price instead of the Gulf spot price because several hurricanes hit this area during our sample period, causing a few instances of spot price spikes that were not reflected in our NY spot or retail price series.
[20] The 18 media types provided by Kantar Media include network television, spot television, cable television, Spanish language network television, syndication, magazines, business-to-business magazines, Sunday magazines, Hispanic magazines, local magazines, national newspapers, local newspapers, Hispanic newspapers, network radio, national spot radio, local radio, U.S. Internet and outdoor activities.
[21] For more details, consult the Kantar Media Ad$pender online documentation at URL: http://kantarmediana.com/intelligence/products/adspender. See also other papers that have used these data, including Dave and Saffer (2006), Reuter and Zitzewitz, (2006), Chou et al., (2008), Clark et al. (2009) and Gurun et al. (2013).

Our data set tracks BP advertising from 2000 through 2011 and all other advertising from 2007 through the 2011.[22] We use these data to construct measures of consumer exposure to BP advertising. In our main specification we use advertisements during the years of the "Beyond Petroleum" campaign (2000-2008) that focused on the BP Corporation, BP fuel products, and on environmental issues. 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).

BP advertising may be endogenous to each area's unobserved preference for the BP brand. We instrument for BP's advertising using television advertising spot prices across all industries and product categories. We focus specifically on the quantity-weighted average spot television advertising price from 2007-2008.[23] This price provides a measure of advertising cost differences across metropolitan areas.[24] Our identifying assumption is that cross-sectional differences in demand and supply for general spot television advertising do not lead to differences in the consumer response to the BP oil spill other than through their impact on BP advertising levels.

We run several specification checks that we document in Online Appendix Section II. These robustness exercises include the consideration of broader BP advertising categories (e.g., including BP-sponsored events), controlling for BP advertising *during* the oil spill, and using BP advertising *units* (the number of spot television ads) as measure of advertising. Our results are robust to these alternative specification checks.

3.3 Measures of green preferences

We construct measures of consumer environmental sentiment by local geographies. In the literature, "green preferences" have been characterized in a variety of ways. For example, List and Sturm (2006) use per capita membership in environmental organizations at the state level. Kahn (2007) uses California Green Party registrations and shows that they are a significant predictor of demand for green products, such as hybrid vehicle registrations. Kahn and Vaughn (2009) create a green index based on California referendum voting outcomes and Green Party registrations; they document that hybrid vehicles as well as

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

[23] Kantar's technology monitors spot television from 5 am through 2 am, where "the monitored stations constitute the principal stations in each market and typically include the network affiliates, major independents, and Spanish affiliates. Public broadcasting stations are not included" (Source: Kantar Ad$pender supporting documentation).

[24] 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.

LEED-certified ("green") buildings cluster in politically green communities. Building on this literature, we compile and combine the following measures to create a green index:[25]

1) Hybrids: Share of hybrid-electric vehicle registrations in 2007 in each zip code obtained from R.L. Polk automotive data. We chose the year 2007 to exclude hybrid car purchases caused by the 2008 spike in gasoline prices.
2) Sierra: Per capita Sierra Club membership in 2010 at the state level created using data from the Sierra Club and the U.S. Census Bureau.
3) LEED: The number of LEED-registered buildings per capita in each zip code, obtained from the U.S. Green Building Council (data accessed in June 2011).
4) Green Party Contributions: Average per-capita contribution to Green Party committees in 2003/04 and 2007/08 at the zip code level, computed using individual level data from the Federal Election Commission.[26] [27]

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

4 Empirical Analysis

4.1 Pooled results

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

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

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

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

We aggregate prices and quantities at two levels. First, we may be concerned that autocorrelation in average weekly net prices or fleet sales might bias our standard errors (Bertrand et al., 2004). We collapse all weekly net price and fleet sales data into averages within three time periods: a *pre-spill* time period (January 01, 2009, through April 16, 2010), a *during-spill* period (April 23, 2010, through September 17, 2010), and a *post-spill* period (through March 2011). Results from this aggregation are presented in Table 1, columns 1 and 2. Table 1, columns 3 and 4 show the fixed effects specification in which we use weekly net price and fleet sales data for comparison. 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.

