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Working Paper # 16-01
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DISCLAIMER

ABSTRACT

Underground storage tanks (USTs) containing petroleum and hazardous substances are ubiquitous. Accidental releases of these substances can present risks to local residents and the environment. The purpose of this paper is to develop monetized estimates of the benefits of preventing and cleaning up UST releases, as reflected in house values. We focus on 17 of the most high-profile UST releases in the United States with release discovery and other milestone events occurring at different points between 1985 and 2013. These data are the broadest analyzed for property value impacts of UST releases, as previous hedonic studies of USTs focused only on a single county, city, or subset of counties within a state. We employ a two-step methodology in which (i) site specific hedonic regressions are estimated using a difference-in-differences approach, and then (ii) an internal meta-analysis of the resulting estimates is conducted. The spatial and temporal variation among the 17 sites improves our identification of the treatment effects by reducing local idiosyncratic biases; thus providing greater confidence to a causal interpretation of the estimated average price effects. The results suggest significant heterogeneity in the price effects across sites, but on average reveal a 3% to 6% depreciation upon the discovery of a high profile release, and a similar appreciation after cleanup. These average effects diminish with distance, extending out to 2 or 3km from the site.

JEL Classification: Q24; Q51; Q53

Keywords: groundwater; hedonic; meta-analysis; property value; underground storage tank; UST; vapor intrusion

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I. INTRODUCTION

Underground storage tanks (USTs) containing petroleum and hazardous substances are ubiquitous, usually associated with gas stations and occasionally with industrial facilities. In the United States, there are over half a million active USTs, and almost two million that are no longer in use (US Environmental Protection Agency, 2011). More than half a million of these active and inactive USTs have been associated with leaks that release chemicals into the environment.[1] Due to state and federal regulations requiring release prevention and detection activities, most UST releases are small in scope and far from being headline news. However, chemicals released from USTs can cause fires, explosions, neurological damage, blood disorders, cancer, and other adverse health outcomes (Jenkins et al., 2014). UST release events may involve contaminated groundwater, vapor emissions and intrusions, and/or contaminated surface water. Thus, UST releases sometimes garner significant press coverage and elicit public concern regarding potential risks to human health and the environment.

The purpose of this paper is to develop monetized estimates of the benefits of preventing and cleaning up UST releases, as capitalized in local residential property values. A few previous studies have used hedonic methods to measure the impacts of UST releases on nearby housing values (Guignet, 2013; Isakson & Ecker, 2013; Simons et al., 1997; Zabel & Guignet, 2012). However, because potential homebuyers typically have little or no information about nearby releases, identifying the property value impacts of UST leaks is difficult. To address this empirical challenge, our study focuses on 17 sites in the United States where high-profile UST releases were widely publicized and involved significant community concern. These sites are drawn from communities ranging from California to the East Coast, and represent some of the most highly

[1] According to the federal EPA Office of Underground Storage Tanks (OUST), since 1984, 520,000 releases have been reported and 74,000 remain to be cleaned up (US Environmental Protection Agency, 2014).

publicized—and at most sites, severe—UST leak events that have occurred in the United States over the last thirty years. Thus, these incidents provide a compelling empirical context in which to measure the monetary tradeoffs that homeowners are willing to make to avoid or accept risks from UST leaks.

Our analysis uses a two-step methodology that involves site-specific hedonic regressions followed by an internal meta-analysis of the resulting estimates. First, at each site, we use hedonic regressions to estimate how housing prices changed in the wake of publicized milestone events. We identify four types of milestones: initial discovery of the release, completion of cleanup, “other positive” events (such as announcements about future remediation plans), and “other negative” events (such as discovery of additional contamination).

To control for pre-existing site-specific trends in housing prices, our regressions use a difference-in-differences (DID) approach that compares the change in prices in neighborhoods near the leak site against the change in prices in neighborhoods located further from the site. To allow for the possibility that homeowners’ perceptions of risk vary by distance, we define five distinct “treatment” neighborhoods for each site, using houses located 0-1 km, 1-2 km, 2-3 km, 3-4 km, and 4-5 km from the leak site. Houses located 5-10 km from the site serve as the control group.

After estimating the change in house prices after each milestone event for each treatment group at each site, we then use an internal meta-analysis to summarize property value impacts across the 17 sites. This meta-analysis combines the coefficients and statistical uncertainty from each hedonic regression to estimate an aggregate distribution of the percent changes in housing values from leaking USTs.

Our results suggest that the impact of an UST release on property values varies considerably across sites and milestone events. However, on average, during the five-year period following the discovery of a release there is a 3% to 6% decrease in housing values. The effects diminish with distance from the site, but houses as far as 2 or3 km away still experience a decrease in value. Additionally, looking at sales within 5 years after a cleanup, on average property prices rebound by 4% to 9%, an effect that also diminishes with distance. Nonetheless, we do observe considerable heterogeneity in how property values respond to both discoveries and clean-ups, with some events appearing to cause very large property value changes, and others appearing to cause negligible changes, or a counterintuitive effect.

Our paper advances existing research in three ways. First, our study is the broadest study ever conducted of the property value effects of UST releases. To support our analysis, we have assembled comprehensive microdata covering 17 high-profile release sites from communities across the United States. In contrast, past hedonic studies of UST releases have focused only on a single county, city, or subset of counties within a state (Guignet, 2013; Isakson & Ecker, 2013; Simons et al., 1997; Zabel & Guignet, 2012). The previous work that is most similar to ours is a study of Maryland by Zabel and Guignet (2012), which found that UST releases only impacted house prices when leaks were publicized and the community was informed about potential risks.

Second, by focusing exclusively on high-profile incidents, our study circumvents broader concerns from the land contamination literature about whether property market participants are aware of the disamenity of interest, UST releases in this case (Guignet, 2013). Of course, this focus on high-profile UST sites also results in estimates that represent the upper range of property value impacts, relative to the population of UST releases. Thus, our estimates are not readily transferable to a *typical* UST release. Nonetheless, the results do inform policymakers about the upper reaches of benefits to nearby residents of actions to prevent and clean up UST releases.

Our third contribution is a useful combination of quasi-experimental methods with meta-analytic techniques within a single study to improve identification of the treatment effect. The DID model used to estimate site-specific treatment effects relies on the assumption that in the absence of a UST-related event, the outcome of interest (in our case housing prices) would have followed similar trends in both the control and treated groups (Gamper-Rabindran and Timmins, 2013). This assumption could be violated if unobserved influences on house prices are correlated with proximity to the site *and* the timing of events. Our diagnostic analysis of pre-event price trends suggests that for some sites in our sample, the estimated treatment effects could be confounded by local trends in the housing market.

However, our use of multiple sites in a meta-analytic framework allows us to generate robust estimates of the average property value impacts, reducing the influence of local unobserved trends at individual sites. Our 17 high-profile releases occurred in different housing markets across the period from 1985 to 2013. This spatial and temporal variation in the treatment of interest (i.e., the release, cleanup, or other milestone events) allows us to use meta-analysis to essentially "average" out any idiosyncratic biases; thereby lending greater confidence to a causal interpretation of the estimated average price effects. We present meta-regression estimates from random effect-size models, which account for unobserved or unmeasured factors that might influence the estimates from individual sites (Nelson, 2015).

The remainder of this paper is organized as follows. Section II presents a brief review of the hedonic property value literature on contaminated sites. Section III describes how we selected our high-profile sites and explains our hedonic property value model and internal meta-analysis.

Section IV describes the data used to estimate the empirical models. Finally, Sections V and VI present our results and concluding remarks.

II. LITERATURE REVIEW

An extensive literature exists on how contaminated sites have affected surrounding property values. Papers have studied the impact of proximity to (or risk of) a nearby contaminated site; or property value changes over time, targeting discovery of contamination, completion of cleanup, or other milestones related to a single site.[2] Many hedonic studies have focused on property values around a small set of sites (e.g., Kohlhase (1991), Kiel (1995), Messer et al. (2006)), but recently the importance of analyzing national samples of contaminated sites has been emphasized, with studies examining sites receiving federal Environmental Protection Agency (EPA) brownfields grants (Haninger et al., 2014) and sites on the EPA National Priorities List (NPL) (Gamper-Rabindran & Timmins, 2013; Greenstone & Gallagher, 2008; Kiel, Katherine A. & Micheal Williams, 2007).

A. Property Value Impacts when Households are Informed

A sizable portion of the literature on the property value impacts of contamination has focused on Superfund NPL sites. These sites are subject to a formal sequence of actions, including proposal to list, final listing, and cleanup completion, among others. The public is likely to be relatively well informed about nearby NPL sites as public notification is required at many steps along the timeline of actions. For example, EPA publishes in the Federal Register any proposal to list a site on the NPL, and notifies the local press (US Environmental Protection Agency, 2015).

[2] See Banzhaf and McCormick (2007), Boyle and Kiel (2001), Sigman and Stafford (2011) and US Environmental Protection Agency (2009) for reviews.

Several early papers (e.g., Michaels and Smith (1990), Kohlhase (1991), Kiel (1995)) examined multiple Superfund sites and generally found that subsequent to discovery or listing, there was a positive correlation between distance from a site and property values, suggesting households were willing to pay a premium to be located further from contamination. However, there is mixed evidence of the price effects of cleanup (Dale et al., 1999; Kiel, Katherine A. & Micheal Williams, 2007; Kohlhase, 1991; McCluskey & Rausser, 2003a), particularly when remedial efforts are prolonged over long periods of time (Messer et al., 2006).[3]

With the goal of investigating beyond only high-profile cases, Kiel and Williams (2007) examined all NPL sites in 13 US counties to learn whether property value impacts were similar across sites. They examined two assertions that previously had been made in the literature: (i) proximity to an NPL site lowers property values, and (ii) cleaning up an NPL site restores property values. Using residential property transaction data from 1970 through 1996, they studied six timeframes[4] but focused on listing. The paper concluded that NPL listing at some sites (18 of 57) had the expected negative impact on house prices, but at others had no impact (32 of 57) or even a positive effect (the remaining 7).

B. UST Releases and Residential Property Values

Compared to NPL sites, the typical UST release can often be considered a relatively small disamenity. Nonetheless, UST releases can still pose risks to human health and the environment. There are three exposure paths through which UST releases can lead to health and environmental

[3] A few hedonic property value studies have gone beyond the conventional identification strategy of examining how the distance gradient changes after key milestones. For example, Gayer and Viscusi (2002) examined whether news stories raised alarm bells or quelled concerns about contaminated land.

[4] The timeframes were pre-discovery; discovery through NPL proposal; proposal through NPL listing; listing through beginning of cleanup; cleanup through removal from NPL; and post-removal.

risks. First, gasoline and hazardous additives can infiltrate local groundwater aquifers, which in some cases are key water sources for private wells and public water systems. Such contamination poses health risks from ingestion, skin contact, and inhalation of fumes, all of which may cause neurological damage, blood disorders, cancer, and other adverse health outcomes (Jenkins et al., 2014). A second common contamination pathway occurs when vapors emitted from released gasoline migrate through soil, septic, or drainage pipes and into structures. This type of contamination poses acute health risks and a risk of fire or explosion. Finally, contaminated runoff can migrate into surface water directly, creating environmental problems and threatening local ecosystems.

There are a few studies that examined the impact of USTs releases on surrounding residential property values. Focusing on Cuyahoga County, Ohio, Simons et al. (1997) estimated a hedonic model using a cross-section of house sales in 1992 and found a 17% depreciation among houses within 300 feet of a registered leaking UST. Focusing on house sales from 1994-1996 in that same county, Simons et al. (1999) found that "contamination" from nearby gas stations reduced house values by 14% to 16%.[5] In a working paper, Isakson and Ecker (2010) examined 50 USTs in Cedar Falls, Iowa, and found that the prices of houses adjacent to UST releases classified as "high risk" by regulators were about 11% lower. Due to the small samples and cross-sectional data, the results of these studies should be interpreted with caution.

Zabel and Guignet (2012) exploited both spatial and temporal variation in house prices in order to identify the causal impact of UST releases. Focusing on three counties in Maryland they

[5] Simons et al. (1999) defined contamination based on a 3-point scale, where 1= well test confirmed contamination at the house, 2= house was adjacent and down-gradient from a LUST, and 3= house was adjacent to a house scored as '1' or '2', down-gradient, and within 50-100 ft of the contamination plume. Only 11 contaminated houses were sold which is too few for a typical hedonic study. Instead they compared the actual transaction prices to house-specific predicted prices from a hedonic regression that did not explicitly account for leaking UST sites.

concluded that the typical (i.e., not high-profile) release had no adverse effect on house values. However, focusing on a subset of the most severe and publicized cases, Zabel and Guignet (2012) found that when a release was discovered, house values within one kilometer decreased by 5%. In a follow-up study of the same house transaction data, Guignet (2013) again found no adverse price impacts associated with the typical release, but did find an 11% depreciation among houses where the private well was tested for contamination, and thus where the household was well-informed of the disamenity. Together these studies suggest that residential property values are only impacted by UST releases when the public is informed, and/or when actual or perceived risks may be higher than typical.

Existing hedonic property value studies of UST releases are limited to one or a few localities. There have been several recent nationwide property value analyses of Superfund and brownfield sites (Gamper-Rabindran & Timmins, 2013; Haninger et al., 2014). Given past findings that the typical UST release does not adversely impact surrounding house values, the understanding gained by gathering and analyzing a nationwide sample of UST releases would likely be limited.[6] The question remains however as to how consistently highly publicized or "high-profile" UST releases affect property values. Learning more about these worst case scenarios helps inform policies to prevent, minimize, and clean up UST contamination.

[6] Furthermore, compiling the necessary nationwide dataset of UST releases would be extremely difficult. Data of UST releases may or may not be maintained by individual states, and not necessarily in a consistent manner. Nationwide studies of NPL sites (Gamper-Rabindran & Timmins, 2013) and brownfields (Haninger et al., 2014), on the other hand, utilized available nationwide datasets.

III. METHODS

A. Selecting High-Profile Release Sites

To identify candidate high-profile release sites we cast a broad net, consulting with EPA's Office of Underground Storage Tanks (OUST), all ten EPA Regional Offices, state and local environmental agencies, and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO). We also identified several sites through internet searches and by reviewing ASTSWMO (2012) and relevant academic literature (see Appendix A for details). Our objective was comprehensive spatial coverage across the contiguous United States.

We initially identified 41 potential high-profile UST sites, located in 23 different states. Unfortunately, we were not able to study all of these sites. Our focus was on residential properties, so we eliminated sites in industrial or rural areas where residential development was too sparse for robust statistical analysis. We eliminated two other sites because the high-profile events were too recent or too far in the past (with insufficient property transaction data either pre- or post-event). Finally, after some preliminary research, we eliminated thirteen additional sites due to data and information constraints; for example, some states (such as Montana) have disclosure laws preventing the public release of property sales data.

In the end, we obtained sufficient data to examine 17 high-profile UST release sites. Of these, the majority (nine) represent areas where retail gas stations released gasoline that contaminated groundwater used in private drinking water wells. At six of the sites vapors migrated to occupied structures. This was sometimes the sole concern, while other times it added to groundwater or other risks. For one site, contamination impacted surface water. Three of our sites had *public* wells contaminated by UST releases. Finally, methyl tertiary butyl ether (MTBE) (a potentially harmful gasoline additive) was a concern at nine of the 17 sites.[7] Appendix A specifies the original source that identified each high-profile release, offers statistics for the affected communities, and briefly describes the events surrounding each release site.

Figure 1 presents a map that shows the distribution of these sites across the contiguous United States. Most sites are located on the East Coast, where the high profile criteria were more frequently met and data on housing sales were more often available.

B. Hedonic Property Value Model

In the first stage of our analysis, we estimate separate hedonic regressions for each high-profile site, denoted by $s = 1, \ldots, 17$. To facilitate a cleaner quasi-experimental comparison and to ensure comparability of the estimates in the later internal meta-analysis, we adopt restrictions to improve uniformity across site-level datasets. We use transactions for single-family homes and townhomes within 10 km of each site. We exclude transactions more than 5 years before or after each milestone event, since the hedonic equilibrium might shift over time (Kuminoff et al., 2010). If a site experienced multiple high-profile events that occurred close together in time, then our hedonic regressions include a separate set of coefficients and variables for each event. However, if the events were more than five years apart, we split the transaction data into separate datasets, and estimate individual hedonic regressions for each event.

Since previous literature indicates that the impacts of contamination vary with distance from the site, we sort houses into discrete one kilometer (km) distance buffers, using functional

[7] MTBE is a contaminant and suspected carcinogen that was previously used as a gasoline oxygenate to improve air emissions. Some states have set limits for MTBE in drinking water and EPA issued a drinking water advisory for it in 1997. MTBE has generally not been used as a gasoline additive since the early 2000s (Jenkins et al., 2014), and so it is often associated with older, sometimes previously unknown, releases.

forms similar to analyses in past literature (Gamper-Rabindran & Timmins, 2013; Zabel & Guignet, 2012). We allow the potential price impacts associated with proximity to an UST site to extend out to 5 km.[8] The functional form of the hedonic models appears in equation (1).

$$\ln p_{ijts} = x_{ijt}\beta + \sum_{d=1}^{5}\left(\psi_s^d D_{is}^d + \theta_{se}^d\{event_{tse} \times D_{is}^d\}\right) + \mathbf{M}_t\boldsymbol{\alpha} + v_j + \varepsilon_{ijts} \quad (1)$$

The dependent variable, ln p_{ijts}, represents the natural logarithm of the price of house *i* in neighborhood *j* at time *t* near high-profile site *s*.

The control vector $\boldsymbol{x}_{ijt}$ contains all structural, parcel, neighborhood, and other control variables, including the number of gas stations within 200 and 500 meters of the house. The vector $\boldsymbol{M_t}$ contains year and quarter fixed effects, v_j is a neighborhood fixed effect (at the census tract level in the presented results), and ε_{ijts} is a normally distributed, zero-mean error term.

The distance buffers are represented by the dummy variables D_{is}^d, for *d* = 1,.., 5 km. The buffers enter the hedonic equation with individual coefficients ψ_s^d that account for any differences in characteristics of houses located at the various distances from the high-profile site. The distance buffer dummies are also interacted with $event_{tse}$, a dummy variable equal to 1 for transactions that occur after the milestone event *e*, and 0 otherwise. For notational ease the equation only shows one event, however in some cases there are multiple events at a particular site. In such cases, multiple interaction terms are included.

In our quasi-experimental framework, houses outside of 5 km from the high-profile site represent the "control" group. Transactions of these houses help identify overall housing market trends, as well as the implicit prices for other characteristics not of primary interest. Houses within

[8] The 5 km extent is based off of a local polynomial regression approach, similar to Linden and Rockoff (2008), as explained later in the results section (V.A).

5 km from the site that are sold before high-profile event *e* are considered the "treated group before the treatment", and so ψ_s^d captures these baseline effects (which are allowed to vary across the distance buffers, d = 1,.., 5 km). Houses within 5 km that are sold after event *e* are considered the "treated" group, and so θ_{se}^d captures the price differential after the event. Assuming all else is constant, θ_{se}^d is the average treatment effect on the treated, which again is allowed to vary with distance from the site.

Since the dependent variable is in logs and the event-distance interaction ($event_{tse} \times D_{is}^d$) variables of interest are binary, we follow Halvorsen and Palmquist (1980) and calculate the percent change in price as:

$$\%\Delta p_{se}^d = (\exp(\theta_{se}^d) - 1) \quad (2)$$

These estimated impacts are the inputs to the meta-analysis described below.

C. Internal Meta-Analysis

In the second stage of our analysis we use meta-analytic tools to compare and synthesize results for the 17 different sites. First, we calculate the average impacts for similar milestones across the different sites. Second, we use meta-regressions to investigate the determinants of price impacts across sites. This allows us to study the effect of local milestone event characteristics that may influence values, such as exposure pathway and types of contaminants.

Meta-analysis has become an important tool in environmental economics for synthesizing work from multiple studies and/or estimates. Notable meta-analyses in environmental economics include applications in air quality (Smith & Huang, 1995) and water quality (Johnston et al., 2005; Van Houtven et al., 2007). Several previous meta-analyses have explored land contamination at

Superfund sites (Kiel and Williams (2007) and Messer et al. (2006)). Kiel and Williams' (2007) meta-analysis included 55 NPL sites and suggested that larger sites in areas with fewer blue collar workers and for which there were more observed house sales, were more likely to have the expected negative impact on property prices. Messer et al. (2006) studied property prices near prominent NPL sites in three cities where cleanup was prolonged by up to twenty years. Their internal meta-analysis concluded that significant price declines were associated with site discovery, initiation of cleanup activities, and the number of site "events" defined to include major EPA announcements and site actions by the public, responsible parties, and others; while significant price increases were associated with NPL listing. We include similar milestone event variables in our own meta-analysis.[9]

Nelson and Kennedy (2009) discuss several common concerns with meta-analyses that aggregate estimates across different studies and datasets, including consistency in the effect under examination and how it was estimated. Here we estimate the hedonic regressions directly, and so the inputs to our meta-analysis are calculated in a homogenous way—i.e., using the same methodology and functional form, and controlling for the same housing and neighborhood attributes in the primary hedonic regressions.

Our first meta-analytic step is to estimate average price effects across sites. The average impacts are estimated for each 1 km distance buffer, after the release discovery and cleanup completion events. We focus on these two milestones because of their importance and commonality across many sites. Following best practices (Nelson & Kennedy, 2009), we calculate

[9] We do not, however, examine how price impacts vary due to location specific characteristics of the surrounding area, as done by Kiel and Williams (2007). The reason is that we only observe housing markets and demographics around 17 sites, and there are other location-specific variables of greater interest. For example, we examine how price impacts vary based on exposure pathways of concern and the presence of MTBE. Furthermore, we use a fairly extensive set of controls across sites, which should capture many local effects.

a weighted average of the post-event percent changes in price ($\%\Delta p$), where the weight given to each observation is based on the inverse variance of the primary estimate from the hedonic regressions. This scheme gives greater weight to more precisely estimated price impacts. Furthermore, the chosen weighting scheme follows the random effect-size (RES) model (Nelson, 2015), which presumes that each estimate of $\%\Delta p$ is a random draw from a *different* underlying distribution of the true price effect at each site.[10] In calculating the RES mean of $\%\Delta p$ we are calculating the average of the different price impacts across the sites.[11]

The second step in our meta-analysis is to examine price effect heterogeneity across different sites, milestone events, and distances using meta-regression techniques. The functional form of the meta-regression model appears in equation (3).

$$\%\Delta\hat{p}_{se}^{d} = \gamma_1 EVENT_{se} + \gamma_2 \left(EVENT_{se} \times DIST_d \right) + u_{se}^{d} \quad (3)$$

The dependent variable observations are the estimated results from our hedonic models.[12] The vector $EVENT_{se}$ includes a series of dummy variables denoting four different milestone events. In addition to the release and cleanup milestones already discussed, we include the two categories, “other positive” and “other negative” events described above that signal that the pollution situation has improved or worsened. Note that a positive signal event does not necessarily suggest a positive effect on house values. Even a positive signal may make more people aware of the threat or heighten negative perceptions.[13] The variable $DIST_d$ is a continuous distance variable ranging from

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[10] Due to the differences in housing markets, populations, leak origin and extent, publicity, and many other factors, there is no reason to believe that the underlying true price effects at each high-profile site are the same.
[11] In contrast, the fixed effect-size (FES) model assumes that there is a common, shared mean (or effect-size) among all sites (Nelson, 2015; Borenstein et al., 2010). Under the FES model, each estimate of $\%\Delta p$ from the different sites would be viewed as a random draw from the *same* underlying distribution of a common true price effect.
[12] There were 17 sites; 31 events; and 5 distance buffers, yielding a total of 155 meta-observations.
[13] For example, several studies of Superfund sites have found that house prices are still negatively affected even after “records of decision” are ordered and cleanup begins (Dale et al., 1999; Kiel, 1995; Kiel & Zabel, 2001; McCluskey & Rausser, 2003a;2003b).

1 to 5, denoting the distance buffer *d* from the hedonic equation (1). Equation (3) is estimated using a meta-analysis RES model (Borenstein et al., 2010; Nelson & Kennedy, 2009).

IV. DATA

We collected extensive property sales and characteristics data for each of the 17 UST leak sites included in our analysis. The property data include house-level transactions for each location (most often the county) where the high-profile release occurred. These data were available from specific states, counties, or municipalities, and included detailed information on house and parcel attributes including age, number of bathrooms, square feet, and acres, among others. One county, Suffolk County, NY, was the location of two high profile releases (Northville Industries and Smithtown Exxon-Mobil). The data go back as early as 1980 for three Florida counties, and as recent as 2014 for Chittenden, Vermont (location of the Pearl Street Gulf case). We use GIS techniques to calculate the distance from each house to nearby gas stations, urban centers, major roads, and most importantly, the corresponding high-profile UST site. To learn more about each release, we reviewed press articles and relevant association, EPA and state environmental department reports, and gathered data on the dates of milestone events.

Figure 2 illustrates the years covered by the house price data and the dates of significant milestone events that occurred within the price data timeframe. For example, we have property transaction data spanning 2005 through 2013 for Los Angeles County, CA, where the UST release at Charnock Well Fields in Santa Monica occurred. There was a single milestone event within the price data timeframe: cleanup completion in February of 2011.

There were sufficient transaction data to examine 31 milestone events across the 17 high-profile sites. Table 1 shows the number of each milestone event and offers examples of each. Although some events like the discovery of a release and completion of cleanup are clear-cut, identifying intermediate milestone events is admittedly subjective. We did our best to identify these events, but the estimated price impacts may also reflect other intermediate events and changes at the sites over time, at least to the extent such changes affect the perceptions of buyers and sellers in the housing market. A full description of the timeline of events at each of the 17 high-profile sites is provided in Appendix A. To give a better sense of the data, we describe a single high-profile release site in detail. The Green Valley Citgo gas station in Monrovia (Frederick County, Maryland), is the site of a gasoline release discovered by the Maryland Department of Environment (MDE) in 2004. While no individual high-profile site is completely representative, we selected the Green Valley Citgo case because it provides an example of the most common milestone event (the discovery of a release), and because the sequence of events at the site are within just a few year timeframe, allowing us to clearly illustrate the empirical methodology. MTBE was detected in the drinking water supply well that serviced a shopping center near the gas station. This initial detection was identified in our data as the "Release Discovered" event. Groundwater monitoring wells were drilled, and over the next few years, MTBE and benzene were detected above the state action levels. In response, a water supply well was closed and filtration systems were installed at other groundwater wells. Nearby residents relied on private potable wells, so their drinking water supply was threatened.

In 2007, MDE directed the County Health Department to send letters to residents located within a half mile of the gas station, notifying them of the contamination issues. Distribution of the letters was identified in our data as an "other negative" milestone. In 2008, the UST system and contaminated soil were removed. New UST and treatment systems were installed.[14] By April

[14] Although such events could be identified as an "other positive" milestone, the magnitude and awareness of this event was unclear and it is relatively close in time to the more prominent milestone (i.e., notification letters sent to all residents within a half mile). Nonetheless, the subsequent price impact estimates may partially reflect this and subsequent events during the study period.

2010, over 200 private drinking water wells had been sampled, of which six were contaminated with MTBE above state action levels. The six residences received filtration systems and subsequent monitoring. As of 2015, the filtration systems remain in effect at these impacted supply wells. The release case remains open, with natural attenuation and ongoing groundwater monitoring in place.

Table 2 includes descriptive statistics of all sales used in the single regression equation for the Green Valley Citgo case. Note that the statistics only reflect data used in the regression; specifically, of transactions of houses within 10 km of the release site, and within the five-year period prior to the first event through the five-year period following the second event. We have listed all variables that were used in the regressions for any of the 17 high-profile sites, even though not all of these variables were available for this specific location.

V. RESULTS

A. Determining the Spatial Extent

We establish the appropriate spatial extent of the price effects by following an approach similar to Linden and Rockoff (2008), and later adapted by Muehlenbachs et al., (2015). We use local polynomial regressions to non-parametrically examine the housing price gradients around each high-profile site before and after the most prominent milestone event. As an example, consider again the Green Valley Citgo case in Frederick County, MD. The most prominent event was the distribution of letters in April, 2007, notifying residents within a half mile about the release.

To provide a clean comparison, for this exercise we narrowed the focus to sales that occurred only two years before or after the event. We maintained the spatial limit of 10 km. To further control for broader market trends over time, we first "de-trend" the prices for each site.[15] The data are then separated into two groups – sales before versus after the milestone – and then plotted against distance to the site. Two curves are fitted using local polynomial regression techniques to depict the pre- and post-event price gradients. As shown in Figure 3 for the Green Valley Citgo example, at greater distances the price gradients are relatively similar, suggesting that the milestone event had little effect. However, at least in this example, we see that the prices of houses closest to the site were noticeably lower after the event. This price differential diminishes at around two to four kilometers.

We applied this same price gradient exercise separately to each of the 17 high-profile releases for each site's most prominent event, and found considerable variation in what the appropriate spatial extent of any price effect might be.[16] In all cases, however, we did not find evidence that the price impacts extended beyond 5 km and therefore chose it as the appropriate distance for the subsequent hedonic analyses. In order to have a representative meta-dataset, it is important to estimate the price effects out to the same distance for all sites, even if these price effects turn out to be zero for some sites.

B. Difference-in-Differences Diagnostics

An important diagnostic test for a DID identification strategy is to compare the price time trends across the treated and control groups. In a valid DID quasi-experiment, such a comparison

[15] The de-trended prices are calculated by estimating a simple linear regression of price on a series of year dummy variables (with the first year omitted), and then adding the residuals back to the constant term.

[16] Estimating the price gradients around just a single site and event in this fashion makes the curves potentially more susceptible to confounding price factors that may be associated with a particular locale and time period (compared to examining multiple sites at once, as done by Linden and Rockoff (2008) and Muehlenbachs et al. (2015), whose data were of a single housing market, and therefore more appropriate for pooling). Nonetheless, this exercise is still informative, and we believe such noise is reduced in the hedonic regression models, and further minimized in the internal meta-analysis, where we do then analyze across multiple sites.

will show that the treatment and control groups followed relatively similar trends up to the treatment (e.g., the discovery of a release), and then diverge after the treatment (if there is in fact a noticeable treatment effect).

Figure 4 shows an example of these trends, for the Green Valley Citgo site. The figure shows how residual log price varies for houses in the treatment group (those within 0-2 km from the site, in this example) relative to the control group (houses located 5-10 km from the site), as a function of time. In order to control for observable characteristics of the houses that were sold in each time period, the figure is based on the residuals from a regression of log sales price on the same set of housing-level characteristics as used in the main regression models (see section V.C), omitting the post-milestone event variables. The figure shows the mean difference in residuals for houses in the treatment group relative to the control group, along with an associated confidence interval for the difference.

Overall, the figure demonstrates that the treatment and control groups have similar price trends in the years leading up to initial detection of the release (Event 1). Despite the discovery of a release, there is no clear difference between the two groups immediately following this milestone event. After local residents received notification letters in 2007 (Event 2), however, prices in the treatment group declined substantially relative to the control group.

At several sites we observed trends that are consistent with a valid quasi-experimental interpretation of the hedonic regressions. At other sites the price trends revealed no difference, or even a differential with a counterintuitive sign, across the treatment and control groups, suggesting that local price trends around the site may confound the estimates of interest (see Appendix A). We also recognize that small sample sizes in some of the distance bins may contribute to the lack of statistical identification for some milestones (see Appendix D). In such cases, a causal interpretation may not be appropriate, and so in general we caution against drawing firm conclusions from the results for any single site.

We posit that such concerns are reduced by examining multiple sites in our subsequent internal meta-analysis. We have no expectation a priori that the biases across sites for a treatment effect should fall in one direction or another. Indeed, we expect that any biases are primarily random, and are just as likely to be negative as positive. The 17 high profile sites all exist in different property markets and the milestone events (i.e., the treatments) are spaced widely over time. Therefore, idiosyncratic biases are reduced when estimating the average treatment effects in our subsequent meta-analysis (Nelson and Kennedy, 2009). In addition, pooling sites in the meta-analysis improves efficiency of our estimates by averaging across primary estimates, some of which may not be very precisely estimated due to a small number of identifying transactions in the initial hedonic regressions.

Figure 5 displays the meta-analytic counterpart to what is often referred to as an "event analysis" (Hanna & Olivia, 2010); as it exploits the panel structure of the metadata with a treatment (the discovery of a release in this case) occurring at different points in time. Analogous to the previous figure that showed just one high-profile site, Figure 5 shows the price trend differential between "treated" houses (within 0 to 2 km from a site) and "control" houses (5 to 10 km from a site) across all 12 high-profile sites where the discovery of a release was observed.[17] The confidence intervals are fairly wide, mainly due to the small sample sizes when dividing transactions into one year increments in the underlying hedonic regressions. Nonetheless, the trend in the point estimates shows that the difference between the control and treated house prices are generally zero prior to the discovery of a release, bouncing above and below the x-axis. In contrast,

[17] See Appendix B for details on the derivation of this graph.

after the discovery of the release the points are always below the x-axis, suggesting that on average across the sites, prices among the treated group are lower after treatment.

In short, the discovery of a release, observed at different locations across the US, and at different times from 1980 through 2010, is followed by a decline in the price of houses in the treated group. This is at least consistent with a causal interpretation, thus providing some evidence that the meta-analysis as a whole is a valid quasi-experiment. We attempt to examine this price effect more formally in the analyses discussed below.

C. Hedonic Regression Results

We estimate separate hedonic property value regressions for each study area, following equation (1). The estimated price changes can be interpreted as relatively short-term effects, since we only include transactions up to 5 years after the event (or less if transaction data are not available or another high-profile event takes place sooner). The hedonic property value regressions include census tract fixed effects, annual and quarterly time dummies, and an extensive suite of attributes describing the housing structure, parcel, and location.[18] Control variables included a fairly consistent set of attributes across different sites. The full hedonic regression results for each study area are presented in Appendix C.

Following equation (2), Table 3 shows the estimated percent changes in price after each event ($\%\Delta p$) for each high profile site and 1 km treatment buffer. There is noticeable heterogeneity among the 155 estimates of $\%\Delta p$, in terms of sign, magnitude, and statistical significance. This is not surprising, given differences in distance intervals and milestone events.

[18] The results of interest are robust to the inclusion of smaller census block group fixed effects, but this resulted in larger standard errors for some sites.

Considering our example Green Valley Citgo site in MD, Table 3 shows that the discovery of the release led to statistically significant declines of 3.1% and 5.5% at houses within 1 to 2 km and 4 to 5 km, respectively, and negative but insignificant declines for the other three distance buffers. It is surprising that the decline from the discovery of a release is so small (an insignificant -0.4%) among houses nearest to the site (0 to 1 km). Perhaps property values at this distance already capitalized some expectation of a future release. Just over two years later letters were sent to residents within a half mile (or 0.8 km, roughly corresponding to our 0 to 1 km buffer), explicitly notifying them of the release and private well contamination concerns. This "other negative" milestone led to an additional decline in surrounding housing values; most notably a 10.1% depreciation among houses within 0 to 1 km. The letters provided to nearby households seem to have alleviated concerns by residents in the farthest 4 to 5 km buffer (who did not get letters), as suggested by the positive price impact (although only marginally significant) of 4.1%.

Several other sites yield fairly intuitive results, with initial property price declines upon the discovery of a release (e.g., the LaSalle and Jacksonville Exxon sites), and an increase in prices after cleanup (e.g., Charnock Well Fields, LaSalle, and Northville Industries). At other sites there are no significant effects on property values (e.g., Pearl Street Gulf), or mixed and even counterintuitive results (e.g., Bithlo and Tuckahoe).[19]

To summarize and better understand the results, we more closely examine the effects of two important and relatively common milestones. First, consider the 12 sites where we estimate the change in price after a release is discovered. Figure 6 shows the estimated %Δp for houses in the 0 to 1 km buffer for each site. The majority of the point estimates are negative or close to zero, but there is a wide range, from a 27.2% decline to a 23.5% (albeit insignificant) increase. The

[19] For some of these sites, such as the Bithlo site, additional caution is warranted in interpreting the results due to a low number of identifying observations within each of the 1 km bins (see Appendix D).

meta-data do reveal significant heterogeneity in the price impacts of release discovery across the different sites ($\chi^2(11) = 237.43$, $p \leq 0.000$). We estimate the RES mean of the 0 to 1 km price effects from the release discovery milestone, across all 12 relevant sites, where the grey boxes in the figure illustrate the weights assigned to each estimate. The last line of the figure shows that the overall RES mean is a marginally significant 4.4% depreciation (p=0.078).

Table 4 shows the RES mean effects of release discovery for each 1 km bin; the unweighted means (where each estimate is given equal weight) are also shown for comparison, and are generally similar (albeit a bit more sporadic, in magnitude and sometimes sign). We prefer the RES mean estimates for the reasons discussed in section III.C.[20] Similar to the 0 to 1 km buffer, we also see a significant 4.7% average decline among houses in the 1 to 2 km buffer (p=0.038). Beyond 2 km the discovery of a high-profile UST release has no significant effect on house values. We emphasize that this is an average effect, and within each of the 1 km bins the meta-data suggest statistically significant heterogeneity in the price effects across the high-profile sites ($p \leq 0.000$).

At five sites the observed data allowed us to examine the price impacts after cleanup of the UST contamination. Looking first at the 0 to 1 km buffer in Figure 7, we see that house prices appreciated at all sites after cleanup, but the increase was only statistically significant at two sites. Nonetheless, the overall RES mean suggests a 4.2% increase after cleanup (p=0.000). As seen in Table 4, the unweighted mean suggests a similar average appreciation after cleanup. Interestingly, the price effects of cleanup at the different sites seems to be relatively homogenous ($\chi^2(4) = 2.73$, p=0.603), suggesting that the true price effect of cleaning up a high-profile release may be similar,

[20] Since some of the distance buffers had a small number of observations in some of the sites, we also estimated the means using sample size weights instead of variance. The results were quite similar to the variance weights (both in terms of magnitude and statistical significance). For instance, the mean impact of discovery in the 0-1 km buffer was -4.02%, and for cleanup it was 4.76%.

at least among houses within this closest 0 to 1 km buffer. Such homogeneity does not hold for the more distant buffers.

The RES mean results in Table 4 show that the average increase in prices post-cleanup extends to houses in the 1 to 2 km buffer, with an 8.7% appreciation (p=0.023). There is weak evidence of a 4% appreciation possibly extending out to the 2 to 3 km and 3 to 4 km buffers (p=0.118 and p=0.067, respectively), on average. In the next subsection we use meta-regression techniques to more thoroughly examine price effect heterogeneity across the different high-profile sites, events, and distances.

D. Meta-Regression Results

Table 5 contains the results of the main set of meta-regressions, which pool all 155 estimates of $\%\Delta p$ from the hedonic regressions in Table 3. The first meta-regression model (Column 1) is an RES model following equation (3), where the moderators, or right-hand side variables, include a separate intercept for each of the event types, following the categorization scheme in Table 1. We also include a continuous variable denoting the different distance buffers, for each kilometer buffer from 1 to 5. This is interacted with each of the four event type dummies to allow the price impact gradients to differ across different types of milestone events.

Following the discovery of a release, the results suggest a marginally significant 6% average price decrease to houses immediately adjacent to a high-profile site (i.e., *distance*=0). The magnitude of this price drop diminishes with distance from the site, as suggested by the positive (albeit insignificant) coefficient on the interaction term *distance* × *discovered*. We also see a positive price impact from the completion of cleanup, as suggested by the marginally significant 9.3% appreciation corresponding to the dummy variable *cleaned*. From the negative (but again insignificant) coefficient on *distance* × *cleaned,* it seems that this post-cleanup appreciation also diminishes as distance from the site increases.

Figure 8 and Figure 9 present the full impact and significance evaluated at each distance buffer. The figures show that, on average, the discovery of a high-profile release and its subsequent cleanup impact property values in an intuitive fashion– prices decrease upon the discovery of a release, but then later increase after cleanup efforts are complete. A series of Wald tests suggest that the average post-cleanup appreciation is of an equal magnitude as the initial decrease, suggesting that property values rebound, on average. It is important to note, however, that the analysis is limited to property value impacts within a relatively short five-year period, and may not capture the full property value effects over the longer-term. Further, at only three of the high-profile sites did we observe both the discovery of a release and the completion of cleanup.

These figures also illustrate that these price effects diminish farther from the site, becoming statistically insignificant at a distance of about three kilometers. Although we impose a linear trend in the meta-regression specification, this is consistent with the weighted averages discussed in section V.C, where no functional form for the distance gradient was assumed.

In Model 1, the constant and distance interaction terms corresponding to the "other negative" and "other positive" milestones are statistically insignificant. On average, it seems that these intermediate events do not lead to any significant impact on residential property prices.[21]

Our estimated price impacts generally capture the short-term effects within five years after an event. In some cases, however, the estimates reflect an even shorter post-event time period,

[21] Although not reported here, we re-estimated a restricted version of Model 1 where both positive and negative signal events were pooled together. The resulting coefficients were insignificant and the results corresponding to release discovery and cleanup were virtually identical to Model 1. Models restricting the price effects to be the same for release discovery and other negative signal events, and for cleanup and other positive events were also estimated. The resulting percent change in price estimates were all statistically insignificant when pooling events in this fashion.

either because later property transaction data was not yet available or because a subsequent milestone event occurred less than five years later. The response of the housing market during these shorter time periods may differ, or be less discernable statistically, than the response after five full years. To examine this, the previous model is re-estimated using only observations corresponding to the 18 milestone events (at 9 different sites) where the full 5 years of post-event transaction data were available for the original hedonic regressions. The meta-regression results are shown in Model 2 in Table 5. Among this subsample of sites, the discovery of a high-profile release seems to have a larger effect on house values, suggesting a 14.4% decline for houses immediately adjacent to the site. The price rebound from cleanup, however, is no longer significant, but this is likely due to the fact that there was only one site where 5 years of transaction data were available post-cleanup.

Model 3 is a Random Effect (RE) Panel regression model. This model is a recommended alternative when more than one estimate is taken from a primary study (Nelson and Kennedy, 2009), or in our case from a high-profile release site. The RE Panel model includes a random intercept for each high-profile site and allows the error terms to be correlated within each site. The point estimates corresponding to the discovery of a release are very similar to the corresponding RES model (Model 1), but are no longer significant, as illustrated in Figure 10. Model 3 also suggests the price effects of cleanup are similar to the corresponding RES Model, although accounting for the correlation across primary estimates yields a stronger level of statistical significance. Model 3 even suggests a small 3.2% price increase extending out to the 3 to 4 km buffer (see Figure 11).

A final model specification examined price effect heterogeneity across the 17 high-profile sites. The results are not reported here, but we examined whether the price impacts varied based on the exposure pathways of concern (private groundwater wells or vapor intrusion), and the presence of MTBE contamination. MTBE is often associated with historical UST releases, and is a challenge to clean up. Across numerous specifications focusing on the full datasets or individual distance buffers, we found no robust evidence of price impact heterogeneity associated with the exposure pathways or the presence of MTBE. These results suggest that benefit transfer from our results to other *high-profile* UST releases, no matter the exposure pathway or presence of MTBE, may be appropriate. This is a useful finding for policy-makers, particularly given the broad attention previously paid to MTBE contamination.[22]

VI. CONCLUSION

UST releases of petroleum and hazardous substances can present risks to local residents and the environment. This study develops monetized estimates of the benefits of cleaning up high profile UST releases, as capitalized in local housing values. More generally, the estimated property value effects lend insight into the value of UST release prevention, early detection, and cleanup.

A few previous studies have used hedonic methods to estimate the impacts of UST releases on surrounding housing values (Guignet, 2013; Isakson & Ecker, 2013; Simons et al., 1997; Zabel & Guignet, 2012), but with a narrow geographic scope. Given the abundance and broad spatial distribution of gas stations, it is important to examine the variability in house price effects across different locations. Identifying property value impacts of UST releases is difficult because potential homebuyers typically have little information about nearby releases. To address this

[22] For example, EPA held a Blue Ribbon Panel on the topic (http://archive.epa.gov/mtbe/web/html/action.html), and the American Cancer Society has directed considerable resources to the study of MTBE (http://www.cancer.org/cancer/cancercauses/othercarcinogens/pollution/mtbe).

challenge, our study focuses on 17 U.S. sites where high-profile UST releases were widely publicized, involved significant community concern, and in most cases were severe.

A two-step methodology is employed, where site specific hedonic regressions are estimated using a difference-in-differences approach for each of the 17 study areas, and then an internal meta-analysis of the resulting hedonic estimates is conducted. Compared to highly refined quasi-experimental property value studies (Haninger et al., 2014; Linden & Rockoff, 2008; Muehlenbachs et al., 2015), this study was constrained by having only one (or in one case, two) high-profile UST sites in each study area. Although great steps were taken to minimize potential omitted variable biases, in some cases there are concerns that our single site estimates might be susceptible to unobserved local and temporally varying influences. However, as the aforementioned studies minimized omitted variable bias by looking at many sites within a single housing market, our internal meta-analysis looks at many sites across the United States with release discovery, and other milestone events occurring at different points between 1985 and 2013. To the extent that any correlated time-variant effects are idiosyncratic across sites, this spatial and temporal variation improves our identification of the treatment effect (Nelson, 2015), and lends greater confidence to a causal interpretation of the estimated average price effects across all high-profile cases.

The results suggest significant heterogeneity in the price effects across sites, but on average show a 3% to 6% depreciation upon the discovery of a release, and a 4% to 9% appreciation after cleanup is completed. These average effects reflect price responses within 5 years of the release or cleanup, and diminish with distance, extending out to 2 or 3 km from the site. Since the analysis focuses on the most high-profile UST releases, we emphasize that these results should *not* be extrapolated to the broader set of more typical UST releases. Nonetheless, our findings provide useful insights for assessing policies that prevent and cleanup UST releases. First, the results demonstrate the upper reaches of cleanup benefits to nearby residents. Additionally, to the extent that policies help prevent high-profile situations, either by preventing UST releases in the first place or detecting them early to help minimize damages, our results may reflect closer to an average of the avoided property value losses. Given the high number and broad distribution of USTs across the country, the latter benefit may be quite substantial.

FIGURES AND TABLES

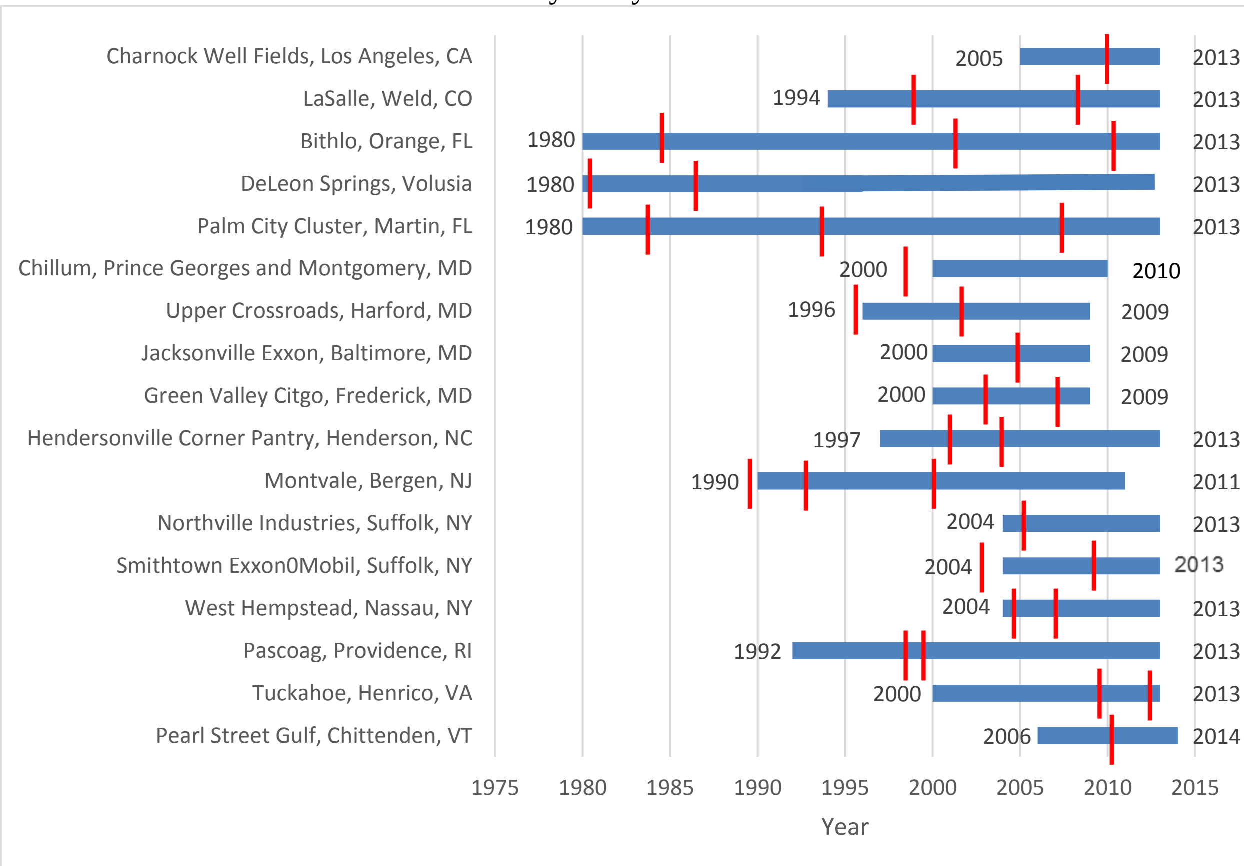
Figure 1

Locations of 17 High-Profile UST Releases

Note: Although it cannot be visually distinguished at this broad scale, the cluster of sites in Maryland actually corresponds to four sites. Similarly, the cluster of sites in northern New Jersey and Long Island, New York consists of four sites.

Figure 2

Years of Transaction Data Available and Milestone Events
by Study Area



Notes: The red lines mark the timing of the high-profile milestone events examined. Case names are followed by study area (usually county) names and for Chillum, MD a second very nearby county.

Figure 3

Local Polynomial Price Gradients:
Before and After "Other Negative" Milestone (Notification Letters Mailed),
Green Valley Citgo, MD

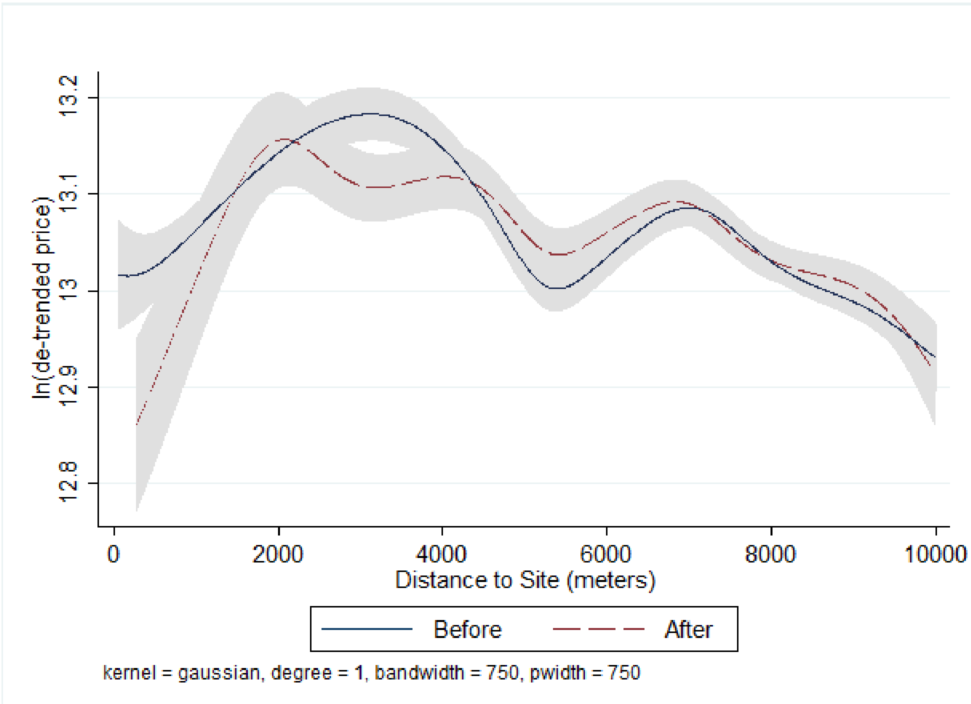
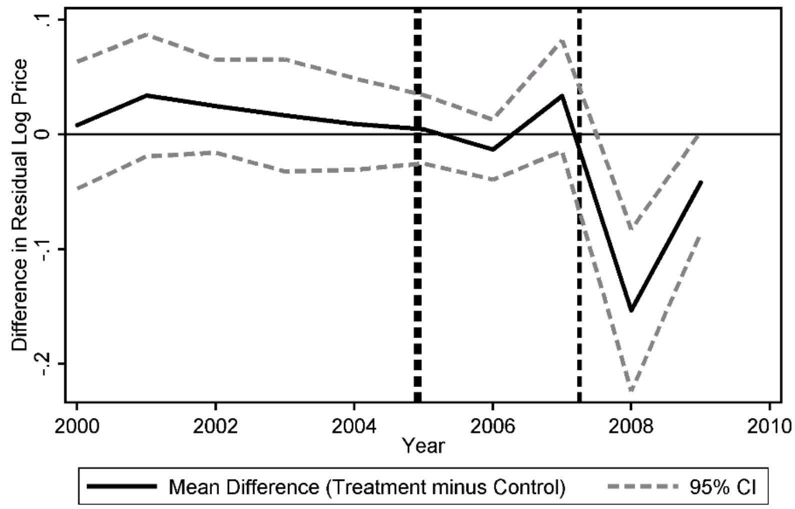


Figure 4

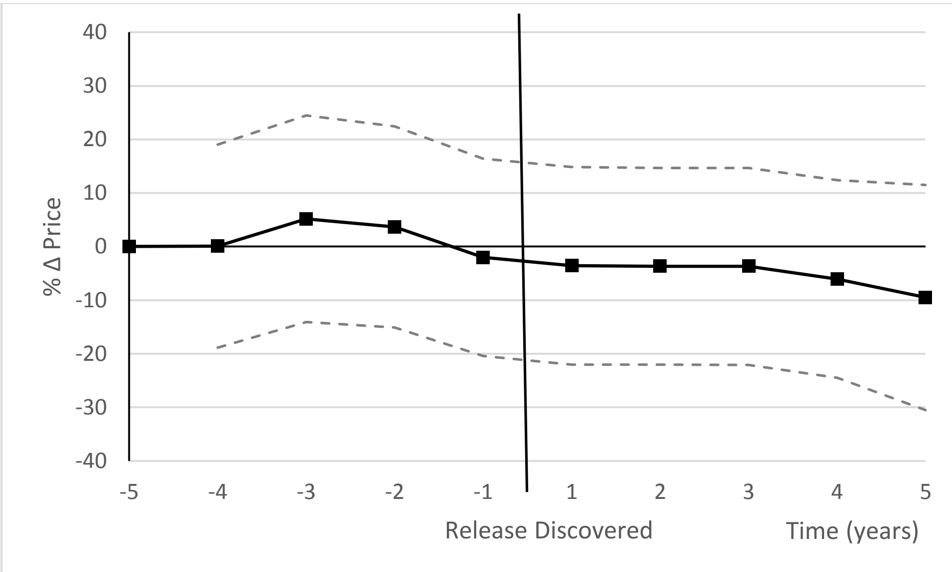
Price Trends in Treated and Control Groups at Green Valley Citgo, MD.



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The lighter dashed vertical line represents the mailing of letters to nearby residences (Event 2). Treated houses for this illustration are defined as those within 0-2 km from the high-profile site, and control houses are within 5-10 km. See Appendix A for details.

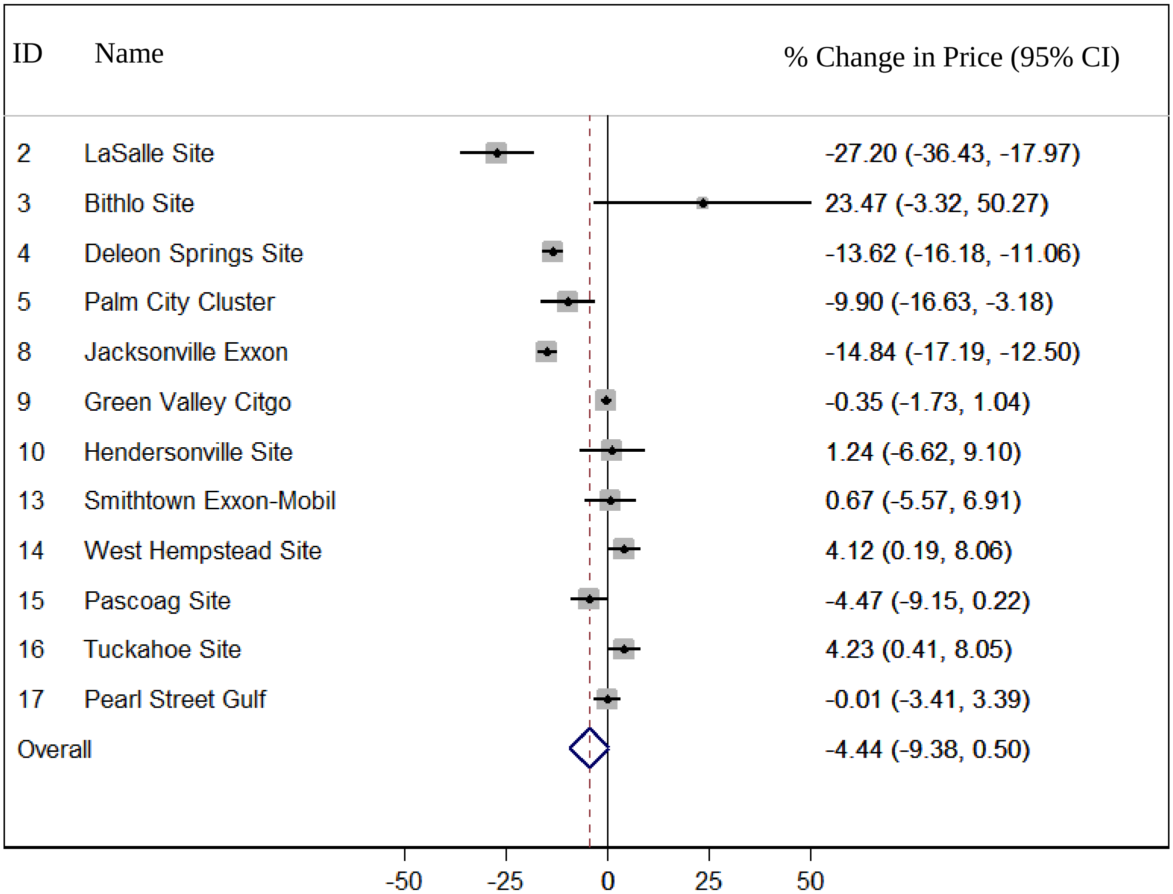
Figure 5

Meta-analytic Price Trend Differential Between Treated and Control Groups.