The two aggregations yield very similar results. Both show a negative, economically and statistically significant effect of the oil spill on both prices and sales at BP stations relative to our control group. The three-period aggregated results (columns 1 and 2) show that in the spill period, BP stations experienced a price decrease of 4.2 cents per gallon and a 3.6 percent drop in sales from fleet customers.[28] The decrease in net price is substantial, given that the National Association of Convenience Stores estimates that the average retail mark-up was 16.3 cents per gallon in 2010.[29] Using that statistic, the point estimate represents a 26 percent decline in retail margins. These effects are, however, temporary in nature. In the post-spill period, the BP retail station prices are actually, slightly, but significantly higher than those at non-BP stations in our control group. BP quantities, however, remain depressed. The results in columns 3 and 4 using weekly aggregations are essentially the same.

Figure 1 displays the mean weekly price (level) for the BP and control stations in our sample. The vertical lines on Figure 1 denote the beginning and sealing of the oil spill, respectively. For much of the period prior to the spill, our sample of BP stations has higher prices, on average, compared to the control group. Almost immediately following the oil spill, the mean price for BP falls below the control price until the spill is capped. In the post-spill period, we see that BP's prices, on average, are higher relative to control stations.

[28] Because our measure of volume comes from fleet sales, we prefer the reduced-form regressions for price and quantity. Using our price and fleet sales data to estimate structural demand 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, because prices and sales are not available at all stations (particularly true for fleet sales), estimating a demand system based on a random utility model is problematic.

[29] See http://www.nacsonline.com/NACS/Resources/campaigns/GasPrices_2011/Documents/GasPriceKit2011.pdf. (Accessed on November 27, 2012).

Table 2 estimates the month-by-month change in BP prices and fleet sales relative to control stations. After the spill, BP stations experienced a small, immediate drop in net price (of one cent per gallon) with no discernible impact on fleet sales. Net prices continued to fall, bottoming out in August at -6.1 cents per gallon. During the same month, BP stations experienced a 6.7 percent reduction in fleet sales compared to control stations. At this point, nearly 205.8 million gallons of oil had spilled into the Gulf and only 17 percent had been captured by BP's containment efforts (New York Times, 2010).[30] By October, the price impact had declined to 0.5 cents per gallon, with quantities remaining lowered by 2.4 percent. These patterns partially reverse themselves as of November 2010. We observe a significant increase in BP stations' prices relative to control stations, which is also accompanied by a return to significantly depressed BP gasoline sales as well. These changes may be indicative of changes in BP pricing strategies. However, in any case, they do not suggest that punishment was widely sustained beyond the end of the oil spill.

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

Our identifying assumption is that, aside from the oil spill, there was no shock to gasoline prices (and quantity sold to fleet vehicles) that affected BP and competitor stations differentially from non-BP/non-BP competitor stations in the aftermath of the oil spill. Although plausible, this assumption could be violated if, for example, BP stations are more likely to be in zip codes that are less (more) likely to be subject to summertime gasoline Reid Vapor Pressure (RVP) standard regulations than markets in which our control group stations lie.[31] This could disproportionately drive down (up) the relative price of gasoline in markets with BP stations in the summer, as content regulations can cause local seasonal increases in gasoline prices through increased production costs. Because the BP spill occurred during the spring and summer of 2010, differential regulations could be a confounding factor.

Table 3 restricts the sample to zip codes with no seasonal gasoline content regulation (uniform RVP of 9.0). The results show a *stronger* overall BP price decrease of 7.5 cents per gallon. Fleet sales

[30] Among the rest, eight percent had been burned or skimmed, 25 percent evaporated or dissolved, 24 percent dispersed either naturally or chemically and 26 percent still at sea or on shore.
[31] See Brown et al. (2008) and Auffhammer and Kellogg (2011) for detailed descriptions of gasoline content regulations.

impacts cease to be significant, although the point estimate remains negative. It should be noted that the Table 3 specification reduces our sample size by over 70 percent. Indeed, when considering a larger sample of standard RVP zip codes from the unfiltered OPIS data (i.e., not restricted to our list of "good" sample zip codes), the quantity impacts are stronger and remain highly significant in this specification as well (see Online Appendix Section II). Overall, seasonal changes in RVP gasoline content requirements do not appear to be driving our results.