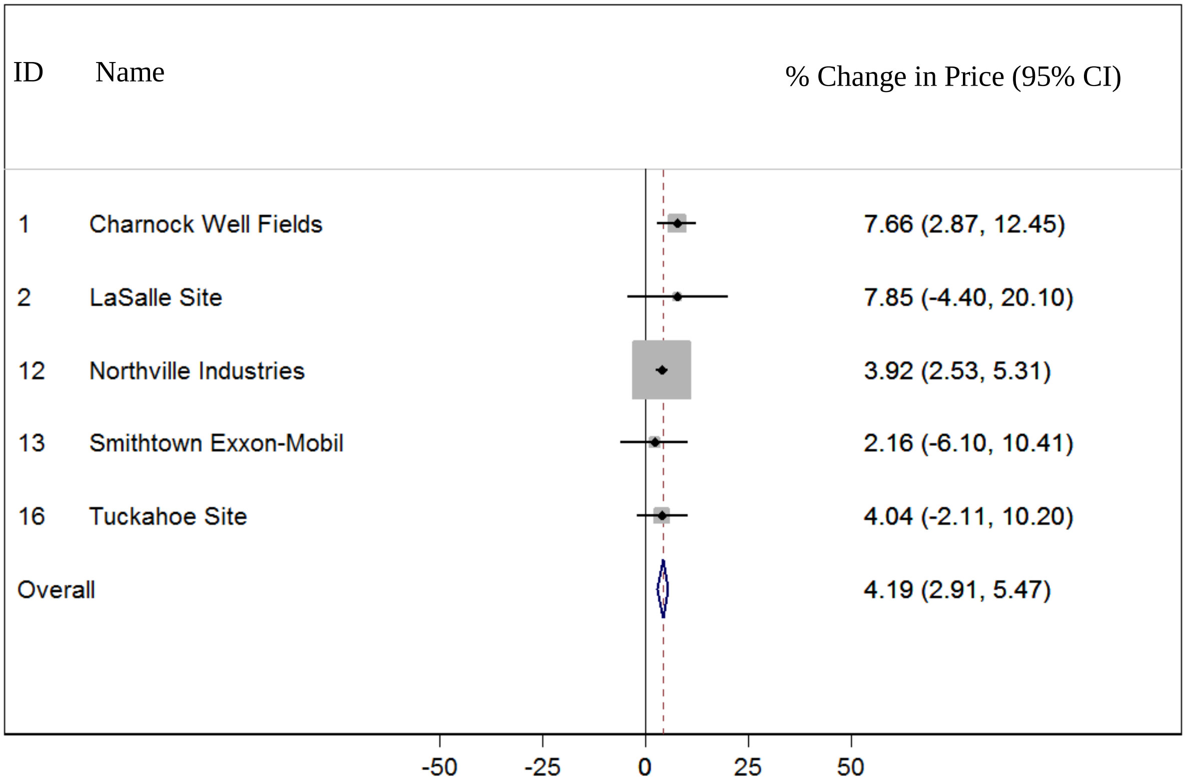
Note: Treated houses are those within 0-2 km from a high-profile site, and control houses are within 5-10 km. See Appendix C for details.

Figure 6
Release Discovery: Percent changes in Price for 0 to 1 km Distance Buffer and Random Effect Size Mean



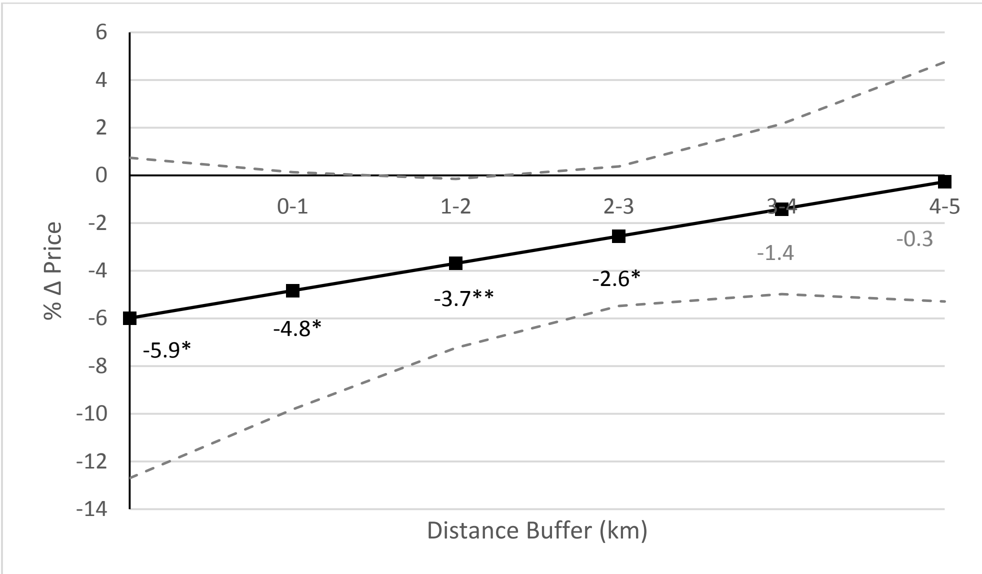
Note: The x-axis is the percent change in price, and the estimated percent changes in price and 95% confidence intervals are shown for each corresponding high-profile release site. The size of the grey boxes depicts the relative weights given to each observation when calculating the Random Effect Size (RES) mean. The weights are the inverse variances of the estimates (see section III.C). The diamond at the bottom depicts the RES mean, and the width of the diamond demonstrates the 95% confidence interval.

Figure 7
Cleanup Complete: Percent Changes in Price for 0 to 1km Distance Buffer and Random Effect Size Mean



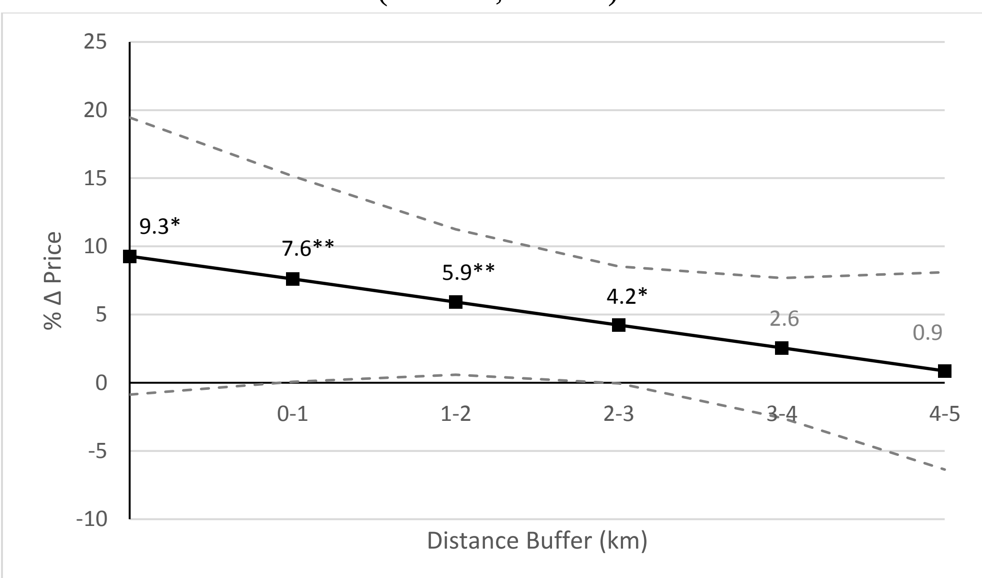
Note: The x-axis is the percent change in price, and the estimated percent changes in price and 95% confidence intervals are shown for each corresponding high-profile release site. The size of the grey boxes depicts the relative weights given to each observation when calculating the Random Effect Size (RES) mean. The weights are the inverse variances of the estimates (see section III.C). The diamond at the bottom depicts the RES mean, and the width of the diamond demonstrates the 95% confidence interval.

Figure 8
Price Impact Gradient of Release Discovery: Random Effect Size Meta-Regression
(Model 1, Table 5)



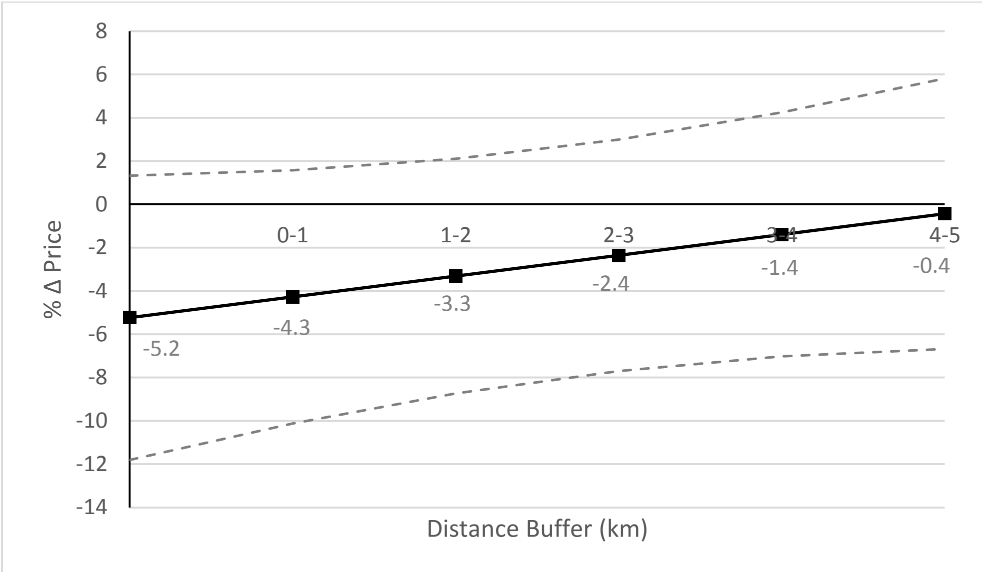
Dashed lines depict 95% confidence interval.

Figure 9
Price Impact Gradient of Cleanup: Random Effect Size Meta-Regression
(Model 1, Table 5)



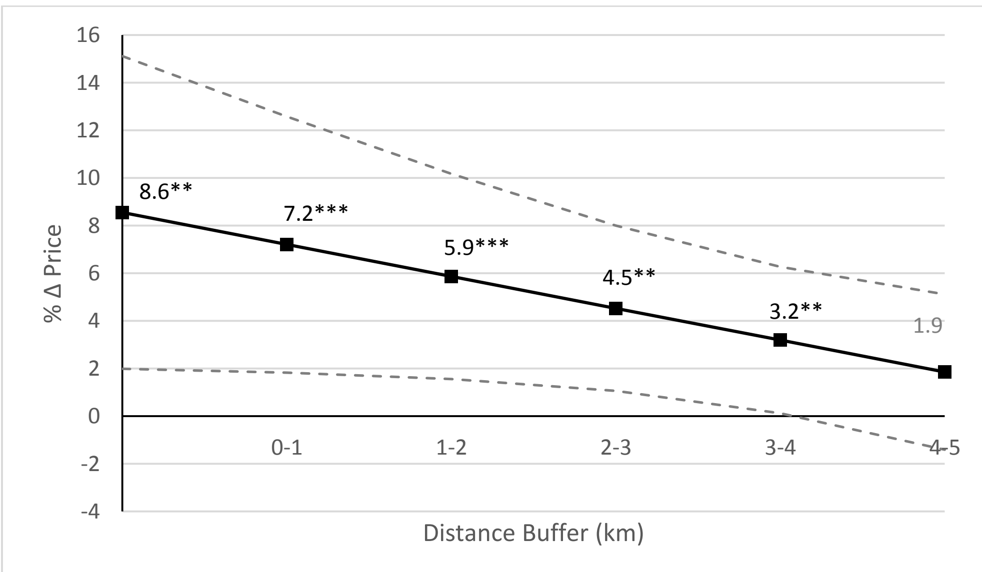
Dashed lines depict 95% confidence interval.

Figure 10
Price Impact Gradient of Release Discovery: Random Effects Panel Meta-Regression
(Model 3, Table 5)



Dashed lines depict 95% confidence interval.

Figure 11
Price Impact Gradient of Cleanup: Random Effects Panel Meta-Regression
(Model 3, Table 5)



Dashed lines depict 95% confidence interval.

Table 1 Types of Milestone Events at High-Profile UST Release Sites		
Event Type	# of Events	Examples
Release Discovered	12	Release occurred, Previously unknown release found
Negative Signal Event	9	Previously resolved release investigation re-opened, Additional contamination found
Positive Signal Event	5	Cleanup plans announced, Permanent clean water supply provided
Cleanup Complete	5	Cleanup completed, Release investigation closed and deemed safe by regulators
TOTAL	31	

Table 2 High-Profile UST Site Example: Transaction Dataset Summary Statistics, Green Valley Citgo (Frederick County, MD).					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sale price (2013$)	8,086	402,131.70	143,948.60	104,657.00	809,475.70
Age of house (years)	8,071	16.03	18.86	0	804
Age missing (dummy)	8,086	0.00	0.04	0	1
Age^2	8,071	612.78	7391.64	0	646,416
Townhome (dummy)	8,086	0.21	0.41	0	1
Total # of bathrooms	8,084	2.46	0.68	0	7
Baths missing (dummy)	8,086	0.00	0.02	0	1
Interior square footage	8,084	1,921.53	732.15	672	5675
Interior sqft. missing (dummy)	8,086	0.00	0.02	0	1
Parcel acreage	8,086	0.62	1.24	0	34.7
Acres missing (dummy)	NA	NA	NA	NA	NA
Air conditioning (dummy)	8,086	0.91	0.29	0	1
Air conditioning missing (dummy)	NA	NA	NA	NA	NA
Basement (dummy)	8,086	0.84	0.37	0	1
Basement missing (dummy)	NA	NA	NA	NA	NA
Porch (dummy)	7,212	0.91	0.28	0	1
Porch missing (dummy)	8,086	0.11	0.31	0	1
Pool (dummy)	8,086	0.02	0.15	0	1
Pool missing (dummy)	NA	NA	NA	NA	NA
Distance to nearest urban cluster (kilometers)	8,086	12.79	3.98	5.59	20.11
Located in public water service area (dummy)	8,086	0.67	0.47	0	1
Distance to nearest major road (kilometers)	8,086	2.23	1.48	0.03	6.90
Located in 100-year flood zone (dummy)	8,086	0.00	0.05	0	1
Located on waterfront (dummy)	NA	NA	NA	NA	NA
# of gas stations within 200 meters	8,086	0.00	0.06	0	1
# of gas stations within 200-500 meters	8,086	0.06	0.26	0	2
Distance to High-Profile Site (meters)	8,086	6,884	2437	65	9,999
0 to 1 km of High-Profile Site (dummy)	8,086	0.025	0.158	0	1
1 to 2 km of High-Profile Site (dummy)	8,086	0.024	0.153	0	1
2 to 3 km of High-Profile Site (dummy)	8,086	0.046	0.210	0	1
3 to 4 km of High-Profile Site (dummy)	8,086	0.063	0.244	0	1
4 to 5 km of High-Profile Site (dummy)	8,086	0.043	0.204	0	1

NA – Variable not available for Frederick County.

Table 3
Estimated % Change in Price After High-Profile Events.

Model			Distance from High-Profile Site (kilometers) 0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Obs.
	Charnock Well Fields, CA							
1	Event 1	Cleanup complete and public well field restored	7.66***	8.68***	8.61***	9.76***	5.51**	27,598
			(2.44)	(2.10)	(1.66)	(2.50)	(2.57)	
	La Salle, CO							
2	Event 1	Leak discovered	-27.20***	-33.49*	-51.05***	-45.99***	-23.18***	31,118
			(4.71)	(17.61)	(5.99)	(4.85)	(8.60)	
3	Event 2	Cleanup complete	7.85	80.22***	1.96	-2.63	-11.46***	16,334
			(6.25)	(18.54)	(7.58)	(5.03)	(3.17)	
	Bithlo, FL							
4	Event 1	Leak discovered	23.47*	-2.27	21.93	27.30**	35.87**	5,383
			(13.67)	(28.44)	(19.82)	(10.86)	(16.41)	
5	Event 2	Widespread well contamination, declared	-2.03	50.44**	42.00**	21.64**	26.30***	33,290
		"imminent threat"	(8.45)	(24.75)	(20.46)	(10.81)	(4.62)	
6	Event 3	Increased notification and media attention	35.58**	56.81**	2.72	13.50***	2.35	8,739
			(14.40)	(23.80)	(7.63)	(4.20)	(7.51)	
	DeLeon Springs, FL							
7	Event 1	Leak discovered	-13.62***	6.16	17.90***	15.95***	17.64*	5,971
			(1.31)	(6.14)	(1.00)	(5.97)	(9.17)	
8	Event 2	Cleanup approved,	21.02***	6.48	-19.33***	-11.11*	-13.74	6,036
		begins year later	(1.89)	(4.13)	(7.30)	(5.97)	(14.36)	
	Palm City Cluster, FL							
9	Event 1	Leak discovered	-9.90***	-78.29***	-29.54	49.80***	-1.13	20,874
			(3.43)	(10.70)	(26.05)	(13.82)	(4.33)	
10	Event 2	Additional contamination	6.18	30.98**	-24.27*	7.26	4.87	25,949
		discovered	(5.33)	(12.15)	(12.68)	(8.44)	(7.55)	
11	Event 3	Partially removed from	-12.13***	0.20	13.62	13.45	-0.02	21,325
		"imminent threat" status	(2.78)	(3.15)	(8.98)	(19.53)	(10.93)	
	Chillum, MD							
12	Event 1	Contamination plume	0.58	2.28***	3.75*	4.17***	5.18***	65,574
		migrated away to DC	(1.45)	(0.76)	(1.95)	(1.12)	(1.01)	
	Upper Crossroads, MD							
13	Event 1	Leak case re-opened	-4.27***	3.01***	-0.86	4.79	1.44	4,245
			(1.05)	(0.79)	(0.91)	(3.70)	(2.11)	

Model			Distance from High-Profile Site (kilometers) 0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Obs.
14	Event 2	Public meeting and increased well testing	-1.84	-5.70***	-2.97**	-2.36	-4.01	7,176
			(1.35)	(1.40)	(1.36)	(1.47)	(2.90)	
	Jacksonville Exxon, MD							
15	Event 1	Leak discovered, emergency cleanup	-14.84***	-5.17	-6.76***	-3.86*	-3.84*	8,154
			(1.20)	(3.61)	(1.03)	(2.31)	(2.13)	
	Green Valley Citgo, MD							
16	Event 1	Leak discovered	-0.35	-3.09***	-0.35	-0.66	-5.50**	8,085
			(0.71)	(0.53)	(3.22)	(1.04)	(2.19)	
16	Event 2	Notification sent to all residents within 1/2 mile	-10.14***	-2.80	-1.66	-6.41***	4.07*	
			(1.26)	(2.72)	(2.11)	(1.53)	(2.15)	
	Hendersonville Corner Pantry, NC							
17	Event 1	Leak discovered	1.24	-4.38*	0.23	1.78	-4.47*	11,771
			(4.01)	(2.66)	(7.26)	(3.06)	(2.35)	
17	Event 2	Public water line extended	-4.75	1.69	-6.03	0.52	4.58	
			(3.21)	(6.05)	(6.10)	(4.49)	(3.14)	
	Montvale, NJ							
18	Event 1	Re-opened (old leak discovered)	1.27	2.10	-5.06**	2.07	1.28	17,487
			(0.89)	(2.39)	(2.46)	(3.18)	(2.66)	
18	Event 2	State mandated cleanup	0.43	-4.37**	-0.74	-0.56	-1.41	
			(0.97)	(2.14)	(2.01)	(2.38)	(2.04)	
19	Event 3	Widespread vapor concerns, RP purchased	-0.58	3.55**	-0.58	-7.29***	-3.06	16,452
		several houses	(1.23)	(1.73)	(2.59)	(2.74)	(2.92)	
	Northville Industries, NY							
20	Event 1	Cleanup complete	3.92***	4.36***	-0.84	3.12	0.07	34,139
			(0.71)	(1.09)	(1.33)	(2.26)	(1.17)	
	Smithtown Exxon-Mobil, NY							
20	Event 1	Leak discovered near	0.67	4.23	3.16	2.93	0.41	
		previous release	(3.19)	(3.33)	(2.39)	(2.95)	(1.93)	
20	Event 2	Cleanup complete	2.16	14.49***	10.06***	7.62***	1.41	
			(4.21)	(2.22)	(2.21)	(1.75)	(2.11)	
	West Hempstead, NY							
21	Event 1	MTBE detected in public	4.12**	5.38	6.08***	2.38*	2.31**	51,945
		well	(2.01)	(3.42)	(1.61)	(1.34)	(1.16)	
21	Event 2	New water supply well	-5.84***	-2.12	-2.11	-0.30	-2.72**	
		installed	(2.15)	(2.64)	(1.53)	(1.69)	(1.23)	

Model			0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Obs.
			Distance from High-Profile Site (kilometers)					
	Pascoag, RI							
22	Event 1	Leak discovered	-4.47*	-13.33***	-1.04	-1.04	-9.37***	1,786
			(2.39)	(2.45)	(7.72)	(3.44)	(2.12)	
	Tuckahoe, VA							
23	Event 1	Leak discovered	4.23**	-1.08	0.52	0.02	-0.47	18,708
			(1.95)	(2.13)	(1.67)	(1.81)	(1.35)	
23	Event 2	Cleanup complete	4.04	-3.10**	-0.20	-0.48	0.82	
			(3.14)	(1.26)	(1.56)	(1.81)	(1.43)	
	Pearl Street Gulf, VT							
24	Event 1	Leak discovered	-0.01	0.13	1.39	1.46	0.99	3,288
			(1.74)	(1.86)	(2.58)	(2.56)	(1.50)	

Note: Alternating color shades denote estimates from the same hedonic regression, as also indicated by the model number in the first column. Estimates are derived from hedonic coefficients, based on regressions of datasets limited to transactions within 10km of high-profile release site and sold within 5 years before or after high-profile event.

Table 4
Meta-Analysis Unweighted and RES Means

	Release Discovered		Cleanup Complete	
	Unweighted	RES	Unweighted	RES
0 to 1 km	-3.05*	-4.44*	5.13***	4.21***
1 to 2 km	-10.43***	-4.72**	20.97***	8.67**
2 to 3 km	-3.13	-2.07	3.92**	4.08
3 to 4 km	4.17**	0.03	3.47***	4.04*
4 to 5 km	0.77	-1.99	-0.74	-0.25

Note: Averages calculated using the ‘metan’ command in Stata 14. RES weights are based on the inverse variance of the estimate (see section III.C). Unweighted means obtained using same command but equal weight given to each primary estimate.

Table 5
Meta-regression Base Results.

VARIABLES	(1) RES Model	(2) RES Model[a]	(3) RE Panel Model[b]
Discovered	-5.99*	-14.40**	-5.24
	(3.43)	(6.76)	(3.35)
Negative Event	-0.43	0.28	-0.59
	(4.02)	(6.39)	(2.37)
Positive Event	0.12	0.18	-0.79
	(5.16)	(6.84)	(4.89)
Cleaned	9.29*	4.82	8.55**
	(5.19)	(14.72)	(3.35)
Distance			
× Discovered	1.14	3.17	0.96
	(1.03)	(2.04)	(0.72)
× Negative Event	0.74	0.81	0.66
	(1.20)	(1.91)	(0.55)
× Positive Event	-0.41	-0.45	-0.35
	(1.62)	(2.13)	(1.57)
× Cleaned	-1.68	-0.90	-1.34*
	(1.54)	(4.44)	(0.71)
Observations	155	90	155
# of Sites	17	9	17

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

a. Estimated using only the 90 primary estimates corresponding to the 18 milestone events (at 9 different sites) where 5 years of post-event transaction data were available for the primary hedonic regressions.

b. Standard errors clustered at the high-profile site level in the Random Effects Panel Model (Model 3).

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APPENDICES

Appendix A: Descriptions of High-Profile Release Cases

This paper examines changes in property values near UST releases at 17 locations across the United States (see Figure 1). Each of the 17 cases was selected because it fit the criteria for being "high profile;" specifically, the release event was characterized by (1) media attention or significant concern from the nearby community; (2) a major milestone such as discovery, cleanup, or publicity within the last 15 years; and (3) close proximity to a residential neighborhood. The objective was comprehensive spatial coverage across the contiguous United States (US). However, sites fitting the high profile criteria tended to be located along the East Coast, and data on housing sales were more often available for eastern states than for other US regions.

Table A-1 lists the 17 high profile release locations including community names, states, and counties. It also identifies the source that originally suggested the case for inclusion in the study. These sources include the federal Office of Underground Storage Tanks, EPA regional offices, and state environmental departments, among others. Following Table A-1, we offer a concise summary of each high profile UST release case, including details and dates surrounding the key milestone events at the site. We begin each summary with brief statistics describing the community in which the release occurred.

Each summary is followed by a set of graphs illustrating the price trends over the time periods before and after the milestone events. The graphs compare houses located within 0-2 km from the site (which we later find tends to be the extent of the average price impacts from the high-profile UST releases and cleanups) versus houses located 5-10 km from the site (which serve as the control groups in the main analysis). These figures show how the average residual log prices vary for houses across the two groups. In order to control for observable characteristics of the houses that were sold in each time period, the figures are based on the residuals from a regression of log sales price on the same set of house and location characteristics as used in the main regression models, including annual fixed effects (see section V.C and Appendix C); but omit the post-milestone event variables in order to allow the price trends to vary freely over time. The figures show the mean difference in residuals for houses in the treatment group relative to the control group, along with an associated confidence interval for the difference.

	Table A1: High-Profile UST Release Sites				
	CASE NAME	*STATE*	*COMMUNITY*	*COUNTY*	*SITE IDENTIFIED BY*
1	Charnock Well Fields	CA	SANTA MONICA	LOS ANGELES	Office of Underground Storage Tanks: EPA Headquarters
2	LaSalle	CO	LASALLE	WELD	EPA Region 8
3	Bithlo	FL	BITHLO	ORANGE	Florida Department of Environmental Protection
4	DeLeon Springs		DeLEON SPRINGS	VOLUSIA	Florida Department of Environmental Protection
5	Palm City Cluster		PALM CITY	MARTIN	Florida Department of Environmental Protection
6	Chillum	MD	CHILLUM	PRINCE GEORGES, MONTGOMERY	Office of Underground Storage Tanks: EPA Headquarters
7	Upper Crossroads		FALLSTON	HARFORD	Office of Underground Storage Tanks: EPA Headquarters
8	Jacksonville Exxon		JACKSONVILLE	BALTIMORE	Office of Underground Storage Tanks: EPA Headquarters; Zabel and Guignet (2012)
9	Green Valley Citgo		MONROVIA	FREDERICK	Zabel and Guignet (2012)
10	Hendersonville Corner Pantry	NC	HENDERSONVILLE	HENDERSON	North Carolina Department of Environment and Natural Resources
11	Montvale	NJ	MONTVALE	BERGEN	Web search
12	Northville Industries	NY	EAST SETAUKET	SUFFOLK	New York State Department of Environmental Conservation
13	Smithtown Exxon-Mobil		SMITHTOWN		New York State Department of Environmental Conservation
14	West Hempstead		WEST HEMPSTEAD	NASSAU	Web search
15	Pascoag	RI	PASCOAG	PROVIDENCE	Office of Underground Storage Tanks: EPA Headquarters
16	Tuckahoe	VA	TUCKAHOE	HENRICO	Association of State and Territorial Solid Waste Management Office (2012)
17	Pearl Street Gulf	VT	ESSEX JUNCTION	CHITTENDEN	Association of State and Territorial Solid Waste Management Office (2012a)

1. Charnock Well Fields, Santa Monica, CA

Santa Monica is a beachfront city located in western Los Angeles County and abutting Los Angeles.

Population (2010): 89,736
Population density (2010): 10,664/sq mi
Median Household income (2008-2012): $72,271
Race identified as White alone (2010): 77.6%
Persons in poverty (2008-2012): 11.3%

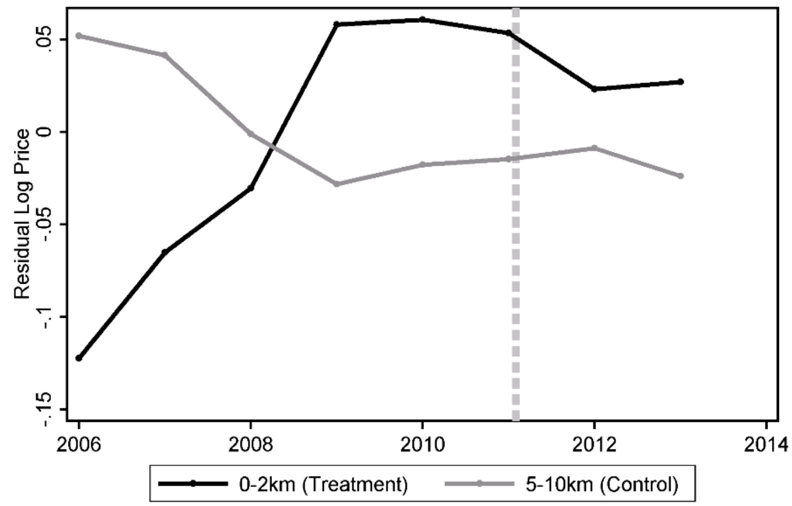
In Fall 1995, a routine water quality test by the City of Santa Monica identified the presence of MTBE in its Charnock well fields, a groundwater source that served approximately half of the city's residents. By 1996, levels of MTBE between 3.1 ppb and 610 ppb were detected in 7 of the city's 11 wells. In response, the City shut down the contaminated wells and rerouted clean drinking water from a neighboring supply (Lindner 2006, US DoJ 2005).

An effort to identify responsible parties for the Charnock well field contamination led to an investigation of 30 UST sites, mostly gas stations within a mile and a half of the well fields. All but two were associated with UST releases containing MTBE. Cleanup costs for the well field were estimated according to one source at $200 million (US DoJ 2005, Adams 2000, Linder 2006). Settlements were paid by up to twelve oil companies to federal EPA and to the city of Santa Monica to compensate for past cleanup expenses. Settlement with the city was made in 2003 and was large: $120 million. Shell, Chevron, and Exxon also signed agreements to clean the well field by building treatment systems to remove the MTBE (Crofton 2004, US DoJ 2005). Responsible parties were also compelled to remediate the sources of pollution (e.g., tank releases) (Linder 2006).

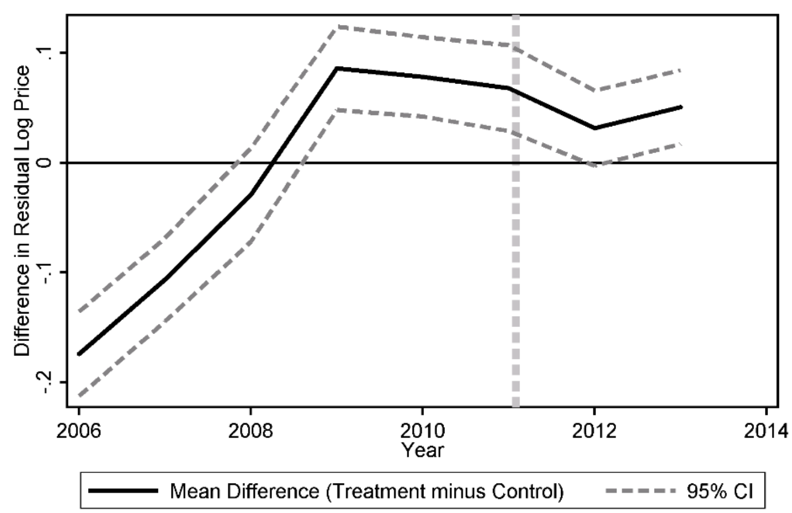
Santa Monica celebrated full restoration of local groundwater at Charnock and renovation of the city water treatment plant in February 2011 (Event 1). The Charnock wells were shut due to MTBE contamination for fifteen years (Santa Monica News Release 2011).

Figure A1

(A) Price Trends in Treated and Control Groups at Charnock Well Fields, CA (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The gray dashed vertical line represents full restoration of local groundwater (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

2. Lasalle, CO

Lasalle is a small town in Weld County in northeast Colorado, about an hour from Denver, consisting of less than one square mile.

Population (2010): 1,955
Population density (2010): 2,200/sq mi
Median Household income (2008-2012): $48,952
Race identified as White alone (2010): 83.9%
Persons in poverty (2008-2012): 12.0%

On March 22, 2002 near the center of the town of Lasalle, Colorado employees at a bank located just north of a combined convenience store/gas station noticed a petroleum odor and evacuated the bank building (Event 1). Testing of the petroleum system at the adjacent store was ordered by the state and determined that one UST was leaking unleaded gasoline at a rate of approximately 30 gallons per hour. The UST system was emptied of product. Later tests indicated the leak probably had started in the prior month of February (Colorado Department of Labor and Employment n.d., Rocky Mountain News 2002).

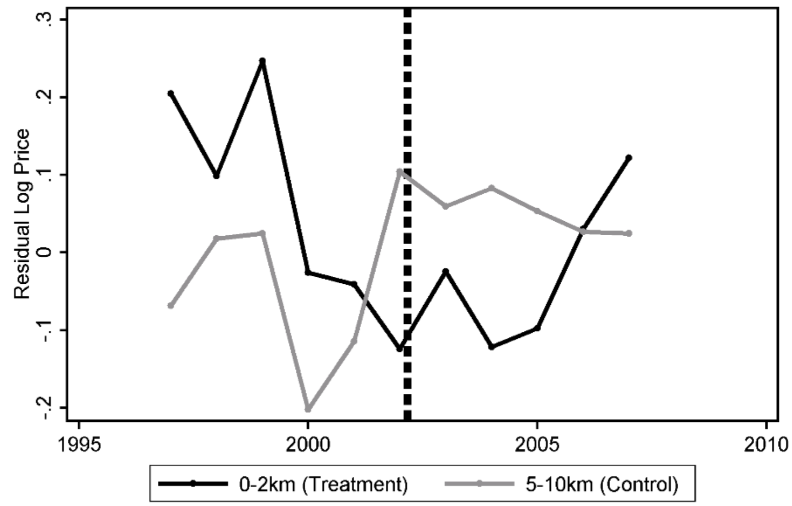
Less than a week after March 22nd, petroleum odors were also detected at two nearby schools and students were evacuated. Air screening tests (both indoor and outdoor) were performed at both schools, the bank, a nearby church, and three nearby houses. Testing confirmed high levels of petroleum vapors. Consequently, occupants of the houses and buildings were evacuated. Remediation involved soil vapor extraction wells and ground water pump and treat systems (Colorado Department of Labor and Employment). The schools were evacuated for 12 to 18 days (Cornelius 2002). The Denver Post reported:

> “This is a big deal because we have people who can't conduct business, people who can't live in their homes, people who can't go to school. This is an emergency," said Eric Gillespie, an environmental protection specialist with the Colorado Division of Oil and Public Safety” (Cornelius 2002).

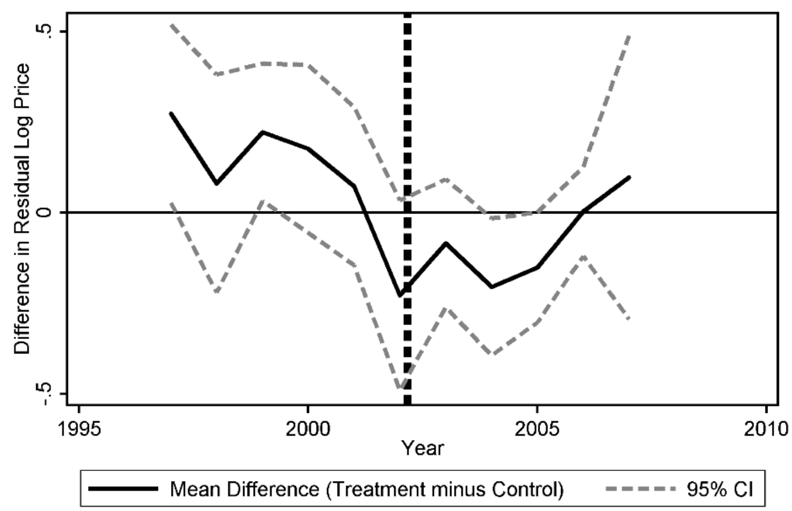
By late March 2002, remediation had resulted in the recovery of approximately 38,000 gallons of ground water and 4,000 gallons of free-phase product. Vapor was monitored in several houses/buildings from 2002 to 2006. In September 2009 the groundwater results along with the clean soil confirmation allowed for event closure (Event 2) (Colorado Department of Labor and Employment).

Figure A2

(A) Price Trends in Treated and Control Groups at Lasalle, CO (Event 1).



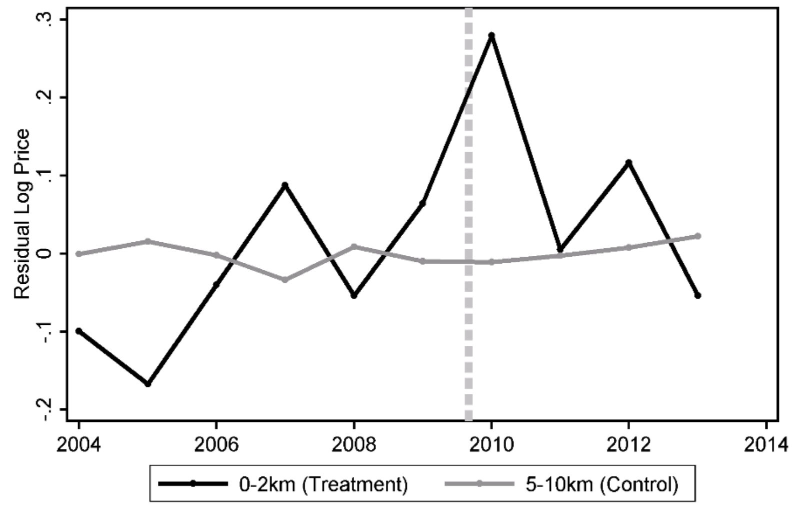
(B) Difference in Price in Treated and Control Groups



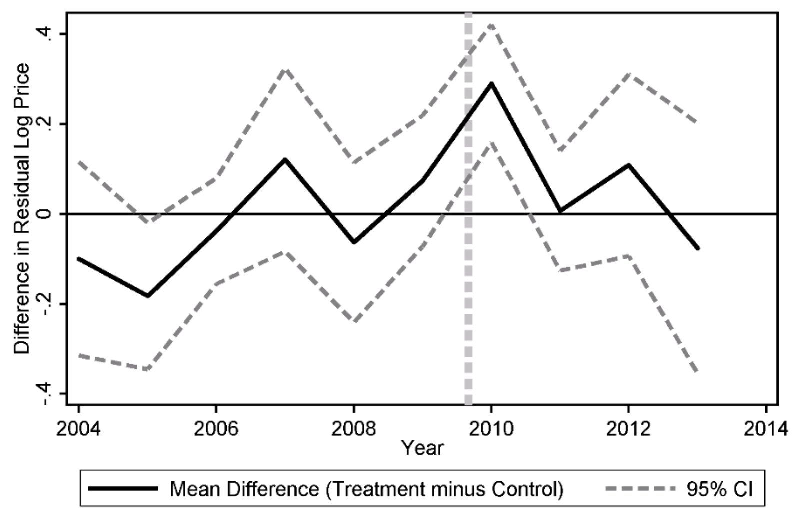
Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A3

(A) Price Trends in Treated and Control Groups at Lasalle, CO (Event 2)



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents event closure for the leak (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

3. Bithlo, FL

> Bithlo consists of about 10 square miles in Orange County. Bithlo is located approximately 20 miles east of Orlando and 20 miles west of the coast.
>
> Population (2010): 8,268
> Population density (2010): 770.3/sq mi
> Median Household income (2008-2012): $50,035
> Race identified as White alone (2010): 80.8%
> Persons in poverty (2008-2012): 20.7%

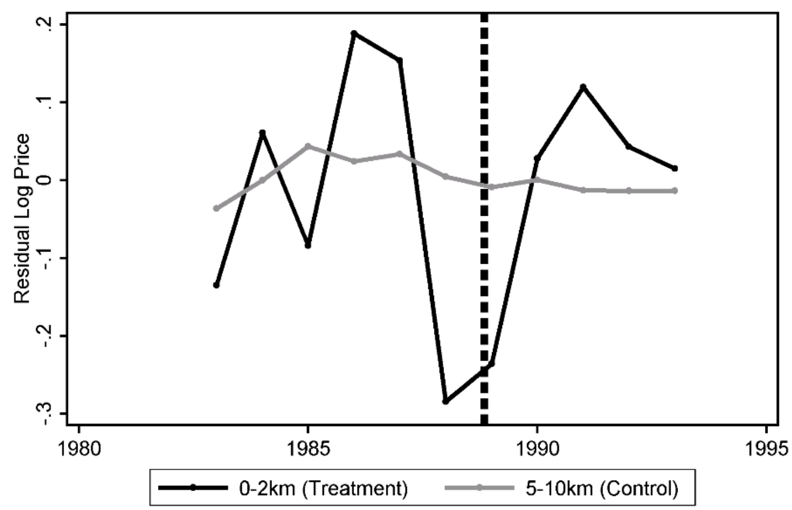
All 8,000 plus residents of Bithlo, Florida as recently as 2011 relied on groundwater for drinking water. The town is host to a notorious persistent gasoline release at a local gas station. Leaking gasoline was reported as early as November 1988 (Event 1) when a determination was made that a large number of affected houses warranted further assessment and cleanup (Roe 2012). Contamination from the same gas station continued as recently as November 2011 when the press reported that the source had contaminated water for thousands of Bithlo residents. The press also reported about other sources of groundwater contamination including an old recycling center (WFTV 2011)

From 1999 to 2000, monitoring wells were installed and have been in place through the present time (Oculus 2015). In April 2003, Bithlo was deemed in "imminent threat status" (Event 2) due to widespread contamination of potable wells (Roe 2012 citing Water Supply Analysis 2011). Following letters being sent to homeowners regarding well water testing in November 2011 (Event 3), press and community meetings were prolific in the 2011 to 2012 period as the community discussed whether to connect to state water lines. However, Bithlo has a high poverty rate and residents have reportedly resisted public water due to the expense (WFTV 2011).

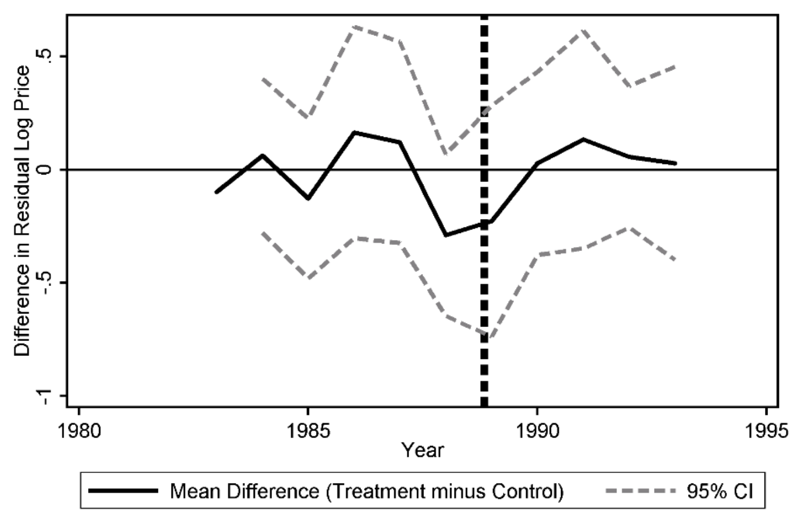
In 2012, the groundwater remediation was continuing at the leaking UST site in Bithlo. Also the responsible party or the state had supplied water filtration units to a total of 24 houses. However, potable wells at 17 houses or other places in Bithlo had been identified as *not* having a filter and exceeding the Maximum Contaminant Level (MCL) for petroleum constituents (Roe 2012).

Figure A4

(A) Price Trends in Treated and Control Groups at Bithlo, FL (Event 1).



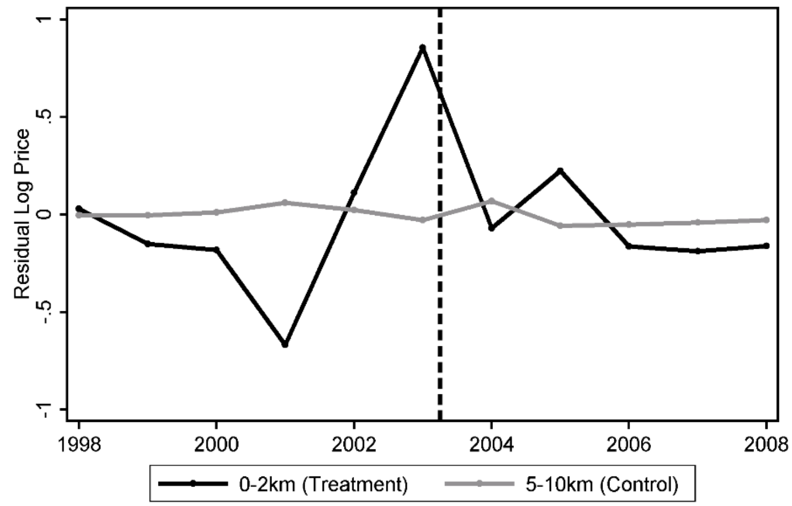
(B) Difference in Price in Treated and Control Groups



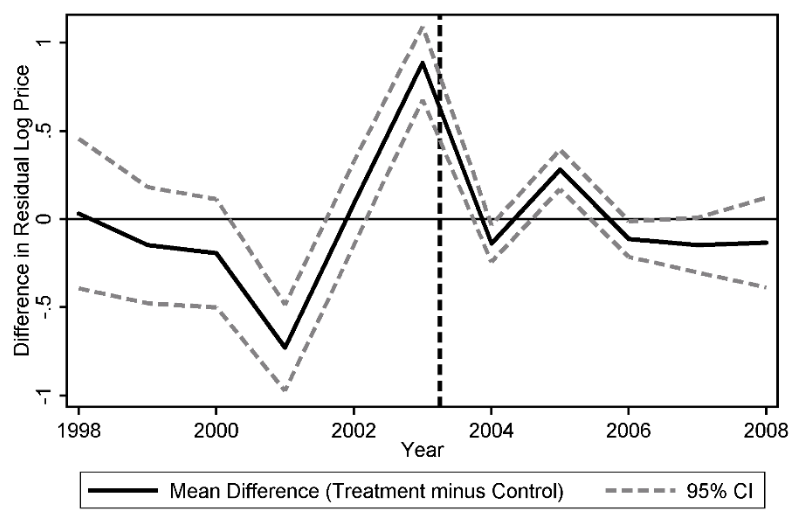
Note: The heavy dashed vertical line represents the discovery of the leak (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A5

(A) Price Trends in Treated and Control Groups at Bithlo, FL (Event 2).



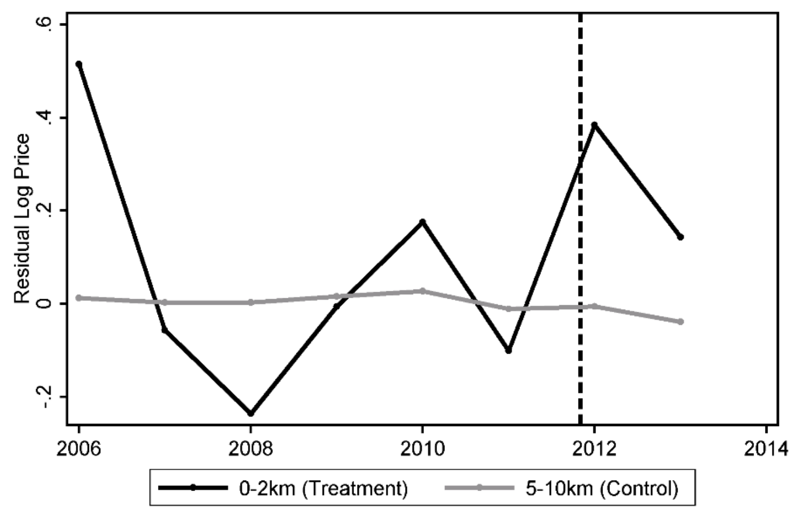
(B) Difference in Price in Treated and Control Groups



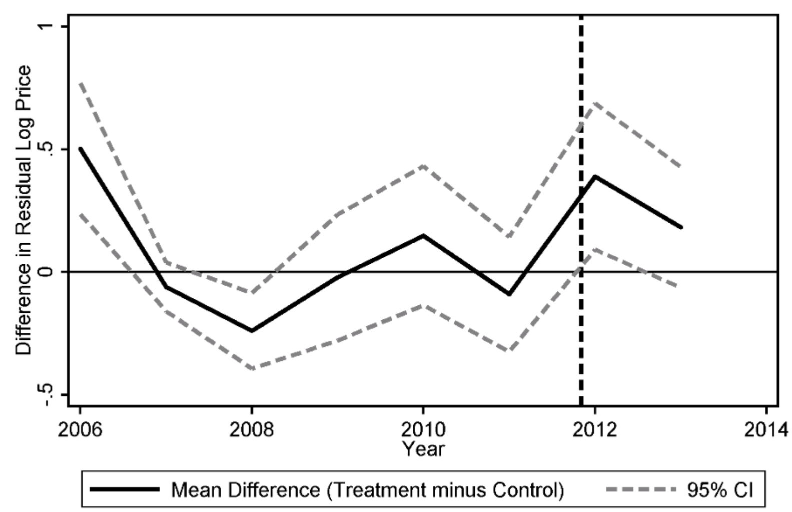
Note: The dashed vertical line represents the imminent threat determination (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

FigureA6

(A) Price Trends in Treated and Control Groups at Bithlo, FL (Event 3).



(B) Difference in Price in Treated and Control Groups



Note: The dashed vertical line represents letters sent to homeowners (Event 3). The figure presents residuals from a regression of log price on a variety of control variables.

4. DeLeon Springs, FL

Natural springs attracted settlers in the 1800s to DeLeon Springs. The current town is about 2.5 square miles, located 30 miles inland from Daytona Beach, and hosts DeLeon Springs State Park. It is located in Volusia County.

Population (2010): 2,614
Population density (2010): 1000.6/sq mi
Median Household income (2009-2013): $47,036
Race identified as White alone (2010): 69.9%
Persons in poverty (2009-2013): 24.1%

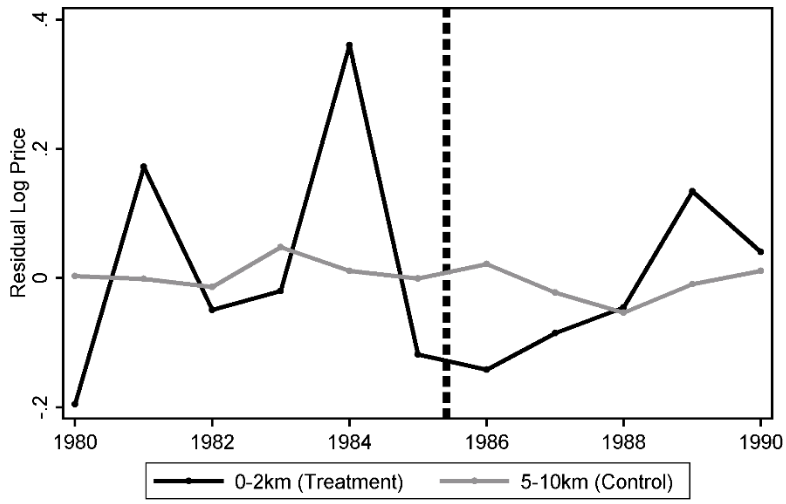
In June of 1985, residential neighbors to a gas station located downtown DeLeon Springs, Florida reported gasoline in their drinking well (Event 1). About a year later, free product was detected by a monitoring well at the gas station. A remedial action plan was approved on August 29, 1990 and groundwater cleanup began soon after (Event 2). Cleanup activities have continued off-and-on since then. Remediation has proven difficult and lengthy, attributed in part to high permeability of the soil, and in part to the plume spreading beneath an adjacent highway. An initial pump and treat remedial system was subsequently abandoned as ineffective (Pulver 2014, Universal Solutions, Inc 2005).

Given that the town grew up around natural springs, it is not surprising that at least some, and perhaps many, residents of DeLeon Springs relied on groundwater when the gasoline release occurred. Thus the contamination plume posed risks to human health. An elementary school discovered gasoline constituents in its seldom-used well. Residents were provided with bottled water, well filtration systems, and deeper wells (Tonyan 1987, Andrews 2011). The gasoline release has been blamed by residents as preventing economic development in the town center (Andrews 2012).

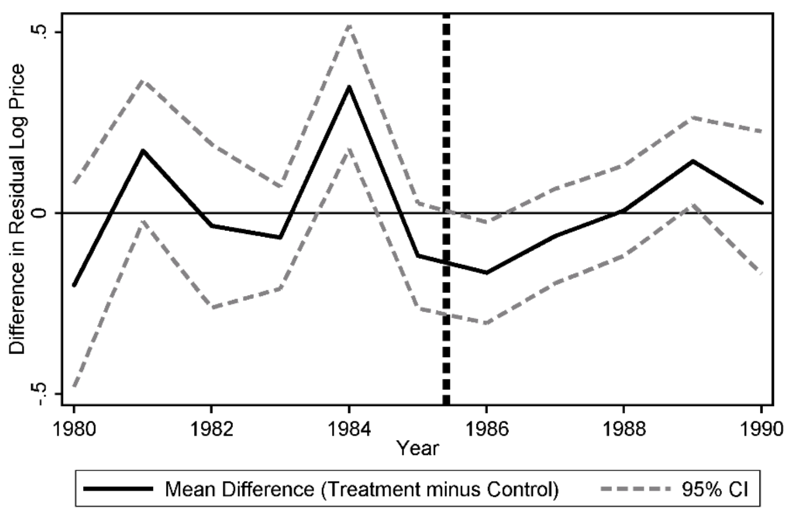
In approximately 2011, the plume was described by the press as moving towards the De Leon Springs State Park. However, in response to cleanup activity, by 2014 the plume had diminished in size. In April 2014 a new remediation effort began that included removing the highway surface and cleaning the soil underneath. The cleanup at DeLeon Springs is one of the 10 most expensive addressing UST releases in Florida (Pulver 2014).

Figure A7

(A) Price Trends in Treated and Control Groups at DeLeon Springs, FL (Event 1).



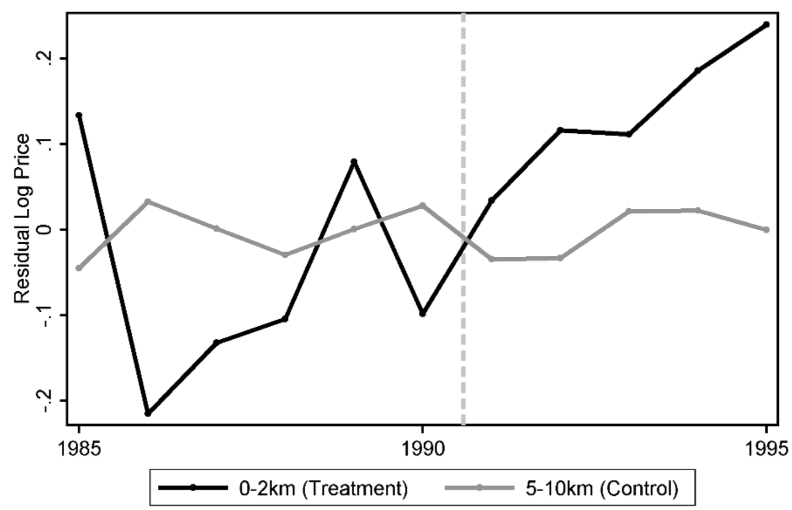
(B) Difference in Price in Treated and Control Groups



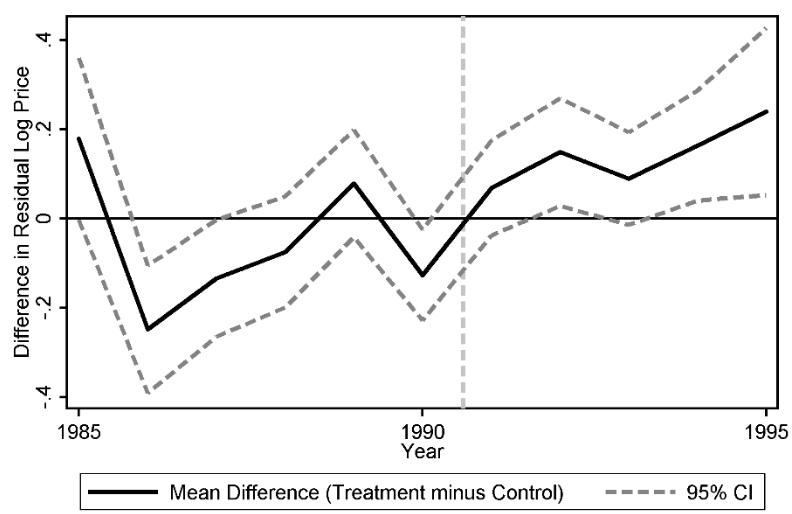
Note: The heavy dashed vertical line represents the initial discovery of gasoline in drinking water (Event 1). The figure presents residuals from a regression of log price on a variety of control variables. For details, refer to Figure 4 in the main text.

Figure A8

(A) Price Trends in Treated and Control Groups at DeLeon Springs, FL (Event 2).



(B) Difference in Price in Treated and Control Groups



Note: The dashed vertical line represents initiation of groundwater cleanup (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

5. Palm City Cluster, FL

Palm City is part of the Port St. Lucie metropolitan statistical area on the east coast of Florida. It consists of about 16.5 total square miles including 2 square miles of water in Martin County.

Population (2010): 23,120
Population density (2010): 1662.2/sq mi
Median Household income (2009-2013): $73,346
Race identified as White alone (2010): 95.4%
Persons in poverty (2009-2013): 5.1%

This event involves UST releases at three gas stations located near one another along a highway in Palm City, Florida (Tyko 2006, Oculus 2013). The releases were discovered in 1988 (Event 1) and initial testing of nearby wells identified a handful as contaminated with benzene and/or MTBE (Sorentrue 2003).