These findings suggest that, on average, consumers acted to punish BP during the spill rather than permanently revise their preferences for the BP brand downward. BP is able to raise prices above pre-spill levels without further losing market share. This suggests that while BP's strategy may have changed post-spill, demand for BP gasoline rebounded post-spill. Cabral (2005) reviews the theoretical literature on trust and reputation, classifying models of trust and reputation between firms and consumers into "bootstrap" models of trust based on repeated interaction versus reputation models with Bayesian updating. Under models of trust, the consumer expects a firm to behave a certain way, punishes it for deviating from expected behavior, but returns to equilibrium after a period of punishment. In reputation models, consumers expect firms to be a particular type (e.g., high quality), and update their beliefs permanently in response to an experience sufficiently different from the initial expectation. Trust models primarily address moral hazard (e.g., shirking on promised quality effort), whereas reputation models primarily deal with adverse selection (e.g., low quality types pretending to be high quality types).

Trust models that involve many consumers suffer from a similar problem to voting; punishment is not individually rational as each individual consumer's demand is not sufficiently large enough to affect aggregate outcomes or incentives.[32] This free-rider problem may explain why consumers organize boycotts as a coordinated response to firm behavior, as many did during the BP spill.[33,34] Alternatively, Fehr and Gaechter (2000) find in laboratory experiments that subjects are willing to expend resources to punish deviating players in a trust game even in single-shot games, where such punishment cannot incentivize better future behavior. It may be that punishment of bad behavior has intrinsic value. Either way, our results seem consistent with a model of trust, where consumers punish firms for deviating from expected behavior.

[32] See the literature on the paradox of not voting (e.g., Downs, 1957; Olson, 1965; Palfrey and Rosenthal, 1985; Feddersen, 2004).

[33] Calls for boycotting BP stations were issued by voices including Public Citizen, Jesse Jackson, and the Backstreet Boys, who reportedly completed their 2010 tour without stopping at BP stations to refuel their tourbus. (Source: Backstreet Boys website, URL: http://backstreetboys.com/news/11968 Accessed: June 2011).

[34] Models of civic duty, peer pressure and group voting have been put forward as social mechanisms to overcome the paradox of not voting. See for example Gerber and Green (2000), Green and Gerber (2004) and Coate and Conlin (2004).

4.2 Interaction effects and advertising exposure

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

Table 4 presents the results. The first two columns repeat the results in Table 1 on the subsample of stations for which the Green Index, hybrid car shares, and income data are all available. The results are essentially unchanged. Columns 3 and 4 add controls and interactions for income and hybrid shares. Income has a positive and significant effect on the price changes at BP stations, indicating that the negative impact of the spill was abated in high-income areas. A one standard deviation increase in income (of $15,563) implies a 1.55 cents per gallon ($0.001*$15.563) smaller price decrease than the average. This difference represents an approximately 39 percent smaller price decrease relative to the overall impact of -4 cents per gallon. The smaller price effects seen in high income areas may be driven by gasoline station selection and by higher valuation of convenience. However, we do find a negative and significant impact of income on quantity sold through fleet cards. A one standard deviation in zip code income drops BP volumes during the spill period by an additional 3 percentage points (0.002*$15.563) relative to our sample mean of -3.6 percent. Thus, while BP prices drop less in high-income areas, BP fleet card customer sales drop more, making the overall impact of income ambiguous if fleet purchasers reflect local income levels in their purchase behavior.