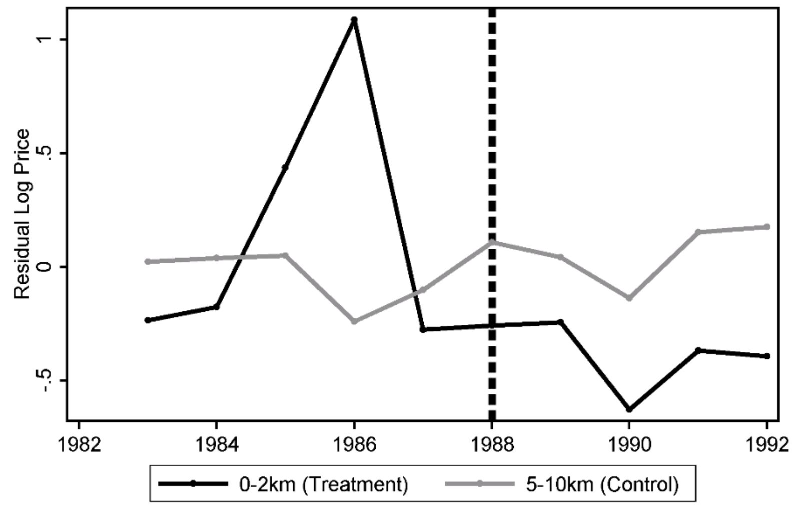
When the county was installing new water and sewer lines in October 1996, two plumes of petrochemicals were discovered (Event 2) (Andreassi 2001). Fears were expressed that the nearby St. Lucie River was threatened. Well testing accelerated in 1996 with calls by the local population for investigations. Indeed, over the entire period between 1991 and 1998, USTs were removed and contaminated soil was excavated (Sorentrue 2003). In 2001, an extraction system was installed to remove contamination from groundwater (Andreassi 2001). Nevertheless, the plume traveled over the years, accelerated in part by draws on the groundwater by drinking wells, and by 2003 at least 58 residential wells had been identified as contaminated (Sorentrue 2003).

Florida Department of Environmental Protect (DEP) paid to connect some, but not all, of these houses to public water sources. Many of the houses were rental properties, which was highlighted by the press as one reason for slow progress. By 2003, a total of 24 houses and businesses had been connected to the public water system. The goal of state and local government was to connect another 241 (Sorentrue 2003).

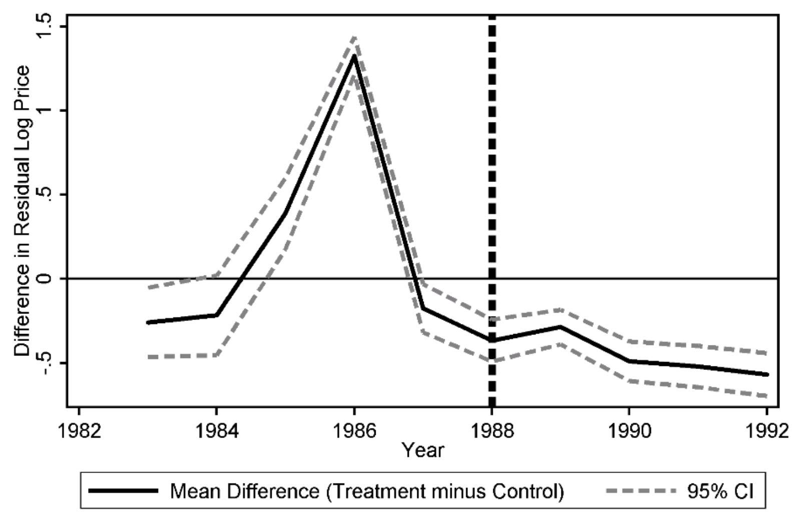
The most recent cleanup activity was completed in 2012 although there is one release still subject to ongoing remediation. Two of the three releases were removed by the Florida DEP from “imminent threat status” in 2008 (Event 3). The third was removed in 2011 (Oculus 2013).

Figure 12

(A) Price Trends in Treated and Control Groups at Palm City Cluster, FL (Event 1).



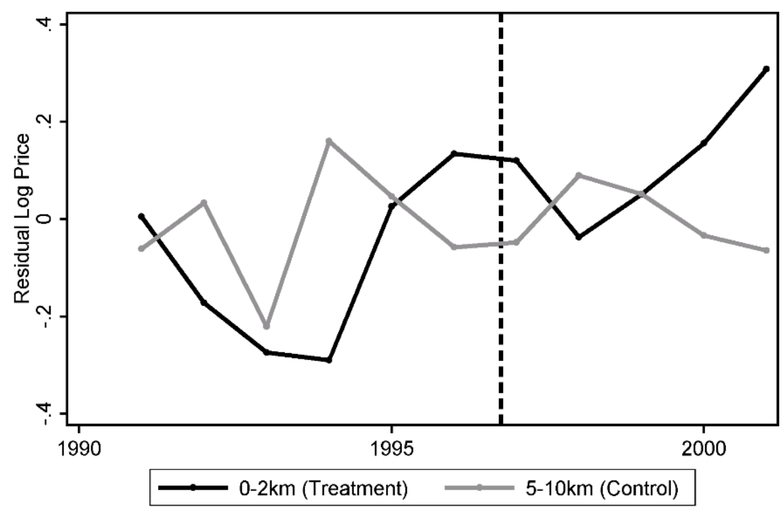
(B) Difference in Price in Treated and Control Groups



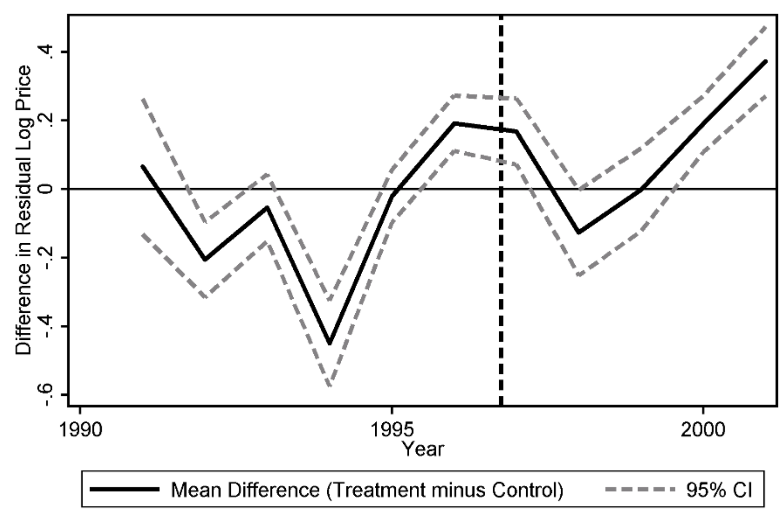
Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A10

(A) Price Trends in Treated and Control Groups at Palm City Cluster, FL (Event 2).



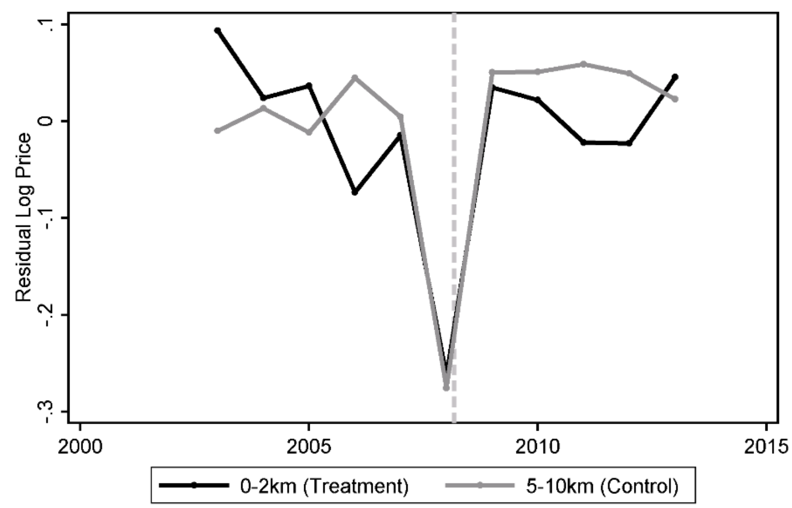
(B) Difference in Price in Treated and Control Groups



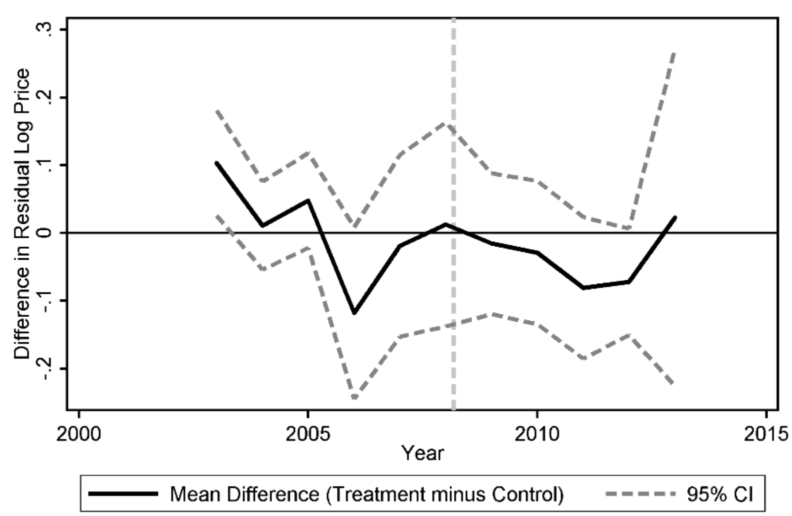
Note: The dashed vertical line represents the discovery of new plumes (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A11

(A) Price Trends in Treated and Control Groups at Palm City Cluster, FL (Event 3).



(B) Difference in Price in Treated and Control Groups



Note: The light dashed vertical line represents removal from imminent threat status (Event 3). The figure presents residuals from a regression of log price on a variety of control variables.

6. Chillum, MD

Chillum is a densely populated suburb located in Prince Georges County Maryland and bordering Montgomery County, Maryland and Washington, D.C. It is predominantly African American and consists of four neighborhoods.

Population (2010): 33,513
Population density (2010): 9819.2/sq mi
Median Household income (2009-2013): $56,123
Race identified as White alone (2010): 13.5%
Persons in poverty (2009-2013): 16.5%

In 1989, there was a reported release of an unknown amount of gasoline from an underground storage tank at a service station located in Chillum, Maryland (US EPA Region 3 2008). The release was initially addressed by the Maryland Department of the Environment (MDE). MDE required owners of the gas station to install a pump and treat system to remove the gasoline from the ground water. That system has been in operation since 1990 (Neibauer 2012).

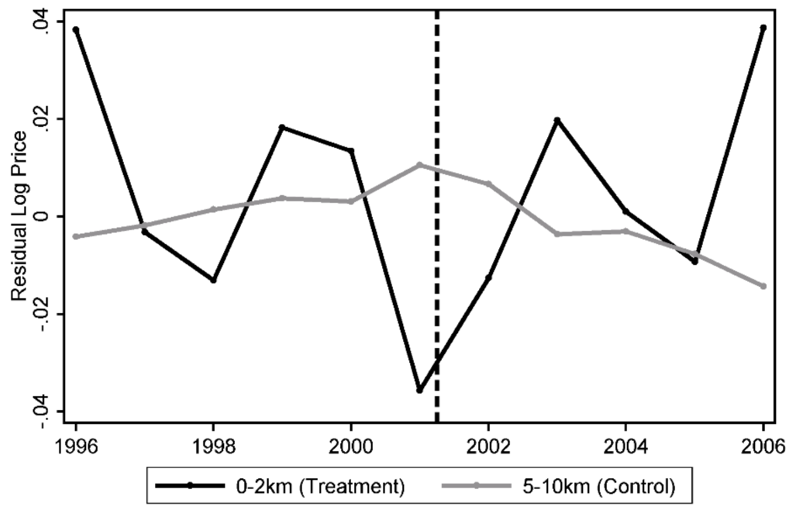
In April 2001, the gasoline plume was reported to have migrated into the District of Columbia (Event 1), underlying a residential area just south of the Washington D.C. boundary (US EPA Region 3 2008). Subsequent investigation revealed that perchloroethylene was also present in groundwater at elevated concentrations. At least one news story suggested this chemical could be associated with a nearby dry cleaner (Santana 2004).

In October 2001, a DC Councilmember (Fenty) asked EPA to assume responsibility for the gasoline release investigation (Santana 2004). EPA's cleanup decision consisted of continued operation of the groundwater remediation (pump and treat) system operating in Maryland. The system was expanded by installing additional wells set at angles to recover contaminated water from the Washington DC neighborhoods. EPA noted that the drinking water for the area was not at risk as its source was a public drinking water supply and not the local groundwater (US EPA Region 3 2008). Air contamination was an issue. Individual vapor mitigation systems were installed in houses located above the gasoline plume where petroleum vapor concentrations exceeded EPA indoor air standards. Work on the vapor mitigation was completed by early 2009 (US EPA Region 3 2009).

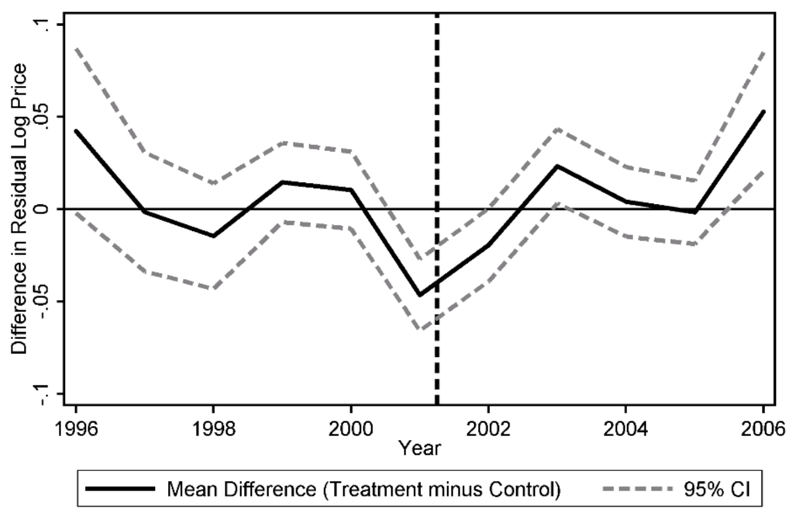
In addition to the precautions above, EPA responded to public comments by strengthening the remediation plan by, for example, adding an independent remedial system to the Washington DC area (US EPA Region 3 2008). An Administrative Order of Consent to implement the final remedy became effective in early 2009 (US EPA Region 3 2015). Cleanup of the plume began soon after and construction of the final remedy was completed in the summer of 2013 and will run for approximately a decade (Fan 2013).

Figure A12

(A) Price Trends in Treated and Control Groups at Chillum, MD (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents gasoline plume migration into D.C. (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

7. Upper Crossroads, Fallston, MD

Fallston is a semi-rural community or an "exurb" located a bit under 30 miles Northeast of Baltimore in Harford County. It is 14 square miles of farms and suburban development and one shopping/business district.

Population (2010): 8,958
Population density (2010): 640.7/sq mi
Median Household income (2009-2013): $113,190
Race identified as White alone (2010): 95.6%
Persons in poverty (2009-2013): 1.6%

In 1990, MTBE was discovered in drinking water wells at a Fallston, Maryland gas station and several other nearby commercial establishments. The most contaminated well was at the gas station, where the MTBE level was just below the state action level. The discovery was an outcome of proactive testing of wells located near gas stations by the county health department. As a result of the discovery, monitoring wells near the UST system were installed and they detected MTBE at levels below the State action level. In May 1993, the level was non-detectable. As a result, the MDE closed the investigation (Maryland Department of Environment 2006).

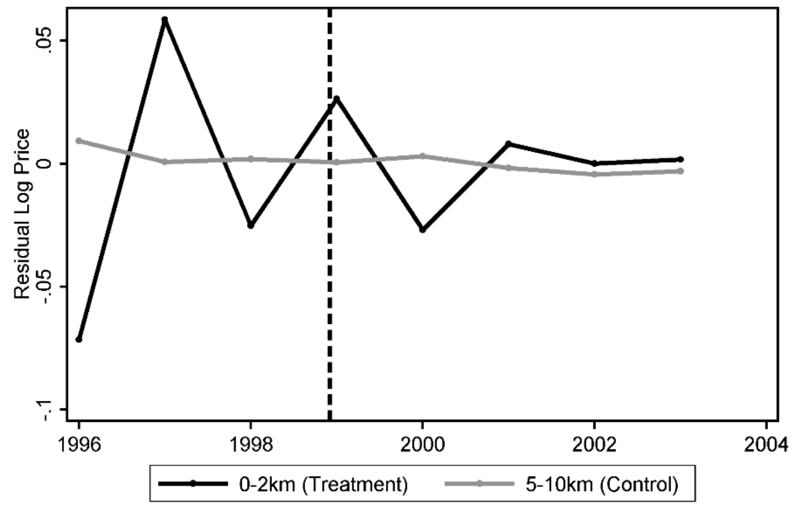
In December 1998, the health department well tests in Fallston turned up MTBE contamination above state action levels at a nearby restaurant (Event 1), which subsequently closed for unrelated reasons. Routine testing again turned up elevated MTBE at a commercial facility near the original gas station in 2000. At that point, MDE required the station's owners to purchase a filtration system for the affected facility and to conduct more extensive subsurface testing to determine the location and extent of the MTBE contamination plume (Maryland Department of Environment 2006, 2010).

The results of the gas station's subsurface investigation were reported in 2003 and led to further testing at off-site wells. By spring 2004, many residential wells were found to have trace amounts of MTBE, and one was discovered with triple state action levels. In June 2004 MDE sent letters notifying impacted residents, followed by a public meeting on June 21, 2004 (Event 2), and a subsequent increase in public communication. This led to still more testing and, before the end of 2004, installation of a remediation technology to collect and treat vapors from the soil around the UST system. At least ten affected houses received a well water filtration system (Maryland Department of Environment 2006, Wheeler 2004). The community expressed outrage in 2004 that they were just learning about contamination detected from a source as early as 1991 (Wheeler 2004). By 2005, the case was associated with 225 residential wells with trace amounts of MTBE; 11 wells contaminated above the state action level; and two class action lawsuits (Mitchell 2005).

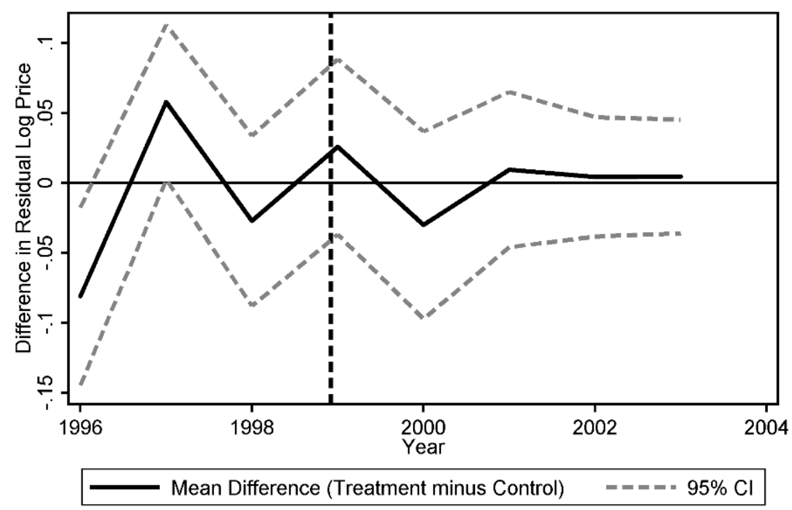
In April 2005, the gas station permanently closed. The company reported the cause as nearby roadwork and bad publicity due to the contamination (Mitchell 2005). Between April 2006 and June 2008, a pump- and-treat remediation system was in place that recovered and treated groundwater and vapors at the closed station. Then the system was turned off to allow groundwater to return to historic baseline levels. In May 2010, historic groundwater levels had returned and samples taken from almost 100 shallow, intermediate, and deep monitoring wells confirmed that MTBE contamination was greatly reduced from 2005 levels and in all but 1 of the 100 wells was below actionable levels. The MDE approved permanent shut-down of the pump and treat system and commencement of post-remedial monitoring (Maryland Department of Environment 2010).

Figure A13

(A) Price Trends in Treated and Control Groups at Upper Crossroads, Fallston, MD (Event 1).



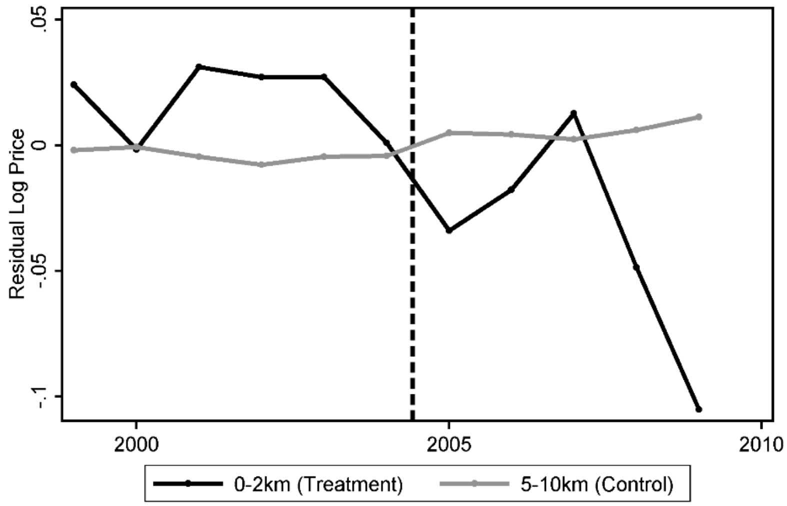
(B) Difference in Price in Treated and Control Groups



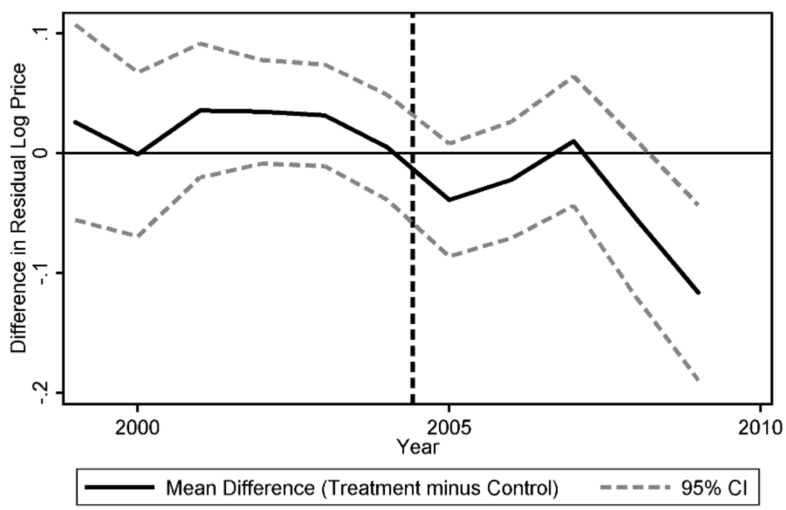
Note: The heavy dashed vertical line represents the discovery of MTBE (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A14

(A) Price Trends in Treated and Control Groups at Upper Crossroads, Fallston, MD (Event 2).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents a public meeting (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

8. Jacksonville Exxon, MD

> Jacksonville itself is not a census designated place, however it is part of the Phoenix, MD zip code area. Phoenix consists of 22 square miles and is located 20 miles north of Baltimore in Baltimore County. The following statistics are for Phoenix.
>
> Population (2010): 7,253
> Population density (2010): 307.2/sq mi
> Median Household income (2009-2013): $128,182
> Race identified as White alone (2010): 94.7%
> Persons in poverty (2009-2013): 5.7%

A major petroleum release from a gas station UST system product line in Jacksonville, Maryland was reported to the MDE in Jacksonville on February 17, 2006 (Event 1). Gasoline 15 feet deep was measured at an on-site monitoring well nearest the underground tanks, and gasoline 8 feet deep was measured at another. The state immediately shared information about the release with both the county department of environment and the community association. By the next day, all tanks at the station had been emptied and the station was closed (Maryland Department of Environment 2008).

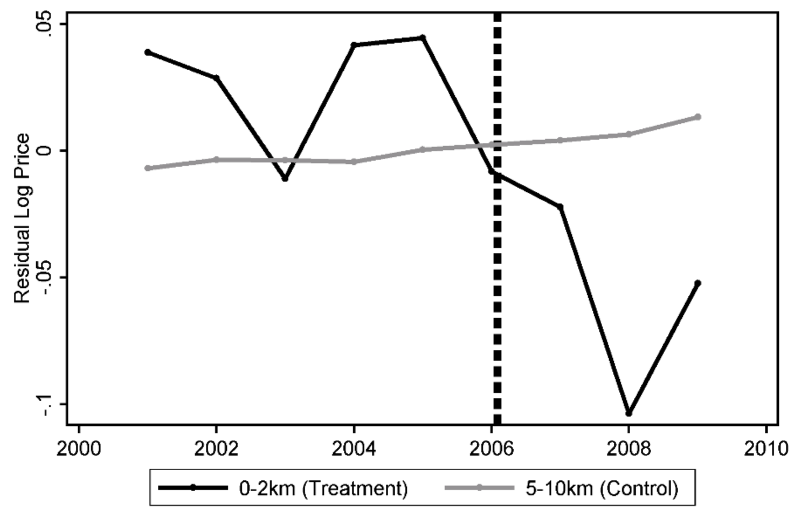
Close study of inventory records suggested that over 25,000 gallons of unleaded gasoline had been released over an approximately one-month period. Recovery wells were installed on site and monitoring wells were installed at surrounding properties. Vapor was monitored as were nearby streams. Over the course of the incident, gasoline was never detected in surface water or in storm water outflows (Maryland Department of Environment 2008).

It did, however, contaminate subsurface soil and groundwater. Over 250 drinking water wells were tested and were still sampled regularly as of 2014 (Maryland Department of Environment 2014b). Either as a precaution or because water samples exceeded contamination standards for MTBE, BTEX, or benzene, filtration systems were installed on wells at 13 houses by September 2008. Some houses also were monitored for vapor intrusion (Maryland Department of Environment 2008). Two court cases were brought against the gas station owners in Jacksonville and gained prominence in part because of the extent of damages awarded. In one case involving over 160 households and businesses, damages of approximately $1.5 billion were awarded, though the largest award of $1 billion in punitive damages was subsequently revoked by an appeals court. In the second case, 84 households were awarded almost $150 million, also later rejected by an appeals court (Hirsch 2013).

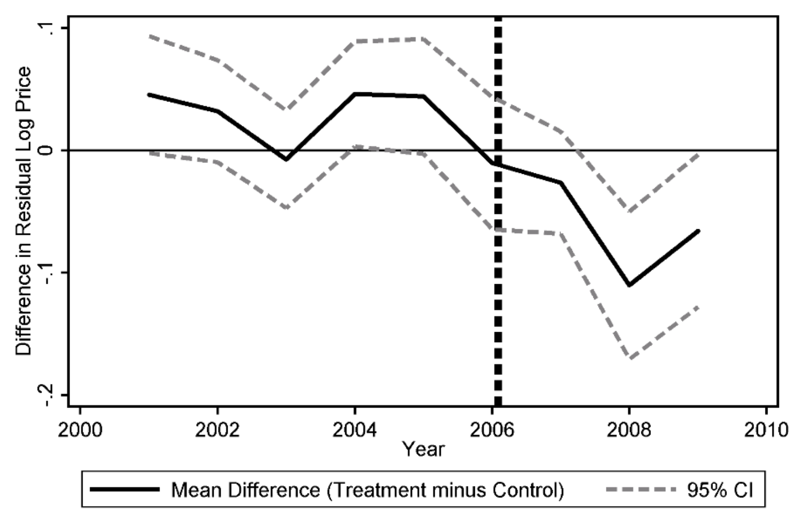
By 2008, almost 11,000 gallons of liquid gasoline had been recovered, and additional gasoline was collected in vapor or dissolved form. Groundwater was being pumped and treated at 78 wells, and monitored at 262 (Maryland Department of Environment 2008). Indeed as of the present time, soil vapor extraction and groundwater pump and treat remediation continues (Maryland Department of Environment 2014).

Figure A15

(A) Price Trends in Treated and Control Groups at Jacksonville Exxon, MD (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the release of petroleum (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

9. Green Valley Citgo, Monrovia, MD

Monrovia is a very small community in Frederick County located almost equidistant (about 45 miles) from Baltimore and Washington DC.

Population (2010): 416
Population density (2010): 186/sq mi
Median Household income (2012): $80,765
Race identified as White alone (2010): 91.1%

In December 2004, the MDE discovered MTBE contamination in the drinking water supply well that serviced a shopping center in Monrovia, Maryland (Event 1). Inspection of a nearby gas station led to drilling of new monitoring wells and in February 2006, MTBE and benzene were detected above state action levels at one of the monitoring wells. Later that same year, MTBE was detected at a nearby plaza above state action levels. Subsequent quarterly sampling of the wells at the plaza and the shopping center identified increasing MTBE levels between 2007 and early 2008. As a consequence, one supply well was closed and filtration systems were installed at several others (Maryland Department of Environment 2010b).

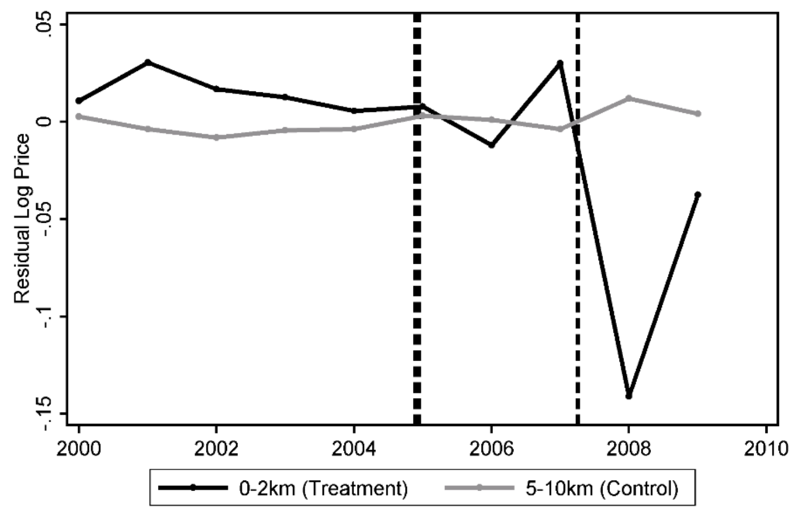
The nearby residential population also depended on groundwater for drinking water. In April 2007, the health department under directive from MDE sent letters to nearby residents within a half mile of the gas station (Event 2) notifying them of MTBE contamination issues (Maryland Department of Environment 2010b). The UST system and petroleum contaminated soil were removed in the summer of 2008 and a new system constructed of higher quality materials was installed. A treatment system was placed at the nearby stormwater discharge (Maryland Department of Environment 2010b).

By April 2010, 239 private drinking water wells had been sampled. Six were identified with MTBE at greater than state action levels and each received filtration systems and regular subsequent monitoring. The wells at an additional 23 residences near the six affected houses received quarterly groundwater monitoring (Maryland Department of Environment 2010b), as did the nearby plaza and shopping center as of 2014 (Maryland Department of Environment 2014c). As of 2015, filtration systems remain in effect at these impacted supply wells. The case remains open, natural attenuation and ongoing monitoring in place (MDE, 2015).

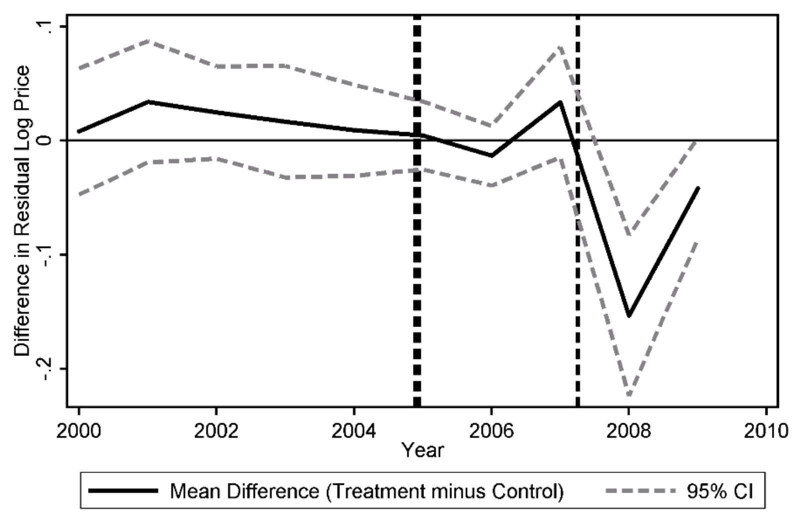
A large lawsuit for $3.75 billion was filed by 75 plaintiffs near the contamination in early 2010 (Lecke 2010). The case reached a confidential settlement in spring 2014 (Gaines 2014). The gas station continued to operate as late as 2014 (Maryland Department of Environment 2014c).

Figure A16

(A) Price Trends in Treated and Control Groups at Green Valley Citgo, MD (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents discovery (Event 1). The light dashed vertical line represents letters (Event 2). The figure shows residuals from a regression of log price on controls.

10. Corner Pantry, Hendersonville, NC

Hendersonville is located about 20 miles south of Asheville and 100 miles west of Charlotte in Henderson County. It consists of 7 square miles at the southern edge of the Blue Ridge Mountains.

Population (2010): 13,137
Population density (2010): 1,892.9/sq mi
Median Household income (2009-2013): $ 37,060
Race identified as White alone (2010): 79.7%
Persons in poverty (2009-2013): 26%

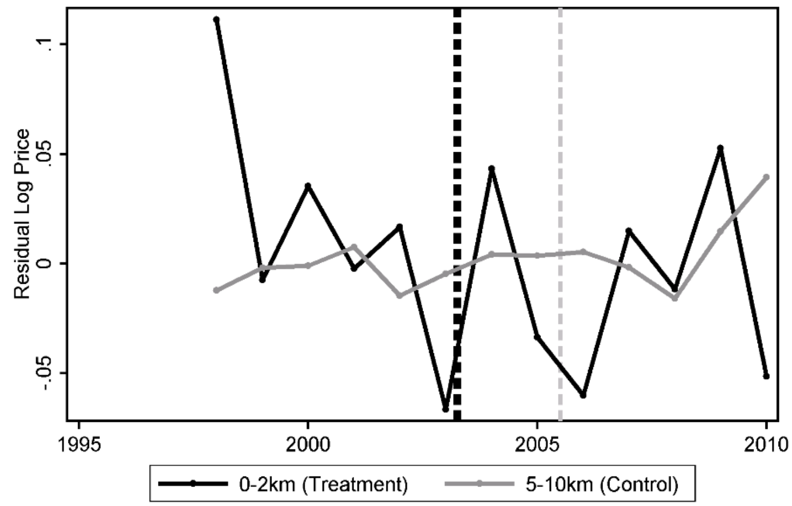
In April 2003, in anticipation of selling the property, an environmental assessment of a Hendersonville gas station discovered soil contaminated with gasoline constituents (Event 1). Months later, while drilling a new well, a nearby homeowner discovered groundwater with a petroleum odor. The water was tested and MTBE and other gasoline chemicals were detected. Further testing of wells in the area turned up high levels of MTBE. The source was traced to the UST system at the gas station (North Carolina Department of Environment and Natural Resources 2004).

By late 2003, approximately 60 private wells had been sampled and community wells that served dozens of nearby houses had been found tainted with MTBE and benzene (North Carolina Department of Environment and Natural Resources 2004, Metzger 2005). According to a state official, among drinking water contamination sites, this one became the state's top priority. The reason was the large number of vulnerable drinking water wells, one of which provided water to an assisted living facility. The cleanup involved vapor collection and treatment and moved forward despite a large backlog of releases and scarcity of cleanup funds in the state (Metzger 2003, 2005).

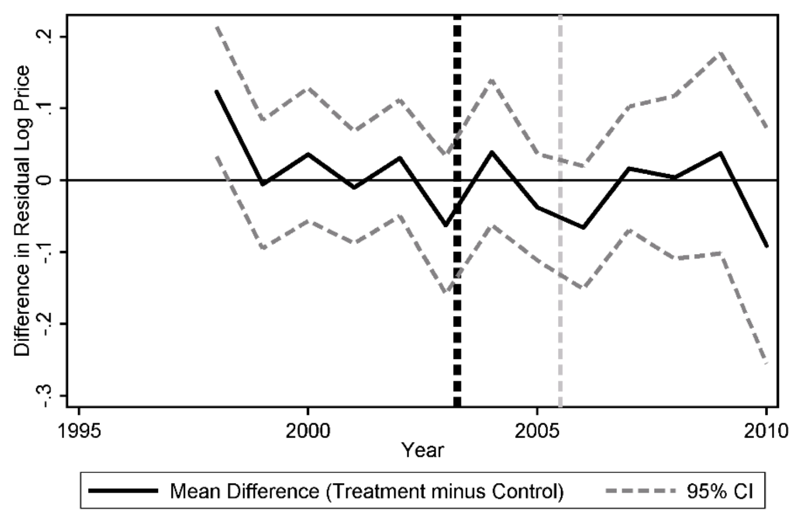
To quickly address contaminated drinking water, filtration systems were installed or alternative sources of water provided, such as hookups to alternative clean wells, or provision of bottled water (North Carolina Department of Environment and Natural Resources 2004). By July 2005, water lines were extended by the city to almost 100 houses with contaminated wells or considered at risk (Event 2) (Metzger 2005).

Figure A17

(A) Price Trends in Treated and Control Groups at Hendersonville Corner Pantry, NC (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The light dashed vertical line represents extension of city water (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

11.Montvale, NJ

Montvale was incorporated as a borough in 1894 and is named for its topography (Montvale, NJ n.d.). It is located along the northern border of New Jersey in Bergen County abutting New York State.

Population (2010): 7,844
Population density (2010): 1,961/sq mi
Median Household income (2009-2013): $ 107,662
Race identified as White alone (2010): 81.5%
Persons in poverty (2009-2013): 6.6%

A slow gasoline release at a gas station in Montvale, New Jersey seeped into groundwater over approximately 10 years. The New Jersey Department of Environmental Protection (NJDEP) first learned of potential contamination at the site in 1988 when there was a surface release from a hose that had been clipped by suspected vandals. At that point, it ordered commencement of monitoring. However, according to gas station records, soil contamination was first discovered by monitoring wells installed in 1983. Then in August 1993, while removing old USTs, the station owner discovered that three of them had been leaking (Event 1). The tanks were replaced with higher quality USTs and the state was notified of contamination. Soil sampling and installation of additional monitoring wells were required (Holahan 2003, 2004).

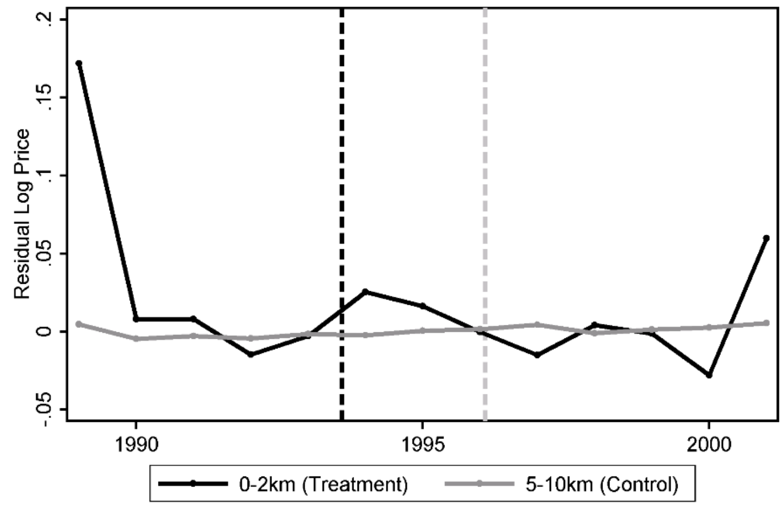
The NJDEP mandated cleanup in February 1996, including vapor extraction (Event 2). In June 2002, a pump and treat system began cleaning polluted groundwater and additional monitoring wells are installed to better assess the severity and extent of contamination (Event 3). This was followed by air sampling of nearby houses, which subsequently led the gas station owner to purchase five impacted houses (Holahan 2003).

In 2004, more than a dozen houses were being monitored for soil and air contamination. The drinking water was not compromised, perhaps because the nearby houses were not using groundwater. Homeowners reported to the press and filed a law suit claiming that house values had dropped precipitously (Holahan 2004).

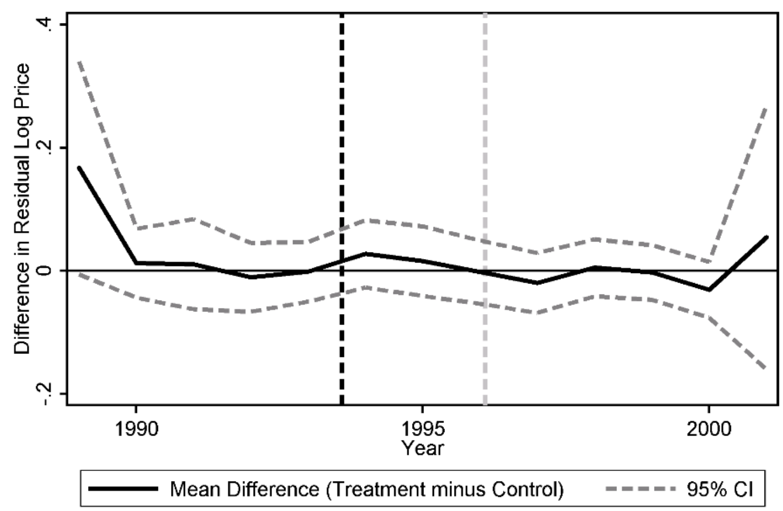
Remedial activities continued as late as 2012 (NJ DEP 2012).

Figure A18

(A) Price Trends in Treated and Control Groups at Montvale, NJ (Events 1 and 2).



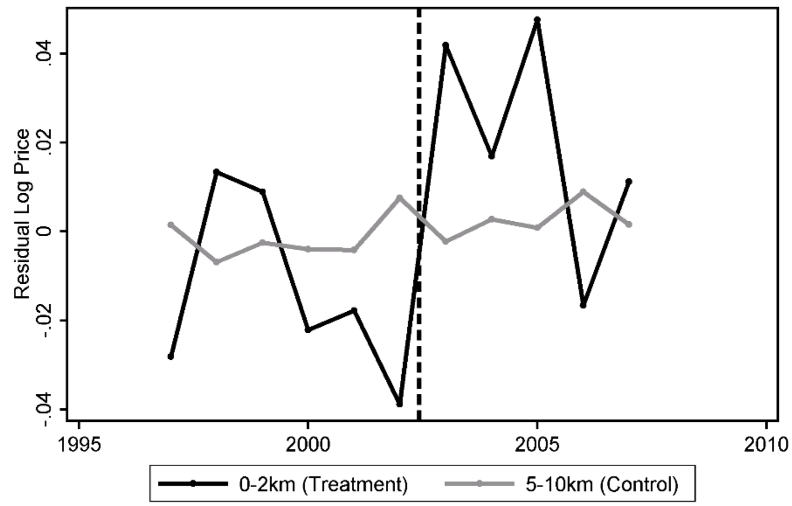
(B) Difference in Price in Treated and Control Groups



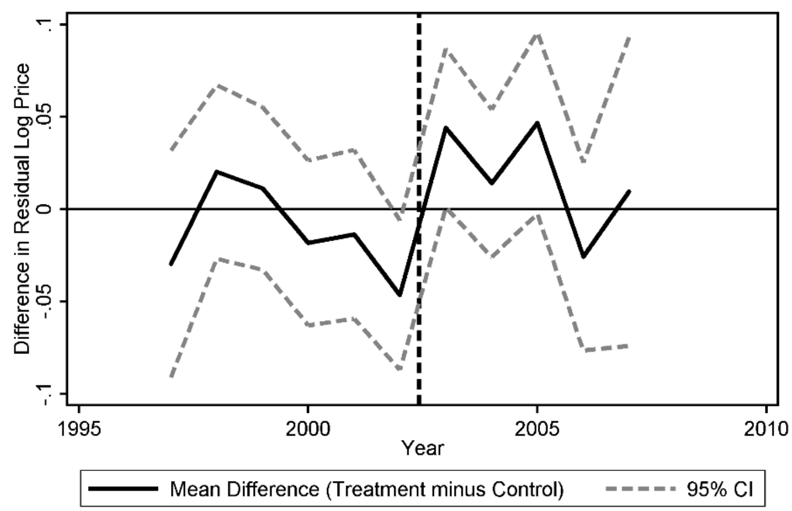
Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The light dashed vertical line represents NJDEP mandating cleanup (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

Figure A19

(A) Price Trends in Treated and Control Groups at Montvale, NJ (Event 3).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents installation of a pump and treat system (Event 3). The figure presents residuals from a regression of log price on a variety of control variables.

12. Northville Industries, East Setauket, NY

East Setauket is not itself a census designated place but is part of the Setauket CDP, a community founded in the mid-17th century. It is located on the northern shore of Long Island in Suffolk County, about 60 miles from Manhattan.

Population (2010): 15,477
Population density (2010): 1,816.5/sq mi
Median Household income (2009-2013): $130,000
Race identified as White alone (2010): 89.1%
Persons in poverty (2009-2013): 2.7%

A gasoline release was discovered at a petroleum storage, distribution and wholesale facility in East Setauket, New York in November of 1987. A small hole in an underground pipeline was uncovered while the firm was installing a groundwater monitoring well. Gasoline had spread over 30 acres and reached the water table, 100 feet down. The facility notified the state and estimated that 1.2 million gallons of gasoline had leaked over the past decade (Schmitt 1990, New York State Department of Environmental Conservation 2006). A *New York Times* article in 1990 declared that since discovery of the release

> "…Robin Hood Lane, the quiet residential street that is the gasoline plume's western boundary, has become the front line of what experts say will be a decade long experiment in combining various kinds of technology to clean up one of the worst underground spills in the New York metropolitan region." (Schmitt 1990)

In 1989, before recovery operations began, soil vapor monitoring identified two houses contaminated with petroleum-related compounds. These houses were remediated and no soil vapors were detected in houses at levels that would harm human health subsequent to 1993 (New York State Department of Environmental Conservation 2006).

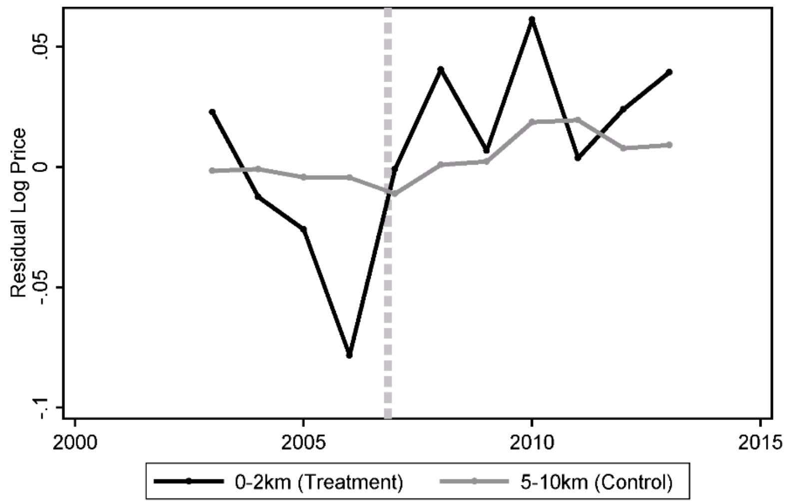
Owners of the petroleum storage facility funded connection to the county water supply for all areas nearby that had not previously received public water. The public well fields were closely monitored and none were found contaminated (New York State Department of Environmental Conservation 2006).

The owners investigated the full extent of contamination which involved installation of more than 300 wells within and surrounding the area of contamination. Soil vapor monitoring occurred at over 100 vapor monitoring wells; groundwater monitoring at over 200. In 1994, the facility reached agreement with the state on plans to remediate the soil and groundwater contamination. A vapor extraction system operated until 2004. Other components of the cleanup included an air sparging system which operated intermittently until 2003, and groundwater extraction and treatment which took place until 2000 (East Setauket 2005; New York State Department of Environmental Conservation 2006). Initial plans were to build a groundwater filtration plant that could treat more than 3.5 million gallons of water each day (Schmitt 1990).

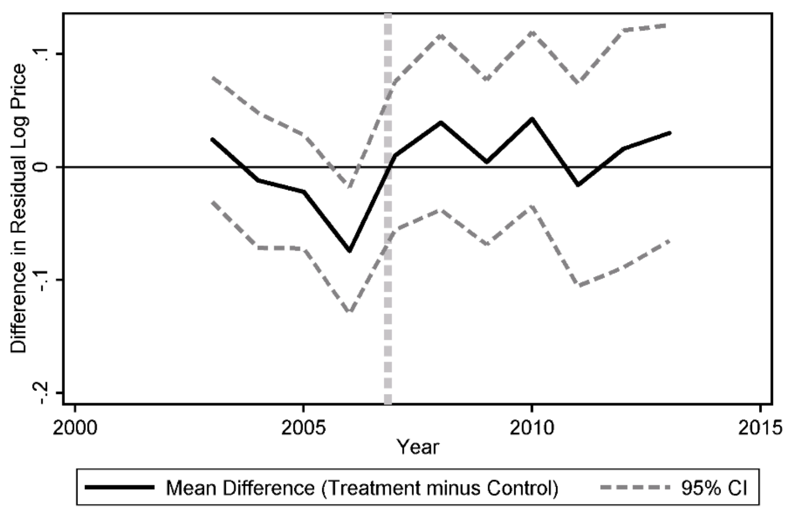
Cleanup and remedial work required by the state was successfully completed as of November 2006 (Event 1). Deconstruction and abandonment of monitoring wells, recovery wells and other buildings and structures associated with the cleanup began and were expected to be completed in approximately four months (Sobel 2006).

Figure A20

(A) Price Trends in Treated and Control Groups at Northville Industries, NY (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The light dashed vertical line represents completion of cleanup (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

13. Exxon-Mobil, Smithtown, NY

Smithtown CDP lies within the boundaries of the town of Smithtown in Suffolk County. The CDP consists of 12 square miles, while the town consists of 111 square miles split almost evenly between land and water. Smithtown is on the northern coast of central Long Island. The town was settled in the mid-17th century and is about 50 miles from Manhattan.

Population (2010): 26,470
Population density (2010): 2,276.2/sq mi
Median Household income (2009-2013): $109,075
Race identified as White alone (2010): 94.0%
Persons in poverty (2009-2013): 4.4%

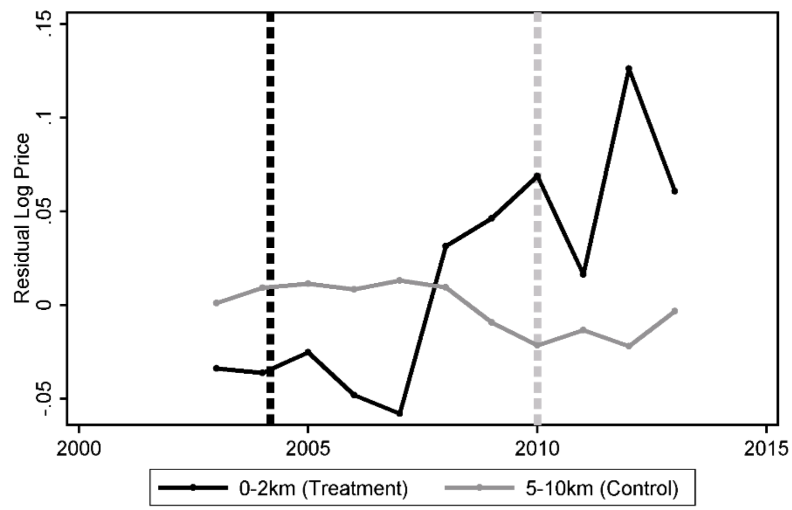
A spill of an unknown quantity of gasoline occurred at a Smithtown, New York gas station in September of 1998 (Vargas 2004). A local resident suspected that her drinking well was contaminated. The county health services confirmed that the well contained levels of MTBE that exceeded regulatory standards. Alternative drinking water was provided to the household. The New York State Department of Environmental Conservation (NYSDEC) began an investigation seeking to identify other affected residences and supply them with alternative drinking water (ExxonMobil Oil Corp 2010). A cleanup ensued that removed a tank and 5,000 tons of contaminated soil near the station before the end of 1999 (Allison 2008, Groundwater & Environmental Services, Inc. 2012).

In March 2004, NYSDEC reported a gasoline release near the 1998 incident but across the street, at a second gas station in Smithtown (Event 1). At least some residents stated they were unaware of any release until this second incident. (Vargas 2004). In July of 2004, individuals from seventy-two households in the path of the release plume sued the gas station owners for damages (Allison 2008).

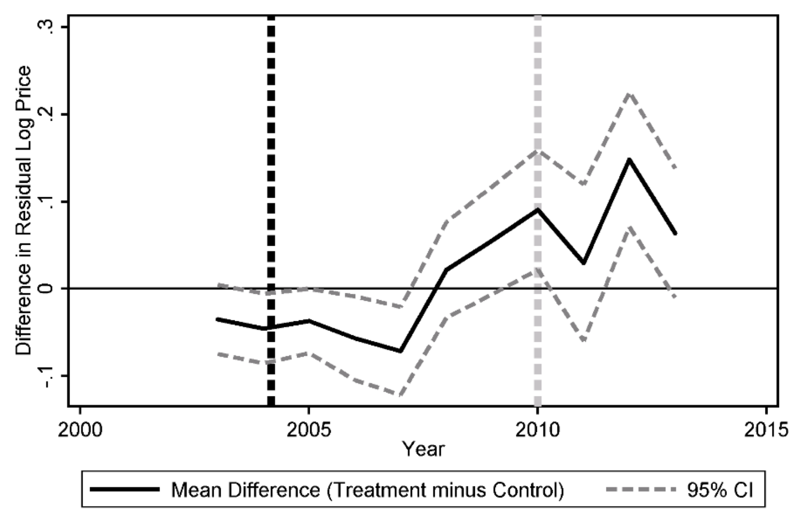
A groundwater pump and treat system operated between June 1999 and June 2007 and a soil vapor extraction system operated from April 2001 to March 2006. Groundwater monitoring was ongoing as late as November 2010, and an off-site pump and treat system operated between 2004 and 2010 (ExxonMobil Oil Corp 2010, Groundwater & Environmental Services, Inc. 2012). Except for ongoing monitoring, cleanup activities seem to be complete by January 2010 (Event 2).

Figure A21

(A) Price Trends in Treated and Control Groups at Smithtown Exxon-Mobil, NY (Events 1 and 2).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The light dashed vertical line represents the completion of cleanup (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

14. West Hempstead, NY

West Hempstead CDP is located on the western portion of Long Island, about 25 miles from Manhattan. It occupies 2.5 square miles in Nassau County and is host to a portion of Hempstead Lake State Park.

Population (2010): 18,862
Population density (2010): 7,101.7/sq mi
Median Household income (2009-2013): $97,228
Race identified as White alone (2010): 74.0%
Persons in poverty (2009-2013): 6.9%

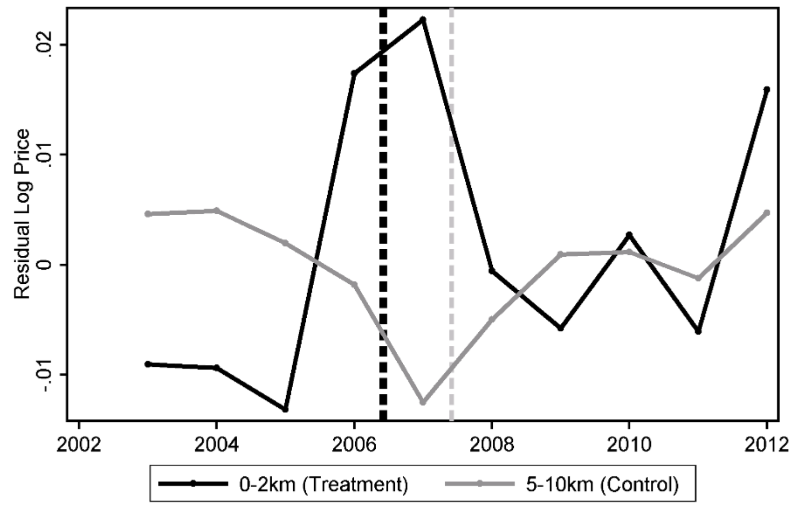
In June of 2006, MTBE was detected at concentrations exceeding the state standard in the West Hempstead (New York) Water District distribution system (Event 1). The contamination infiltrated through a public supply well, one of four relatively shallow wells. A precautionary health advisory warned approximately 30,000 customers not to ingest or wash with the tap water. All four wells were closed pending further investigation by the NYSDEC exploring the source, extent, and degree of the contamination (New York State Department of Environmental Conservation 2007, Smith 2007, Three Village Times 2006, White 2006). Ultimately the four wells were found to be contaminated (New York State Comptroller 2007).

Beginning in August 2006, a pump and treat system was installed to clean water from the contaminated well. By early 2007, the contaminant plume had been delineated. Besides MTBE, tert-amyl-methyl-eter and tert-butyl-alcohol were also detected. Only the shallow aquifer was affected so public wells drawing from a deeper aquifer were considered safe. Also in early 2007, a second remedial measure was started consisting of new recovery wells that pumped and treated water from the contaminated plume. Both remedial measures were expected to operate for two to three years. A gas station located about one mile north of the public wells was identified as a source of the contamination, possibly sharing responsibility with other sources. (New York State Department of Environmental Conservation 2007, Smith 2007).