We further find that consumers punished BP significantly more in areas with larger shares of hybrid vehicles. The results imply that a one-standard deviation increase in hybrid vehicle share is associated with an additional 0.6 cent per gallon (0.012*0.5%) drop in BP retail gasoline prices in the aftermath of the spill. However, the hybrid vehicle share interaction term is not a significant predictor of changes in BP sales after the spill. Columns 5 and 6 of Table 4 substitute our Green Index for percentage of hybrid vehicles, as described in Section 3, compiling measures of green preferences used by List and Sturm (2000), Kahn (2007) and Kahn and Vaughn (2009). Using this measure, we again find that greener areas responded more strongly to the BP oil spill. The coefficient on Green Index implies that a one standard deviation increase in the Index intensifies price decreases by 0.94 cents per gallon (-0.006*1.56),

or a 23.5 percent further decrease relative to a mean decrease of four cents per gallon. We do not find a significant interaction effect between the Green Index and changes in fleet-card volume sold at BP stations.

Table 5 adds interactions with demeaned BP advertising expenditures. We focus on expenditures, as opposed to quantities, since we are aggregating over many forms of advertising media (e.g., television, print, etc.) (Clark et al., 2009). The first two columns replicate the benchmark results from Table 1 for the sample of stations that have income, green preference, and advertising data available. The average impact of the spill is slightly smaller in this sample, but remains economically and statistically significant. The next two columns add demeaned advertising expenditures by BP during the Beyond Petroleum campaign years (2000 through 2008) for advertisements focused on the BP Corporation, BP fuels, or environmental issues, to the OLS regressions in Table 5. If green advertising worked to convince consumers of BP's commitment to the environment through investments in production processes that provide an environmental public good (or reduce negative environmental externalities), one might expect to see higher punishment in areas where BP advertised more heavily. On the other hand, in the early days of the spill, such convictions could have swayed consumers' beliefs about whether the disaster was due to bad luck or bad management (Minor and Morgan, 2011). We find that pre-spill exposure to BP advertising significantly dampened the response to the oil spill. The point estimate on BP*Advertising suggests that a one standard deviation increase in advertising expenditure softened the price impact of the spill by 1.4 cents per gallon (0.004*3.4), resulting in a 45 percent decline in the price impact of the spill. The effects of the spill on BP station prices in high income and high Green Index areas remain unchanged; the coefficients on these interaction terms are similar to those in Table 4. We find no significantly different effect of the spill on quantity sold in areas exposed to more versus less advertising.

Columns 5 and 6 use spot prices for television advertising as an instrument for advertising expenditures.[35] We use the quantity-weighted average spot price in the late Beyond Petroleum campaign years from 2007-2008 when we have advertising data for all brands and all products in all product categories. This instrument has been used in the prior literature (e.g. Dube and Manchanda, 2005) and is valid under the assumption that spot prices are determined by the broad advertising market rather than factors endogenous to proclivity to BP gasoline products *per se*. The estimated impact of being a post-spill BP station and being located in an area with differentially more BP advertising becomes even stronger when instrumenting for BP ad spending.

We conduct several further robustness checks in the Online Appendix. These robustness exercises include the consideration of broader BP advertising categories (e.g., specific BP service station advertisements), controlling for BP advertising *during* the oil spill, and using BP advertising *units* (the

[35] The corresponding first stage regression results are presented in the Online Appendix.

number of spot television ads) as a measure of advertising. Our results are robust to these specification checks. We also include additional interaction terms which could be correlated with advertising and with the impact of the oil spill on BP stations. For example, we include an interaction with BP's market share in the metropolitan area. Market share should be positively related to advertising expenditures. Including this interaction term has no impact on our advertising results. This supports the validity of our instrument; the instrument is uncorrelated with BP's baseline market share but positively correlated with advertising expenditures.

The positive and significant impact of advertising suggests that, rather than punishing BP more for the spill, consumers in high-advertising metropolitan areas were less likely to punish BP, lowering the impact of the spill on BP station prices. This result suggests that firms which may cause environmental damage may benefit from green advertising, in line with the notion that corporate social responsibility may provide reputational insurance in case of adverse events by persuading customers of green quality in spite of evidence to the contrary (see Minor and Morgan, 2011).

It is important to note that we are unable to determine whether the same effects would have resulted if BP had simply engaged in any sort of advertising campaign, environmentally related or not; we do not have variation in the type of campaign BP ran across metropolitan areas. For example, Clark et al. (2009) use the same advertising data linked to survey data on quality and brand awareness for firms across many sectors. They find that advertising has a larger impact on brand awareness than on quality perception (they do not, however, distinguish between advertising campaigns targeted at communicating quality versus brand awareness). In this context, while the Beyond Petroleum campaign appeared in the surveys to position BP as the environmentally responsible petroleum company, it may also have boosted brand awareness and changed shopping habits in a way that cushioned rather than exacerbated the impact the Deepwater Horizon disaster had on demand.

4.3 Long-run impact on station brand affiliation

Given the short-lived punishment apparent in Table 2 and Figures 2, we may or may not expect to see long-run effects on BP's share of branded gasoline stations. Most gasoline stations are owned or leased by independent dealers who sign long-term contracts with upstream refiners to sell and market a particular brand of gasoline.[36] Depending on the severity of the impact on station owners' profits, we might expect

[36] Although many stations are not convenience stores, the National Association of Convenience Stores describes contracting and pricing generally among its members (http://www.nacsonline.com/NACS/Resources/campaigns/GasPrices_2012/Documents/NACSFuelsReport2012__HowBrandedStationsOperate_Pink.pdf, accessed November 27, 2011). The Federal Trade Commission has also discussed the ease with which

to see a long-run impact on BP through loss of station share, if not through permanent impacts on prices and volumes, as retailers switch affiliations based on expectations during the spill. We measure changes in BP's *share of stations* across zip codes before and after the oil spill, as well as how these patterns differ with BP advertising.

Specifically, we estimate the following specification:

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

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

The figures show no significant decline in station share in zip codes in high-Beyond Petroleum advertising areas, but a significant loss to station share in below-median areas. The losses appear about six months after the oil spill, coinciding with the largest monthly drop in prices and sales volumes according to Figure 2. The loss in station share is fairly sizeable, representing a five percent decline (-0.5% relative to a sample station share of 9.67%). While this analysis uses only over-time variation, the comparison of outlet share changes between areas of high pre-spill environmental advertising versus those with low pre-spill advertising suggests that not only did advertising dampen the short-run impact on consumer sentiment, margins, and sales, but that buffer prevented longer term losses through attrition of retail outlets to competitor brands.

branded stations that are dealer-owned can switch between brands in response to changes in local market conditions (see for example http://www.ftc.gov/os/1999/04/9810345c3868swindlestatement.htm, accessed November 27, 2012).

5 Conclusion

This paper explores the ability of private markets to provide incentives for environmental stewardship in the context of retail gasoline markets, the Beyond Petroleum advertising campaign, and the 2010 BP oil spill. In particular, we study the consumer response to the spill and how it varied across time, across areas with different levels of green preferences, and with pre-spill exposure to the environmentally targeted Beyond Petroleum campaign.

Using retail gasoline data, we find a statistically and economically significant (relative) decline in BP stations' prices and gasoline sales (for fleet card customers) that is consistent with a demand shift away from BP-branded gasoline in response to the oil spill. We also find that this response was in part temporary, with margins rebounding after the spill. Thus, consumers may have generally "punished" BP temporarily, rather than permanently updating their beliefs about BP's environmental quality. This finding is consistent with mechanisms explored by the theoretical literature on product quality provision when quality is not readily observable (e.g., Cabral, 2005).

Further, we document significant heterogeneity in the response to the BP oil spill. We find that the punishment was significantly larger in areas that exhibit green preferences in other ways, such as hybrid vehicle ownership or Green Party donations. This finding relates to a growing literature linking political green preferences with consumers' retail purchasing behavior (e.g., Kahn, 2007; Kahn and Vaughn, 2009). As such, evidence that consumers may be voting with their wallets is essential for the ability of private markets to incentivize any degree of environmental protection.