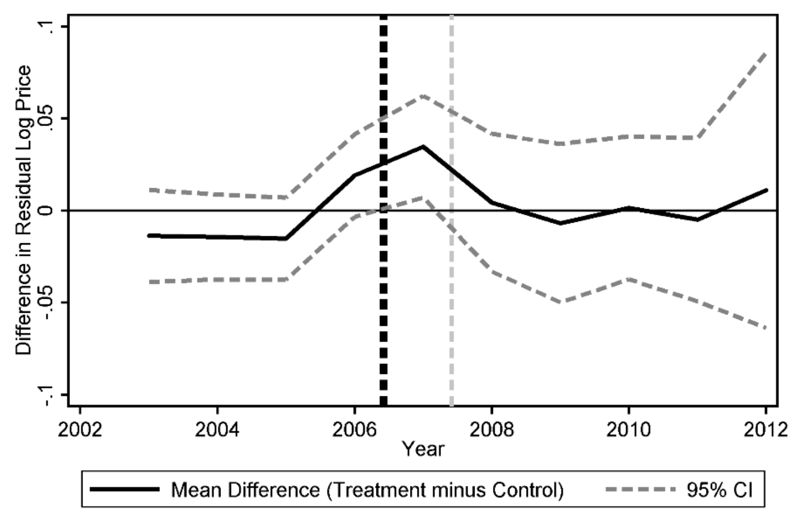
A new drinking water supply well was installed at an alternative location. The new source was put into service in June 2007 (Event 2) (New York State Comptroller 2007).

Figure A22

(A) Price Trends in Treated and Control Groups at West Hempstead, NY (Events 1 and 2).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The light dashed vertical line represents installation of a drinking water supply well (Event 2). The figure presents residuals from a regression of log price on a variety of control variables.

15.Pascoag, RI

The Pascoag CDP is the principal village (out of seven villages) in the town of Burrillville, RI. The village consists of 5.5 square miles and is centered around the Pascoag River and Reservoir (Pascoag, Rhode Island). It is about 25 miles from Providence.

Population (2010): 4,577
Population density (2010): 832/sq mi
Median Household income (2009-2013): $50,896
Race identified as White alone (2010): 96.4%
Persons in poverty (2009-2013): 12.3%

High levels of MTBE were discovered in a public-supply drinking water well field that served Pascoag Village, Rhode Island in August 2001 (Event 1), just a few months after a new well had been activated. The state health department issued an order to limit exposure to the well water on September 4, 2001. Over the next 3 months, several health advisories were issued and the levels of MTBE detected kept rising. More than 4,000 residents received deliveries of bottled water for several months. The Burrillville School District provided access to water for showering and filling water jugs at a hockey rink. The public wells were shut down in January 2002. The contamination was traced to leaking tanks at a very nearby gas station (Schweisberg 2005, Allen and Boving 2006, Fisher 2011, Fitzgerald 2012).

The UST system release occurred only 1700 feet from the public water supply wellhead. Prior to the release event, the source had been identified as a relatively high risk point source of contamination within a designated protection zone surrounding the wellhead. The source had been inspected just months before the contamination was discovered in the water supply (Schweisberg 2005).

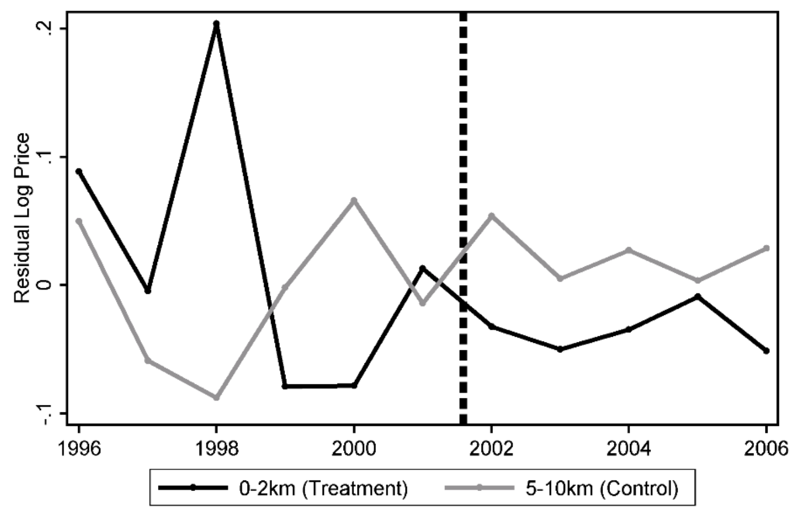
During the emergency investigation, at some wells over 6 inches of gasoline was discovered. Vapors intruded a nearby house for the elderly and caused a temporary evacuation. Contamination was consistently detected in the nearby Pascoag River (Allen and Boving 2006).

Eventually, public water was provided to Pascoag residents from a neighboring district (Schweisberg 2005, Fisher 2011). However, new drinking water wells closer to house were being sought as late as 2012 (Fitzgerald 2010).

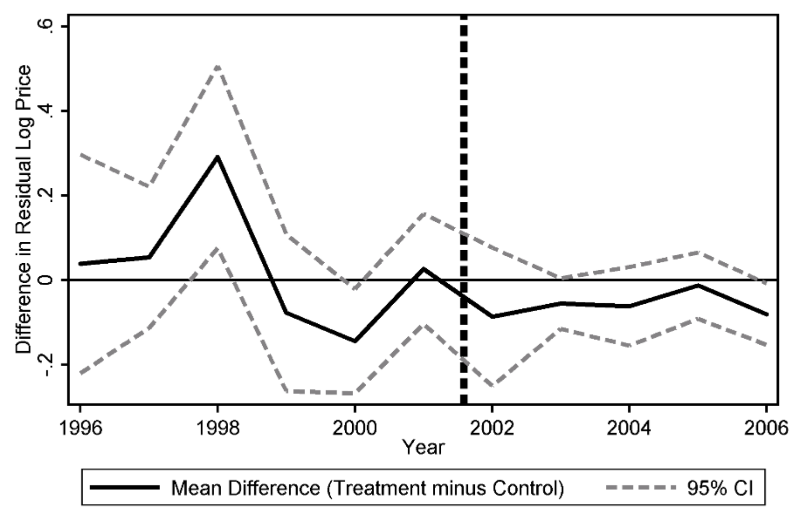
1,300 homeowners were involved in a suit against the gas station which settled for $7 million in 2012; $2 million for residents and $5 million to Pascoag's Public Utility for cleanup costs and supplying alternative sources of water. The latter were supplied through new wells and pipelines to connect houses that relied on private wells to public sources. Cleanup activities included soil removal, installation of filtration units, and pumping groundwater (Fitzgerald 2012).

Figure A23

(A) Price Trends in Treated and Control Groups at Pascoag, RI (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

16.Tuckahoe, VA

Tuckahoe CDP is a close-in north-western suburb of Richmond; in fact, the mailing address is Richmond. It consists of about 20 square miles in Henrico County. The Western boundary of Tuckahoe is formed by a large undeveloped swampy creek of the same name.

Population (2010): 44,990
Population density (2010): 2,197.9/sq mi
Median Household income (2009-2013): $64,796
Race identified as White alone (2010): 81.9%
Persons in poverty (2009-2013): 9.8%

In early 2010, new owners of a Tuckahoe gas station hired contractors to install new line leak detectors for an existing fiberglass tank system. Approximately one week later, on March 4, a release was reported (Event 1) to the Virginia Department of Environmental Quality (VDEQ). Inventory reconciliation suggested that about 15,000 gallons of gasoline had been released. The contractor took responsibility for the release which was attributed to faulty installation (Association of State and Territorial Solid Waste Management Office 2014, Springston 2010).

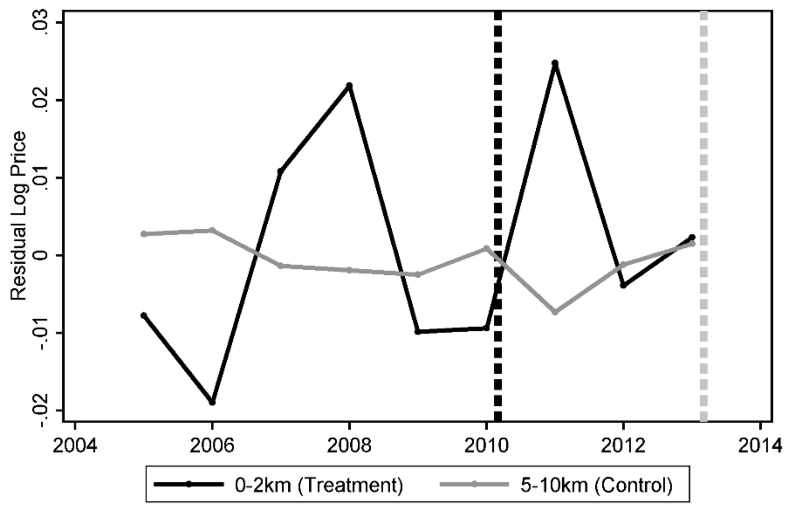
The gasoline seeped into a nearby creek, through soil and a concrete culvert. The cleanup effort included protecting the creek with booms and other devices intended to prevent the spread of gasoline into water. Vacuum extraction was employed from the tank pit and wells near the creek. Vacuum operations ended and soon after, explosive levels of vapors were detected in the sewer lines near the station. In addition, a restaurant almost one mile away reported gasoline vapors in their floor drains (Association of State and Territorial Solid Waste Management Office 2014). Public water supplies were not threatened (Jenks 2010).

VDEQ and EPA delineated the boundaries of the vapor movement through sewer lines. The sewer system led to a nearby residential neighborhood and other businesses, all of which faced risks of vapor intrusion. Surfactant was fed into the tank pits to suppress the vapors. Blowers were installed in sewer manholes located between the gas station and the neighborhood. Vacuum truck recovery of product from the tank pit was reinstated and an extraction unit was eventually installed for 24-hour operation. Finally, the county initiated a lining project for the nearby sanitary sewer line for protection from possible future releases. Over 11,000 gallons of gasoline were recovered during the first two weeks of cleanup (Association of State and Territorial Solid Waste Management Office 2014). By the end of the two weeks, VDEQ reported that while there were complaints of gasoline odors during the initial days, there had been no recent complaints (Springston 2010).

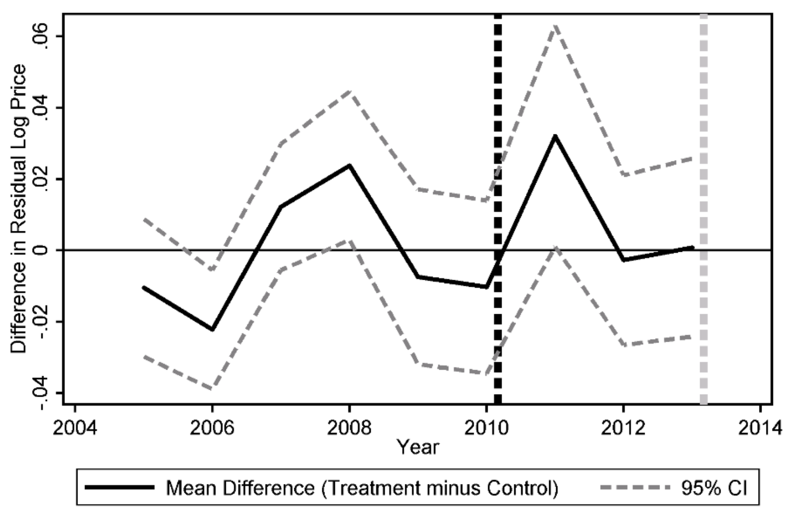
Cleanup was completed and this case was closed in March of 2013 (Event 2), with no further remediation onsite (V. McGee, Virginia Department of Environmental Quality, Personal Communication, Nov. 21, 2013).

Figure A24

(A) Price Trends in Treated and Control Groups at Tuckahoe, VA (Events 1 and 2).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The light dashed vertical line represents completion of cleanup. The figure presents residuals from a regression of log price on a variety of control variables.

17.Pearl Street Gulf, Essex Junction, VT

The Village of Essex Junction is located in the heart of Chittenden County, Vermont, near the western border of Vermont and the shore of Lake Champlain. It is 6 miles east of Burlington.

Population (2010): 9,271
Population density (2010): 2,030.9/sq mi
Median Household income (2009-2013): $56,463
Race identified as White alone (2010): 91.5%
Persons in poverty (2009-2013): 6.1%

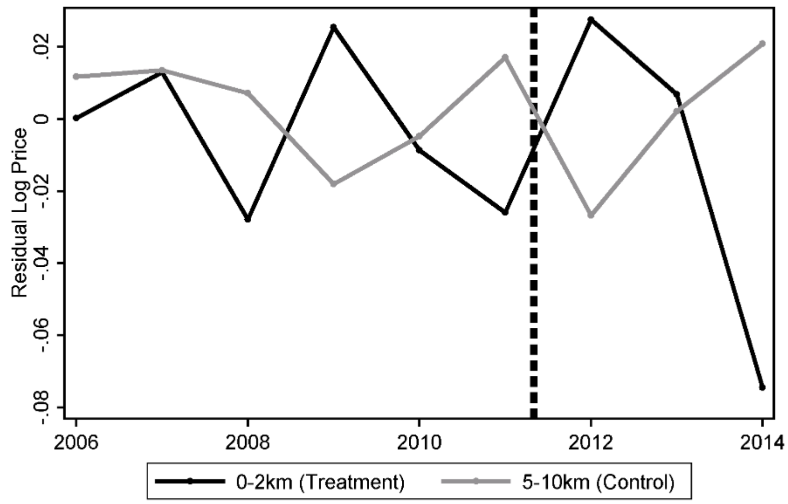
In May of 2011, business owners at a shopping plaza in Essex Junction, Vermont smelled a strong odor of gasoline coming from the parking lot and ultimately rising from a storm drain system. The vapors were evaluated and deemed by local and state officials to be at combustible levels (Event 1). The shopping plaza was placed under evacuation orders and more than 15 businesses were evacuated for a day while the vapors were vented and concentrations reduced (Reading 2011, Association of State and Territorial Solid Waste Management Office 2014).

Inventory records at an adjacent gas station were reviewed and between 1,600 to 2,600 gallons of gasoline were unaccounted for (Baird 2011). The release had occurred over a three-month period. Inspections led to the discovery of a leaking submersible pump. For three weeks following discovery of the release, the storm drains at the shopping center were vented with fans and treated with a carbon filtration system. Over that period and despite removal/treatment of gasoline-contaminated liquids, vapors in the system occasionally increased to explosive levels (Association of State and Territorial Solid Waste Management Office 2014).

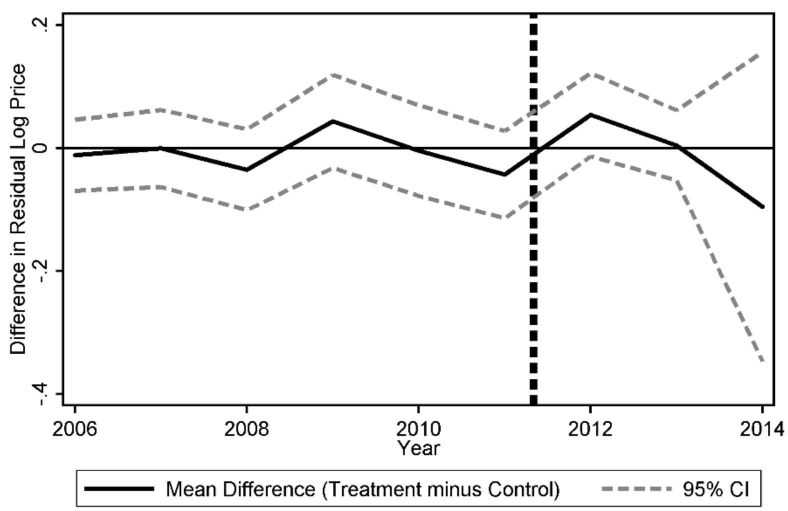
In mid-June, 2011, the gas station was ordered to remove all USTs to allow for an emergency cleanup operation. In addition, soil removal was initiated and continued for a month. Following tank and soil removal and site reconstruction, monitoring and recovery wells were installed. As of April 2012, two monitoring points still contained petroleum volatile organic compounds in excess of state groundwater enforcement standards (Association of State and Territorial Solid Waste Management Office 2012a).

Figure A25

(A) Price Trends in Treated and Control Groups at Pearl Street Gulf, Essex Junct., VT (Event 1).



(B) Difference in Price in Treated and Control Groups



Note: The heavy dashed vertical line represents the initial discovery of the leak (Event 1). The figure presents residuals from a regression of log price on a variety of control variables.

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Appendix B: Meta-data Quasi-Experimental Diagnostics

Even though a quasi-experimental interpretation may not be valid for the primary hedonic framework at some high-profile sites, perhaps such an interpretation is reasonable when considering all sites as a whole. We posit that potentially confounding factors are reduced by examining multiple sites in our internal meta-analysis. In a valid quasi-experiment, diagnostic comparisons of the treated and control groups would suggest similar time trends prior to the treatment event, and then, if there is a measurable treatment effect, demonstrate a divergence in these trends after treatment. Analogous to the price trend differential graphs presented in Appendix A and discussed in section V.B, a graph of the corresponding meta-data (i.e., estimates from the primary hedonic regressions) is developed here.

For each of the 12 high-profile sites where we observed the discovery of a release, the below hedonic regression is estimated (equation B1). Similar to the hedonic analyses the corresponding samples are constrained to only sales within 5 years before or after the discovery of the release. In contrast, here the regression for each of the sites is estimated using only houses within 0-2 km (the treated group) or within 5-10 km (the control group) of the high-profile site.

The treatment event (or release discovery in this case) occurred at a different date for each site, ranging from the Deleon Springs release in June, 1985 in Florida, to the Pearl Street Gulf release in May, 2011 in Vermont. Treatment assignment is fairly well dispersed over space and time, and so even if primary estimates from one specific location suffered from an omitted variable bias, one could hypothesize that the probability of the same confounding influences systematically existing at all treatment locations and times may be relatively low.

For each high-profile site *s*, time was normalized with respect to the release date, and transactions were grouped into one year bins relative to the date of the release. Following this normalization, $T_{\tau s}$ is a dummy variable denoting that the transaction took place in year τ relative to the date the release was discovered at site *s*. An interaction term between the time dummy variables and a dummy variable equal to one for homes within 0-2km of the high-profile site $\left(D_{is}^{0-2km}\right)$ is also included. The primary hedonic regressions that are estimated for each of the 12 high-profile sites in this exercise is:

$$\ln p_{ij\tau s} = x_{ij\tau}\beta + T_{\tau s}\gamma_{\tau s} + \left(T_{\tau s} \times D_{is}^{0-2km}\right)\alpha_{\tau s} + v_j + \varepsilon_{ij\tau s} \qquad \text{(B1)}$$

The vector $\boldsymbol{x}_{ij\tau}$ contains all structural, parcel, neighborhood, and other control variables that are not of direct interest, v_j is a neighborhood fixed effect (at the census tract level), and ε_{ijts} is a normally distributed and assumed mean zero error term. The coefficients to be estimated are β, $\gamma_{\tau s}$, $\alpha_{\tau s}$, and v_j. The coefficient of interest is $\alpha_{\tau s}$, which reflects the price differential between the time trends for the treated and control groups. Taking the estimates of $\alpha_{\tau s}$ for each of the high-profile sites *s*, we estimated the percent difference in prices between the treated and control groups in year τ as:

$$\%\Delta p_{\tau s} = (e^{\alpha_{\tau s}} - 1) \times 100 \qquad \text{(B2)}$$

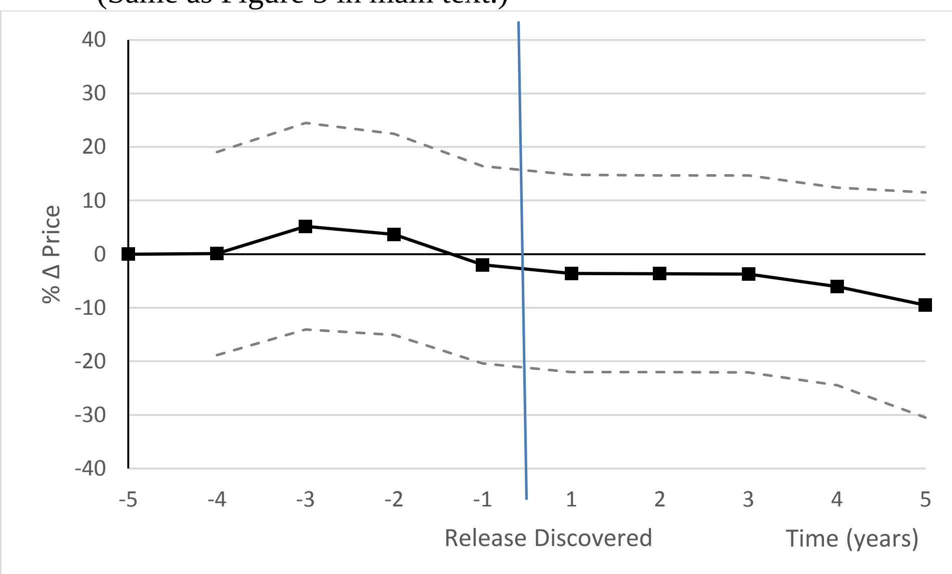
These estimates compose the meta-data used to graph the price trend differential at the meta-analysis level. Notice that the release discovery or "treatment" date is not specified. These estimates reflect the general trends over time without imposing any structure with respect to the treatment date.

Next the meta-data are used to estimate the following random effect size (RES) meta-regression:

$$\%\Delta\hat{p}_{\tau s} = \lambda_0 + \lambda_1 T_{\tau s} + e_{\tau s} \qquad \text{(B3)}$$

where λ_0 is a constant term to be estimated, and λ_1 is a coefficient vector that reflects the average price differential in each year τ between the treated and control groups. Note that 5 years before the release is discovered (τ = -5) is the omitted category. The estimated price trend differential is depicted in the below graph (which corresponds to Figure 5 in the main text). Again, we emphasize that no structure was imposed relative to the release discovery date. This trend merely reflects the difference between how the treated group prices changed over time relative to the control group.

Figure B1. Meta-analytic Price Trend Differential Between Treated and Control Groups. (Same as Figure 5 in main text.)



Note: Treated group houses within 0-2 km from a high-profile site, and control group as houses from 5-10 km.

The confidence intervals are fairly wide given the small number of transactions in the treated group when divided up into annual bins, but the point estimates reveal an interesting story. The near zero, and even slightly positive, difference in the left portion of the graph suggests that there was little difference in price between the treated and control groups before the release was discovered, on average. In contrast, the negative point estimates in the right portion of the graph suggest that prices among homes within 0-2km of the high-profile site (the treated group) are slightly lower relative to homes located at 5-10km away from the site (the control group) after the discovery of the release (i.e., post treatment). Again, these differences are not statistically significant, which is not surprising given the small number of transactions each year in the treated group (and hence wide confidence intervals in the meta-data), but the story is consistent with the notion that the meta-analysis provides a valid quasi-experiment as a whole, even when such an interpretation may not necessarily be appropriate among some study locations in the primary hedonic analysis.

Appendix C: Full Hedonic Regression Results

Table C.1. Full Regression Results for Models 1 through 3: Dep Var. = ln(price).

VARIABLES[a]	Model 1 Charnock Well Fields, CA Period 1	Model 2 LaSalle, CO Period 1	Model 3 LaSalle, CO Period 2
Age of House	-0.001987*	-0.000808	-0.004815***
	(0.001)	(0.002)	(0.002)
Age Missing	-0.297820***	0.793372***	0.002209
	(0.101)	(0.136)	(0.240)
Age^2	0.000023**	-0.000002	0.000014
	(0.000)	(0.000)	(0.000)
Townhome	-0.247056***	0.008797	-0.071479
	(0.061)	(0.046)	(0.043)
Total # Bathrooms	0.023993***	0.010875	0.093184***
	(0.006)	(0.032)	(0.010)
Bathrooms Missing	-0.308792	-0.044891	0.737436***
	(0.294)	(0.094)	(0.129)
ln(interior square footage)	0.501674***	0.168114***	0.164274***
	(0.026)	(0.048)	(0.041)
Square Footage Missing	4.150611***	1.021012***	0.945592***
	(0.440)	(0.264)	(0.279)
ln(lot acreage)	0.062002*	0.009445	0.202088***
	(0.036)	(0.035)	(0.033)
Acreage Missing		-0.060676	-0.208763***
		(0.075)	(0.073)
Air Conditioner		-0.058733*	0.014002
		(0.030)	(0.026)
Air Conditioner Missing			0.122182
			(0.306)
Basement		0.119095**	0.143494***
		(0.053)	(0.025)
Basement Missing		-	-
Porch		-0.105323	0.009577
		(0.111)	(0.067)
Porch Missing			
Pool	0.095846***		
	(0.012)		
Pool Missing			
Distance to nearest urban cluster (km)		-80.269636	-23.104865***
		(58.697)	(7.744)
Distance to nearest urban cluster (meters)	0.037913**		
	(0.016)		
Distance to nearest major road (km)	0.043634**	-0.013159	-0.054742***
	(0.019)	(0.064)	(0.015)

In a 100 yr floodplain	-0.004250		
	(0.030)		
Public Water Service Area (PWS)			
PWS Area Missing			
Waterfront			
# of gas stations w/in 200 meters	-0.040894***	0.033800	-0.036220**
	(0.008)	(0.029)	(0.016)
# of gas stations w/in 200-500 meters	-0.012290***	-0.016705	-0.016444
	(0.004)	(0.023)	(0.010)
1 km from High-profile (HP) Site	0.057715	-0.176997	0.038950
	(0.073)	(0.302)	(0.080)
1-2 km from HP Site	0.038704	-0.001508	-0.414066
	(0.063)	(0.310)	(0.405)
2-3 km from HP Site	0.031306	0.214849	-0.081789
	(0.046)	(0.261)	(0.120)
3-4 km from HP Site	0.018598	0.145933	-0.039592
	(0.040)	(0.234)	(0.126)
4-5 km from HP Site	0.002229	-0.087074	-0.042041
	(0.032)	(0.067)	(0.067)
Event 1 × 1 km from HP Site	0.073830***	-0.317473***	
	(0.022)	(0.065)	
Event 1 × 1-2 km from HP Site	0.085157***	-0.407769	
	(0.019)	(0.265)	
Event 1 × 2-3 km from HP Site	0.082835***	-0.714429***	
	(0.015)	(0.122)	
Event 1 × 3-4 km from HP Site	0.092824***	-0.616086***	
	(0.023)	(0.090)	
Event 1 × 4-5 km from HP Site	0.053280**	-0.263739**	
	(0.024)	(0.112)	
Event 2 × 1 km from HP Site			0.075590
			(0.058)
Event 2 × 1-2 km from HP Site			0.589011***
			(0.103)
Event 2 × 2-3 km from HP Site			0.019437
			(0.074)
Event 2 × 3-4 km from HP Site			-0.026653
			(0.052)
Event 2 × 4-5 km from HP Site			-0.121682***
			(0.036)
Quarterly Dummies	Yes	Yes	Yes
Annual Dummies	2006-2013	1997-2007	2004-2013
Tract FE	Yes	Yes	Yes
# of FE	236	24	23
Observations	27,597	31,118	16,334
Adj. R-squared	0.450	0.188	0.228

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.
a. All variables are binary indicators unless otherwise noted.

Table C.2. Full Regression Results for Models 4 through 6: Dep Var. = ln(price).

VARIABLES[a]	Model 4 Bithlo, FL Period 1	Model 5 Bithlo, FL Period 2	Model 6 Bithlo, FL Period 3
Age of House	0.016686	0.007559	0.010254*
	(0.010)	(0.015)	(0.005)
Age Missing	-1.205105***	-0.705305***	-0.046024
	(0.049)	(0.071)	(0.088)
Age^2	-0.000466*	-0.000157	-0.000235*
	(0.000)	(0.000)	(0.000)
Townhome		-0.340735***	-0.204546***
		(0.054)	(0.016)
Total # Bathrooms	0.093201**	0.077614***	0.048922**
	(0.031)	(0.016)	(0.016)
Bathrooms Missing	2.406279*	0.097313	-0.002705
	(0.966)	(0.146)	(0.115)
ln(interior square footage)	0.309667*	0.532039***	0.726676***
	(0.130)	(0.045)	(0.047)
Square Footage Missing		4.280033***	5.125086***
		(0.352)	(0.364)
ln(lot acreage)	0.239112***	0.358419***	0.435787***
	(0.047)	(0.063)	(0.062)
Acreage Missing	0.093049	0.364035***	0.202612***
	(0.124)	(0.063)	(0.042)
Air Conditioner			
Air Conditioner Missing			
Basement			
Basement Missing			
Porch			
Porch Missing			
Pool			
Pool Missing			
Distance to nearest urban cluster (km)			
Distance to nearest urban cluster (meters)	0.027231	-0.032676	-0.071511**
	(0.019)	(0.027)	(0.028)
Distance to nearest major road (km)	-0.001789	-0.068091**	-0.056591

	(0.022)	(0.019)	(0.031)
In a 100 yr floodplain	0.226134	-0.004641	-0.107942***
	(0.184)	(0.132)	(0.008)
Public Water Service Area (PWS)			
PWS Area Missing			
Waterfront			
# of gas stations w/in 200 meters	-0.271480	-0.192739	-0.181561**
	(0.232)	(0.134)	(0.054)
# of gas stations w/in 200-500 meters	0.095334	-0.061034	0.019245
	(0.048)	(0.078)	(0.037)
1 km from High-profile (HP) Site	-0.506267*	-0.952495***	-0.971445***
	(0.200)	(0.116)	(0.206)
1-2 km from HP Site	-0.187943	-0.711109***	-0.433727***
	(0.231)	(0.145)	(0.109)
2-3 km from HP Site	-0.311183	-0.458026**	-0.255530**
	(0.164)	(0.177)	(0.074)
3-4 km from HP Site	-0.245720*	-0.294375**	-0.113414***
	(0.106)	(0.105)	(0.022)
4-5 km from HP Site	-0.274444***	-0.350408***	0.032743
	(0.067)	(0.059)	(0.029)
Event 1 × 1 km from HP Site	0.210842		
	(0.111)		
Event 1 × 1-2 km from HP Site	-0.022994		
	(0.291)		
Event 1 × 2-3 km from HP Site	0.198238		
	(0.163)		
Event 1 × 3-4 km from HP Site	0.241360**		
	(0.085)		
Event 1 × 4-5 km from HP Site	0.306504*		
	(0.121)		
Event 2 × 1 km from HP Site		-0.020541	
		(0.086)	
Event 2 × 1-2 km from HP Site		0.408396**	
		(0.165)	
Event 2 × 2-3 km from HP Site		0.350671*	
		(0.144)	
Event 2 × 3-4 km from HP Site		0.195884*	
		(0.089)	
Event 2 × 4-5 km from HP Site		0.233470***	
		(0.037)	
Event 3 × 1 km from HP Site			0.304411**
			(0.106)
Event 3 × 1-2 km from HP Site			0.449890**
			(0.152)
Event 3 × 2-3 km from HP Site			0.026835

			(0.074)
Event 3 × 3-4 km from HP Site			0.126601**
			(0.037)
Event 3 × 4-5 km from HP Site			0.023270
			(0.073)
Quarterly Dummies	Yes	Yes	Yes
Annual Dummies	1983-1993	1998-2008	2006-2013
Tract FE	Yes	Yes	Yes
# of FE	6	7	7
Observations	5,383	33,290	8,739
Adj. R-squared	0.487	0.419	0.613

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.

a. All variables are binary indicators unless otherwise noted.