We also show that pre-spill exposure to BP advertising significantly dampened the spill's impacts on BP stations' prices. During the decade preceding the oil spill, BP had embarked on a large and celebrated marketing campaign to brand itself as an environmentally friendly company. In the absence of formal certification schemes, advertising is a way for firms to signal and commit to environmental stewardship. However, we find that increased exposure to BP advertising may have led consumers to attribute the oil spill to bad luck rather than to negligent practices, playing a persuasive rather than an informative role about environmental practices. Expenditures on corporate social responsibility may function more as insurance (Minor and Morgan, 2011) and less as investment in signaling unobserved environmental product quality.. Finally, we find that advertising cushioned BP from long-run, negative impacts on sales as it decreased the fraction of gasoline stations who re-branded to other brands as a result of the spill.

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

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TABLE 1: OIL SPILL IMPACT: BASIC DIFFERENCE ESTIMATES

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

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

TABLE 2: OIL SPILL IMPACT BY MONTH

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

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

TABLE 3: OIL SPILL IMPACT AND REID VAPOR PRESSURE REGULATION

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

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

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

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

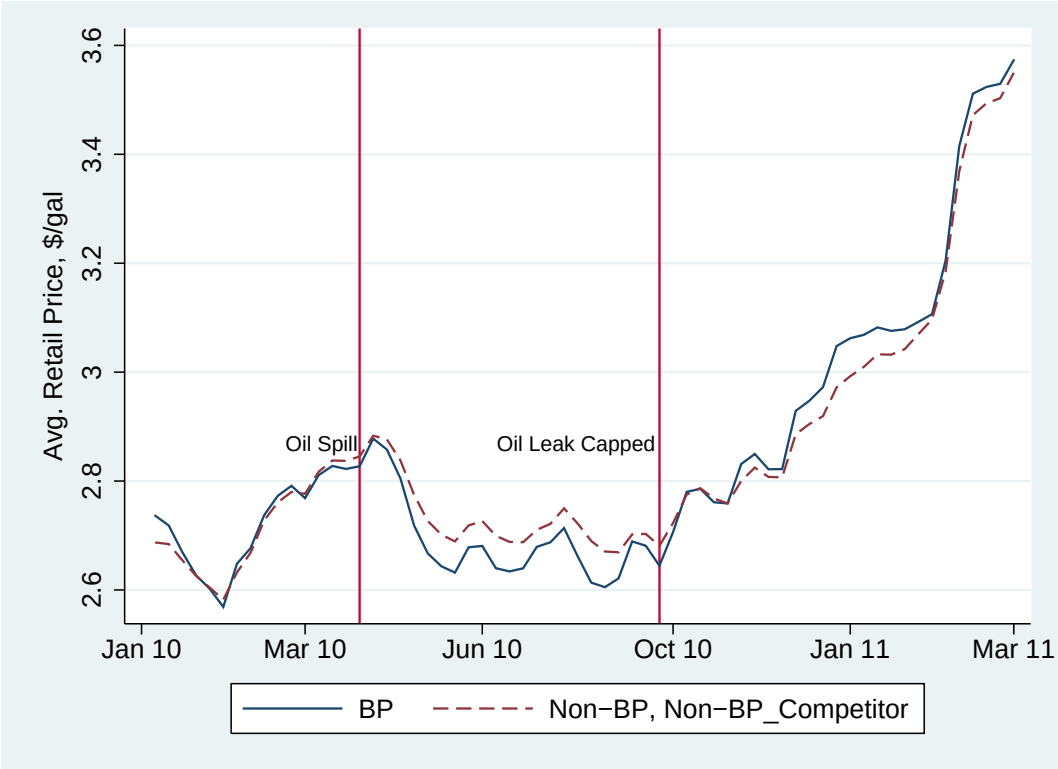
Notes: Sources: OPIS, Sierra Club, the U.S. Green Building Council, the U.S. Census and Kantar Media. The sample is restricted to stations with available data on Green Index and household income. Columns (1) and (2) report the benchmark estimates from Table 2 for the sample of stations that has income,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

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

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

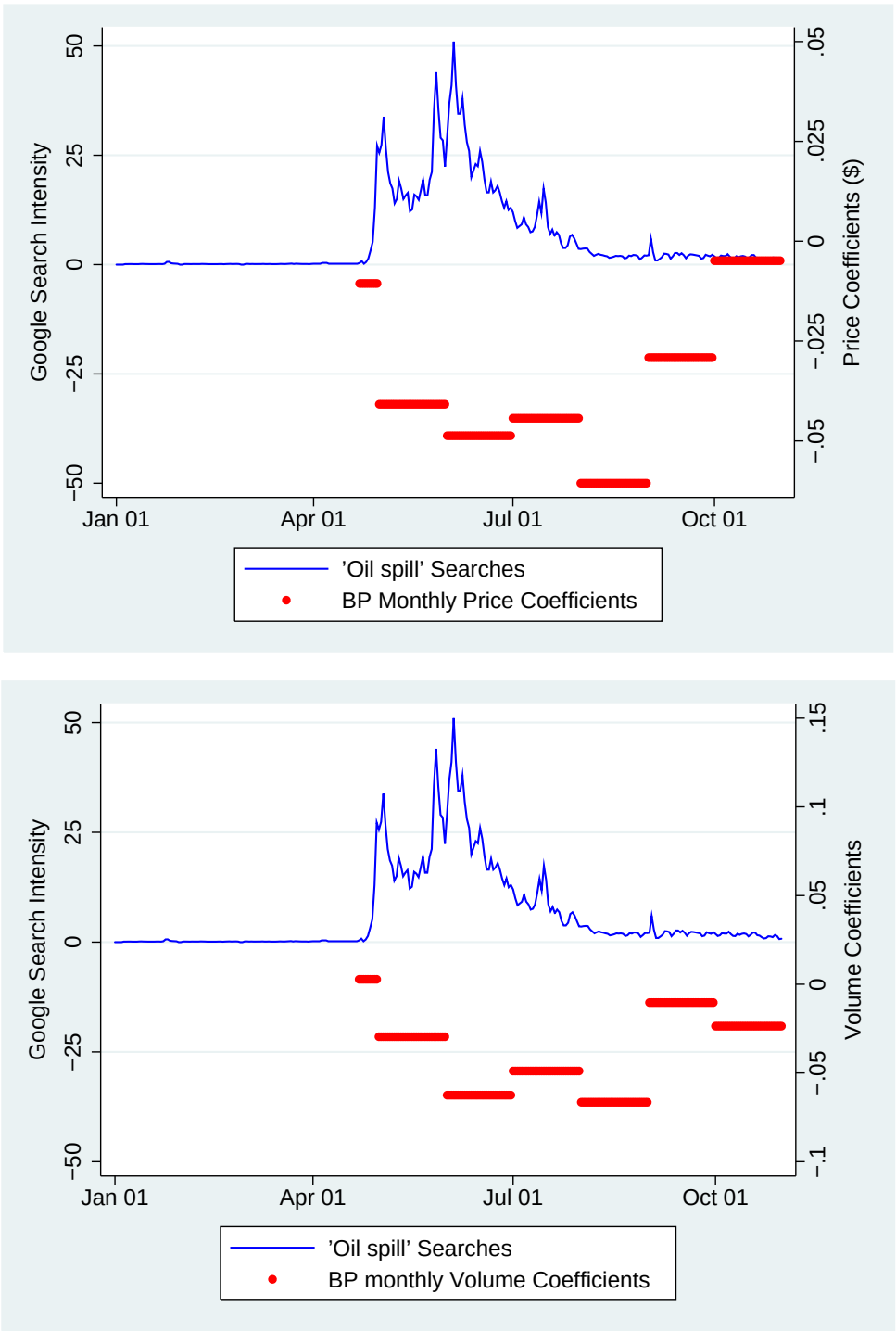
Notes: Source: OPIS, Sierra Club, R.L. Polk, the U.S. Green Building Council, and U.S. Census. The sample is restricted to stations with available data on Green Index, household income, and BP advertising expenditures. Columns (1) and (2) report the benchmark estimates from Table 2 for the sample of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

FIGURE 1
AVERAGE WEEKLY PRICE (LEVEL) FOR BP AND CONTROL STATIONS
JANUARY 2009 TO MARCH 2011



Notes: Source: OPIS. The figure displays average weekly prices for BP and non-BP competitor stations in our sample of 7,503 stores. See text and appendix for details on our sample construction.

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



Notes: Source: OPIS and Google Insights (accessed 8/16/2011). The figures display in blue the Google search intensity for the phrase "oil spill" relative to January 2004. For a given month, the Google search intensity is measured as the ratio of searches in that month to searches during a baseline month. Here, the baseline month is January 2004, so a value of 50 indicates that searches in the baseline month were 50 times greater than they were in January 2004. The red lines in each figure 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 effects.

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

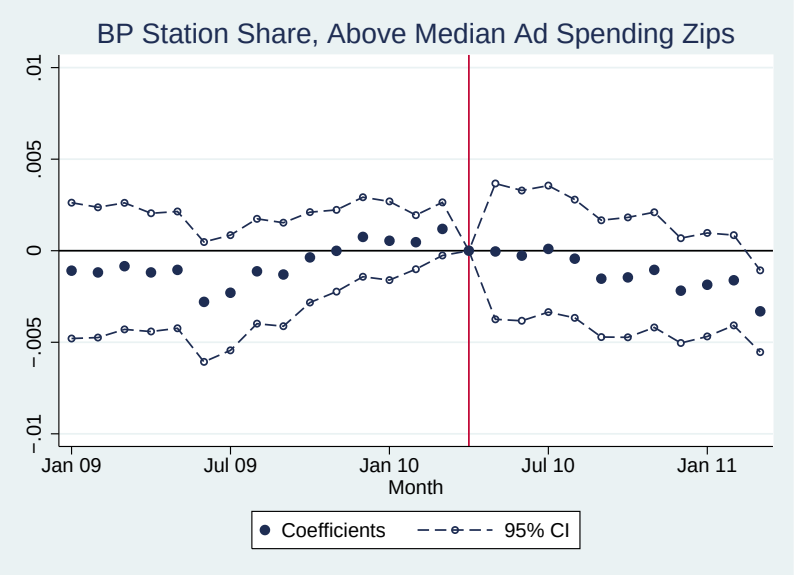
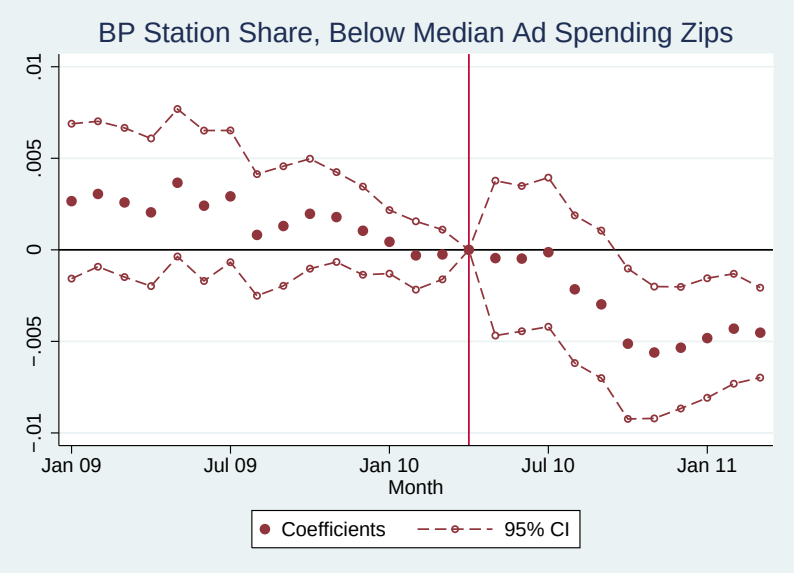


FIGURE 3B: BP MARKET SHARE TIME-DUMMY COEFFICIENTS, BELOW MEDIAN ADVERTISING SPENDING



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