Table C.3. Full Regression Results for Models 7 through 11: Dep Var. = ln(price).

VARIABLES[a]	Model 7 DeLeon Springs, FL Period 1	Model 8 DeLeon Springs, FL Period 2	Model 9 Palm City Cluster, FL Period 1	Model 10 Palm City Cluster, FL Period 2	Model 11 Palm City Cluster, FL Period 3
Age of House	0.028430***	0.026956**	0.011899*	-0.005808	-0.013387***
	(0.005)	(0.009)	(0.006)	(0.005)	(0.004)
Age Missing	-1.277399***	-1.151720***	0.281439	-0.344564	-1.027592***
	(0.054)	(0.070)	(0.191)	(0.295)	(0.123)
Age^2	-0.000473***	-0.000462**	-0.000168	0.000055	0.000146**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Townhome	0.122546	0.106399	0.078379	-0.062937	-0.134509
	(0.064)	(0.073)	(0.079)	(0.119)	(0.129)
Total # Bathrooms	0.087103***	0.090316***	0.018281	-0.039236	0.093655***
	(0.012)	(0.018)	(0.037)	(0.032)	(0.017)
Bathrooms Missing	0.253097		-0.374102	5.569753***	0.217952
	(0.164)		(0.442)	(0.780)	(0.198)
ln(interior square footage)	0.476240***	0.465210***	0.382368**	0.838308***	0.543720***
	(0.080)	(0.064)	(0.147)	(0.095)	(0.084)
Square Footage Missing			2.786391**		4.396570***
			(0.979)		(0.640)
ln(lot acreage)	0.245077***	0.165589***	-0.133528*	0.020753	0.267605***
	(0.035)	(0.029)	(0.071)	(0.080)	(0.038)
Acreage Missing	-0.187407***	-0.146123***	0.180392	-0.164748	-1.036464***
	(0.007)	(0.016)	(0.207)	(0.185)	(0.175)
Air Conditioner			0.317082***	0.150697**	0.105682
			(0.089)	(0.059)	(0.083)
Air Conditioner Missing					
Basement			0.176798	0.269278***	0.263754***
			(0.180)	(0.089)	(0.086)
Basement Missing					
Porch			-0.085456	0.102370	-0.086365
			(0.127)	(0.065)	(0.063)
Porch Missing			0.231983*	0.941917***	0.617553***
			(0.118)	(0.142)	(0.108)
Pool			0.080762*	0.077714*	0.057525***
			(0.042)	(0.045)	(0.019)
Pool Missing			0.158460***	0.000942	0.056012
			(0.052)	(0.043)	(0.073)
Distance to nearest urban cluster (km)					
Distance to nearest urban cluster (meters)	-0.011220	-0.062009*	0.088333**	0.081503**	0.082514***
	(0.018)	(0.025)	(0.033)	(0.029)	(0.020)

Distance to nearest major road (km)	0.056663**	0.101435***	0.043717	0.068518*	-0.038793
	(0.022)	(0.019)	(0.036)	(0.036)	(0.050)
In a 100 yr floodplain	-0.206211	0.011439			
	(0.153)	(0.034)			
Public Water Service Area (PWS)			-0.129561	0.072157	0.054175
			(0.101)	(0.119)	(0.081)
PWS Area Missing					
Waterfront			0.437413***	0.328688***	0.274326***
			(0.146)	(0.099)	(0.065)
# of gas stations w/in 200 meters	-0.069926**	0.107860	-0.441773***	-0.343321***	-0.234909***
	(0.026)	(0.059)	(0.142)	(0.088)	(0.069)
# of gas stations w/in 200-500 meters	-0.043818	-0.043684	-0.239672***	-0.238481***	-0.140905**
	(0.033)	(0.038)	(0.072)	(0.071)	(0.056)
1 km from High-profile (HP) Site	-0.441199*	-0.509615**	-0.419117*	-0.390382**	-0.176771
	(0.186)	(0.174)	(0.212)	(0.180)	(0.190)
1-2 km from HP Site	-0.558737**	-0.455084**	1.327383**	-0.403363*	-0.117578
	(0.145)	(0.163)	(0.512)	(0.201)	(0.205)
2-3 km from HP Site	-0.222622*	-0.028712	0.517587**	0.218890	0.031449
	(0.109)	(0.070)	(0.229)	(0.171)	(0.213)
3-4 km from HP Site	-0.306166***	-0.131206*	-0.173877	-0.034648	0.224554
	(0.072)	(0.065)	(0.111)	(0.178)	(0.131)
4-5 km from HP Site	-0.283046***	-0.079610	-0.149328*	-0.139843	0.297247
	(0.041)	(0.067)	(0.085)	(0.148)	(0.186)
Event 1 × 1 km from HP Site	-0.146363***		-0.104296**		
	(0.015)		(0.038)		
Event 1 × 1-2 km from HP Site	0.059795		-1.527393***		
	(0.058)		(0.493)		
Event 1 × 2-3 km from HP Site	0.164694***		-0.350084		
	(0.008)		(0.370)		
Event 1 × 3-4 km from HP Site	0.148008**		0.404126***		
	(0.051)		(0.092)		
Event 1 × 4-5 km from HP Site	0.162425*		-0.011401		
	(0.078)		(0.044)		
Event 2 × 1 km from HP Site		0.190792***		0.059935	
		(0.016)		(0.050)	
Event 2 × 1-2 km from HP Site		0.062778		0.269882***	
		(0.039)		(0.093)	
Event 2 × 2-3 km from HP Site		-0.214746*		-0.277958	
		(0.090)		(0.167)	
Event 2 × 3-4 km from HP Site		-0.117717		0.070055	
		(0.067)		(0.079)	
Event 2 × 4-5 km from HP Site		-0.147853		0.047559	

		(0.166)		(0.072)	
Event 3 × 1 km from HP Site					-0.129330***
					(0.032)
Event 3 × 1-2 km from HP Site					0.002027
					(0.031)
Event 3 × 2-3 km from HP Site					0.127680
					(0.079)
Event 3 × 3-4 km from HP Site					0.126213
					(0.172)
Event 3 × 4-5 km from HP Site					-0.000186
					(0.109)
Quarterly Dummies	Yes	Yes	Yes	Yes	Yes
Annual Dummies	1980-1990	1985-1995	1983-1992	1991-2001	2003-2013
Tract FE	Yes	Yes	Yes	Yes	Yes
# of FE	6	6	20	20	19
Observations	5,971	6,036	20,874	25,949	21,325
Adj. R-squared	0.530	0.493	0.199	0.205	0.444

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.

a. All variables are binary indicators unless otherwise noted.

Table C.4. Full Regression Results for Models 12 through 15: Dep Var. = ln(price).

VARIABLES[a]	Model 12 Chillum, MD Period 1	Model 13 Upper Crossroads, MD Period 1	Model 14 Upper Crossroads, MD Period 2	Model 15 Jacksonville Exxon, MD Period 1
Age of House	-0.001413***	-0.005516***	-0.006827***	-0.006060***
	(0.000)	(0.001)	(0.001)	(0.001)
Age Missing	-0.157002***	-0.330638***	-0.367114***	-0.268161***
	(0.023)	(0.094)	(0.077)	(0.085)
Age^2	0.000001***	0.000024***	0.000030***	0.000032***
	(0.000)	(0.000)	(0.000)	(0.000)
Townhome	-0.123296***	-0.125370***	-0.140335***	-0.099157**
	(0.021)	(0.014)	(0.025)	(0.041)
Total # Bathrooms	0.059051***	0.052397***	0.042863***	0.053590***
	(0.003)	(0.016)	(0.007)	(0.013)
Bathrooms Missing			-0.607287***	-0.312884***
			(0.039)	(0.048)
ln(interior square footage)	0.379572***	0.408276***	0.373079***	0.459916***
	(0.017)	(0.014)	(0.017)	(0.039)
Square Footage Missing	3.110271***	3.104216***	2.792784***	3.574613***
	(0.135)	(0.240)	(0.201)	(0.299)
ln(lot acreage)	0.099273***	0.105700***	0.105969***	0.101457***
	(0.011)	(0.008)	(0.007)	(0.017)
Acreage Missing		-0.153709	-0.597077***	
		(0.174)	(0.025)	
Air Conditioner	0.035742***	0.042485***	0.054651***	0.101176***
	(0.004)	(0.010)	(0.012)	(0.014)
Air Conditioner Missing				
Basement	0.097404***	-0.017107	-0.001751	0.034029**
	(0.006)	(0.010)	(0.006)	(0.014)
Basement Missing				
Porch	0.031050***		0.030122**	0.066944***
	(0.003)		(0.012)	(0.020)
Porch Missing	0.026174***		0.010098	0.075816**
	(0.006)		(0.026)	(0.031)
Pool	0.002493		0.051274***	0.025214
	(0.022)		(0.010)	(0.021)
Pool Missing				
Distance to nearest urban cluster (km)	-0.039932***	0.007710*	0.005304	0.003391
	(0.015)	(0.004)	(0.004)	(0.010)
Distance to nearest urban cluster (meters)				
Distance to nearest major road (km)	0.036092***	-0.003278	0.000111	-0.010834
	(0.012)	(0.005)	(0.004)	(0.009)

In a 100 yr floodplain	-0.053749***	-0.073564*	-0.073041	0.161653***
	(0.018)	(0.035)	(0.048)	(0.056)
Public Water Service Area (PWS)		0.018733	0.016410	0.059376*
		(0.030)	(0.013)	(0.030)
PWS Area Missing				
Waterfront				
# of gas stations w/in 200 meters	-0.011997*	-0.038397	-0.032628	-0.012895
	(0.007)	(0.030)	(0.031)	(0.021)
# of gas stations w/in 200-500 meters	0.004534	-0.010821	-0.003153	-0.017433
	(0.003)	(0.012)	(0.005)	(0.015)
1 km from High-profile (HP) Site	-0.222753**	0.073876***	0.051146**	0.119741*
	(0.088)	(0.019)	(0.020)	(0.067)
1-2 km from HP Site	-0.149087***	0.044091**	0.079999***	0.033929
	(0.054)	(0.018)	(0.019)	(0.056)
2-3 km from HP Site	-0.111270**	0.043164	0.052829**	0.039506
	(0.049)	(0.027)	(0.021)	(0.062)
3-4 km from HP Site	-0.115186***	-0.038610	0.029998	0.093339
	(0.029)	(0.040)	(0.021)	(0.061)
4-5 km from HP Site	-0.078156***	0.022469*	0.053742**	0.058787
	(0.016)	(0.012)	(0.018)	(0.046)
Event 1 × 1 km from HP Site	0.005825	-0.043663***		-0.160673***
	(0.014)	(0.011)		(0.014)
Event 1 × 1-2 km from HP Site	0.022525***	0.029675***		-0.053097
	(0.007)	(0.008)		(0.038)
Event 1 × 2-3 km from HP Site	0.036813*	-0.008588		-0.070008***
	(0.019)	(0.009)		(0.011)
Event 1 × 3-4 km from HP Site	0.040883***	0.046789		-0.039360
	(0.011)	(0.035)		(0.024)
Event 1 × 4-5 km from HP Site	0.050490***	0.014264		-0.039204*
	(0.010)	(0.021)		(0.022)
Event 2 × 1 km from HP Site			-0.018538	
			(0.014)	
Event 2 × 1-2 km from HP Site			-0.058739***	
			(0.015)	
Event 2 × 2-3 km from HP Site			-0.030197*	
			(0.014)	
Event 2 × 3-4 km from HP Site			-0.023910	
			(0.015)	
Event 2 × 4-5 km from HP Site			-0.040931	
			(0.030)	
Quarterly Dummies	Yes	Yes	Yes	Yes
Annual Dummies	1996-2006	1996-2003	1999-2009	2001-2009
Tract FE	Yes	Yes	Yes	Yes
# of FE	122	10	10	28
Observations	65,574	4,245	7,176	8,154
Adj. R-squared	0.775	0.793	0.856	0.743

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.
a. All variables are binary indicators unless otherwise noted.

Table C.5. Full Regression Results for Models 16 through 19: Dep Var. = ln(price).

VARIABLES[a]	Model 16 Green Valley Citgo, MD Period 1	Model 17 Hendersonville Corner Pantry, NC Period 1	Model 18 Montvale, NJ Period 1	Model 19 Montvale, NJ Period 2
Age of House	-0.003264***	-0.003527***	-0.005270***	-0.006294***
	(0.000)	(0.001)	(0.001)	(0.001)
Age Missing	-0.317500**	-1.430659***	-0.207967***	-0.260668***
	(0.096)	(0.101)	(0.049)	(0.045)
Age^2	0.000004***	0.000014	0.000024***	0.000029***
	(0.000)	(0.000)	(0.000)	(0.000)
Townhome	-0.127665***	0.045250		
	(0.020)	(0.065)		
Total # Bathrooms	0.049857***	0.018640		
	(0.008)	(0.012)		
Bathrooms Missing	-0.504805***	0.129390		
	(0.023)	(0.165)		
ln(interior square footage)	0.421113***	0.690990***	0.401690***	0.351367***
	(0.019)	(0.033)	(0.054)	(0.052)
Square Footage Missing	2.951842***	5.349674***	3.025653***	2.668830***
	(0.375)	(0.385)	(0.410)	(0.395)
ln(lot acreage)	0.102265***	0.060611***	0.194859***	0.153446***
	(0.008)	(0.006)	(0.019)	(0.016)
Acreage Missing			-0.210011***	-0.193257***
			(0.043)	(0.031)
Air Conditioner	0.042820**	0.099608***		
	(0.014)	(0.015)		
Air Conditioner Missing				
Basement	0.046290**	-0.010892		
	(0.018)	(0.014)		
Basement Missing				
Porch	-0.003904	0.073672**		
	(0.008)	(0.031)		
Porch Missing	-0.007118	-0.009416		
	(0.010)	(0.193)		
Pool	0.043128**	0.024193		
	(0.012)	(0.030)		
Pool Missing				
Distance to nearest urban cluster (km)	-0.005118			
	(0.006)			
Distance to nearest urban cluster (meters)		-0.006330	0.010987	0.008198

		(0.007)	(0.010)	(0.008)
Distance to nearest major road (km)	-0.002548	0.004892	-0.037922***	-0.033407***
	(0.013)	(0.011)	(0.013)	(0.012)
In a 100 yr floodplain	0.047368	-0.108542***	-0.056442***	-0.055318***
	(0.034)	(0.023)	(0.019)	(0.015)
Public Water Service Area (PWS)	0.073291***			
	(0.011)			
PWS Area Missing				
Waterfront				
# of gas stations w/in 200 meters	-0.012695	0.002562	-0.086329***	-0.056157***
	(0.011)	(0.039)	(0.013)	(0.013)
# of gas stations w/in 200-500 meters	-0.006649	0.023947**	-0.031893***	-0.019573***
	(0.014)	(0.010)	(0.008)	(0.005)
1 km from High-profile (HP) Site	-0.001613	-0.055363	-0.317132***	-0.314236***
	(0.015)	(0.042)	(0.063)	(0.049)
1-2 km from HP Site	0.012254	0.016581	-0.241164***	-0.281427***
	(0.019)	(0.043)	(0.081)	(0.058)
2-3 km from HP Site	0.041393	-0.060402	-0.143467**	-0.183779***
	(0.021)	(0.039)	(0.067)	(0.056)
3-4 km from HP Site	0.040001*	-0.013254	-0.157458***	-0.095273**
	(0.017)	(0.048)	(0.056)	(0.041)
4-5 km from HP Site	0.053882	0.086490***	-0.037063	-0.023112
	(0.034)	(0.030)	(0.024)	(0.021)
Event 1 × 1 km from HP Site	-0.003498	0.012336	0.012626	
	(0.007)	(0.040)	(0.009)	
Event 1 × 1-2 km from HP Site	-0.031371***	-0.044826	0.020740	
	(0.006)	(0.028)	(0.023)	
Event 1 × 2-3 km from HP Site	-0.003494	0.002256	-0.051914*	
	(0.032)	(0.072)	(0.026)	
Event 1 × 3-4 km from HP Site	-0.006647	0.017629	0.020530	
	(0.010)	(0.030)	(0.031)	
Event 1 × 4-5 km from HP Site	-0.056603*	-0.045685*	0.012687	
	(0.023)	(0.025)	(0.026)	
Event 2 × 1 km from HP Site	-0.106952***	-0.048639	0.004291	
	(0.014)	(0.034)	(0.010)	
Event 2 × 1-2 km from HP Site	-0.028422	0.016772	-0.044642*	
	(0.028)	(0.060)	(0.022)	
Event 2 × 2-3 km from HP Site	-0.016747	-0.062221	-0.007392	
	(0.021)	(0.065)	(0.020)	
Event 2 × 3-4 km from HP Site	-0.066263***	0.005181	-0.005597	
	(0.016)	(0.045)	(0.024)	

Event 2 × 4-5 km from HP Site	0.039892	0.044817	-0.014151	
	(0.021)	(0.030)	(0.021)	
Event 3 × 1 km from HP Site				-0.005857
				(0.012)
Event 3 × 1-2 km from HP Site				0.034848**
				(0.017)
Event 3 × 2-3 km from HP Site				-0.005855
				(0.026)
Event 3 × 3-4 km from HP Site				-0.075709**
				(0.030)
Event 3 × 4-5 km from HP Site				-0.031073
				(0.030)
Quarterly Dummies	Yes	Yes	Yes	Yes
Annual Dummies	2000-2009	1998-2010	1989-2001	1997-2007
Tract FE	Yes	Yes	Yes	Yes
# of FE	6	19	37	37
Observations	8,085	11,771	17,487	16,452
Adj. R-squared	0.865	0.601	0.280	0.581

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.
a. All variables are binary indicators unless otherwise noted.

Table C.6. Full Regression Results for Models 20 and 21: Dep Var. = ln(price).

VARIABLES[a]	Model 20[b] Northville Industries & Smithtown Exxon-Mobil, NY Period 1	Model 21[c] West Hempstead, NY Period 1
Age of House	-0.007044***	-0.001990***
	(0.001)	(0.001)
Age Missing	-0.785547***	-0.505961***
	(0.139)	(0.063)
Age^2	0.000029***	0.000009**
	(0.000)	(0.000)
Townhome	0.453541**	0.079530*
	(0.217)	(0.045)
Total # Bathrooms	0.017131*	-0.008619
	(0.010)	(0.012)
Bathrooms Missing	0.387988***	0.298629*
	(0.142)	(0.177)
ln(interior square footage)	0.226510***	0.334930***
	(0.024)	(0.030)
Square Footage Missing	2.023215***	2.916885***
	(0.266)	(0.226)
ln(lot acreage)	0.167819***	0.125349***
	(0.018)	(0.014)
Acreage Missing	-0.112524	-0.209939***
	(0.095)	(0.037)
Air Conditioner	0.054092***	0.012510
	(0.013)	(0.013)
Air Conditioner Missing		
Basement	-0.001658	-0.015275
	(0.019)	(0.012)
Basement Missing	-0.112247	
	(0.087)	
Porch	0.017116	0.074007***
	(0.010)	(0.018)
Porch Missing		
Pool	0.075221***	0.117197***
	(0.013)	(0.034)
Pool Missing		
Distance to nearest urban cluster (km)		
Distance to nearest urban cluster (meters)	-0.034342***	-0.008372
	(0.010)	(0.014)
Distance to nearest major road (km)	0.001603	0.021183*

	(0.011)		(0.013)	
In a 100 yr floodplain	0.101228		-0.010361	
	(0.092)		(0.022)	
Public Water Service Area (PWS)	-0.152429**		0.266929	
	(0.072)		(0.184)	
PWS Area Missing	-0.214466**			
	(0.092)			
Waterfront				
# of gas stations w/in 200 meters	-0.016396		-0.030646***	
	(0.012)		(0.006)	
# of gas stations w/in 200-500 meters	0.001679		-0.018435***	
	(0.007)		(0.004)	
	Northville Industries	**Smithtown-Exxon-Mobil**	**West Hempstead**	**Bellemore**
1 km from High-profile (HP) Site	-0.170083**	-0.091986	0.144170*	-0.155800***
	(0.079)	(0.071)	(0.073)	(0.036)
1-2 km from HP Site	-0.104578	-0.065670	0.133960**	-0.152974***
	(0.080)	(0.079)	(0.068)	(0.034)
2-3 km from HP Site	-0.087268	-0.059774	0.117354**	-0.072598**
	(0.055)	(0.053)	(0.055)	(0.035)
3-4 km from HP Site	-0.109800*	-0.040409	0.063926**	
	(0.058)	(0.053)	(0.031)	
4-5 km from HP Site	-0.036314	0.008712	0.003255	
	(0.033)	(0.037)	(0.014)	
Event 1 × 1 km from HP Site	0.038460***	0.006690	0.040412**	
	(0.007)	(0.032)	(0.019)	
Event 1 × 1-2 km from HP Site	0.042665***	0.041443	0.052394	
	(0.010)	(0.032)	(0.032)	
Event 1 × 2-3 km from HP Site	-0.008419	0.031072	0.059068***	
	(0.013)	(0.023)	(0.015)	
Event 1 × 3-4 km from HP Site	0.030713	0.028883	0.023567*	
	(0.022)	(0.029)	(0.013)	
Event 1 × 4-5 km from HP Site	0.000666	0.004124	0.022880**	
	(0.012)	(0.019)	(0.011)	
Event 2 × 1 km from HP Site		0.021323	-0.060173***	
		(0.041)	(0.023)	
Event 2 × 1-2 km from HP Site		0.135304***	-0.021441	
		(0.019)	(0.027)	
Event 2 × 2-3 km from HP Site		0.095854***	-0.021363	
		(0.020)	(0.016)	
Event 2 × 3-4 km from HP Site		0.073482***	-0.003032	
		(0.016)	(0.017)	
Event 2 × 4-5 km from HP Site		0.013958	-0.027577**	
		(0.021)	(0.013)	
Quarterly Dummies	Yes		Yes	
Annual Dummies	2003-2013		2003-2012	
Tract FE	Yes		Yes	

# of FE	106	158
Observations	34,139	51,945
Adj. R-squared	0.346	0.247

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.

a. All variables are binary indicators unless otherwise noted.

b. County includes two high-profile release sites, just over 10 km of each other. The milestone events at both are accounted for in this model.

c. County includes two high-profile release sites, just over 10 km of each other. The milestone events at the Bellemore site took place prior to the available transaction data, and so proximity to this site is merely controlled for when examining the price impacts associated with milestone events at the West Hempstead site.

Table C.7. Full Regression Results for Models 22 through 24: Dep Var. = ln(price).

VARIABLES[a]	Model 22 Pascoag, RI Period 1	Model 23 Tuckahoe, VA Period 1	Model 24 Pearl Street Gulf, VT Period 1
Age of House	-0.000926	-0.007637***	-0.003821***
	(0.001)	(0.001)	(0.001)
Age Missing	-0.750716*	-0.326941**	-0.881555***
	(0.234)	(0.128)	(0.167)
Age^2	-0.000001	0.000063***	0.000017***
	(0.000)	(0.000)	(0.000)
Townhome		0.013632	0.098070**
		(0.029)	(0.037)
Total # Bathrooms	0.061781	0.049560***	0.042373*
	(0.025)	(0.006)	(0.020)
Bathrooms Missing		0.116341***	3.646822***
		(0.025)	(0.469)
ln(interior square footage)	0.277507***	0.570615***	0.416443***
	(0.026)	(0.032)	(0.048)
Square Footage Missing		4.910234***	
		(0.306)	
ln(lot acreage)	0.020716	0.080602***	0.074469***
	(0.014)	(0.012)	(0.013)
Acreage Missing			
Air Conditioner	0.015391	0.052951***	
	(0.014)	(0.013)	
Air Conditioner Missing	-0.605714	-0.024514	
	(0.318)	(0.016)	
Basement	0.075809**	-0.061448***	0.056151***
	(0.012)	(0.012)	(0.010)
Basement Missing		-0.069467	0.658209*
		(0.074)	(0.312)
Porch		-0.049118***	
		(0.010)	
Porch Missing			
Pool			
Pool Missing			
Distance to nearest urban cluster (km)			
Distance to nearest urban cluster (meters)	0.001996	0.000768	0.003332
	(0.010)	(0.007)	(0.015)
Distance to nearest major road (km)	-0.018650**	0.019424**	0.014790
	(0.004)	(0.009)	(0.032)
In a 100 yr floodplain	-0.143015	-0.069554**	-0.014148
	(0.097)	(0.027)	(0.106)

Public Water Service Area (PWS)			
PWS Area Missing			
Waterfront			
# of gas stations w/in 200 meters	0.008472	-0.043498**	-0.089892***
	(0.022)	(0.017)	(0.024)
# of gas stations w/in 200-500 meters	-0.099715***	-0.006993	-0.043972**
	(0.002)	(0.009)	(0.018)
1 km from High-profile (HP) Site	0.032597	-0.126331**	0.130628
	(0.050)	(0.060)	(0.084)
1-2 km from HP Site	0.178454**	-0.143419**	0.008818
	(0.039)	(0.056)	(0.079)
2-3 km from HP Site	0.143026	-0.126018**	-0.006497
	(0.070)	(0.051)	(0.106)
3-4 km from HP Site	0.074724*	-0.122302***	-0.097259
	(0.019)	(0.034)	(0.121)
4-5 km from HP Site	0.092960**	-0.095300***	-0.003518
	(0.020)	(0.030)	(0.053)
Event 1 × 1 km from HP Site	-0.045688	0.041444**	-0.000094
	(0.025)	(0.019)	(0.017)
Event 1 × 1-2 km from HP Site	-0.143074**	-0.010896	0.001327
	(0.028)	(0.022)	(0.019)
Event 1 × 2-3 km from HP Site	-0.010433	0.005154	0.013799
	(0.078)	(0.017)	(0.025)
Event 1 × 3-4 km from HP Site	-0.010458	0.000155	0.014457
	(0.035)	(0.018)	(0.025)
Event 1 × 4-5 km from HP Site	-0.098394*	-0.004705	0.009897
	(0.023)	(0.014)	(0.015)
Event 2 × 1 km from HP Site		0.039621	
		(0.030)	
Event 2 × 1-2 km from HP Site		-0.031457**	
		(0.013)	
Event 2 × 2-3 km from HP Site		-0.001982	
		(0.016)	
Event 2 × 3-4 km from HP Site		-0.004819	
		(0.018)	
Event 2 × 4-5 km from HP Site		0.008172	
		(0.014)	
Quarterly Dummies	Yes	Yes	Yes
Annual Dummies	1996-2006	2005-2013	2006-2014
Tract FE	Yes	Yes	Yes
# of FE	3	37	9
Observations	1,786	18,708	3,288
Adj. R-squared	0.504	0.811	0.334

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses, clustered by Census Tract.
a. All variables are binary indicators unless otherwise noted.

Appendix D: Number of Sales by Buffer and Before/After each Milestone Event.

Table D.1. Number of Transactions by Proximity Buffer and Before/After High-Profile Events.

			Distance from High-Profile Site (kilometers)				
			0 to 1	1 to 2	2 to 3	3 to 4	4 to 5
Charnock Well Fields, CA							
Event 1	Cleanup complete and public well field restored	Before	488	904	1,587	1,328	1,620
		After	296	646	915	833	1,037
La Salle, CO							
Event 1	Leak discovered	Before	192	6	554	2,865	1,493
		After	292	20	729	1,378	1,081
Event 2	Cleanup complete	Before	242	33	388	879	720
		After	115	18	236	581	415
Bithlo, FL							
Event 1	Leak discovered	Before	18	22	37	39	185
		After	14	29	28	35	291
Event 2	Widespread well contamination, declared "imminent threat"	Before	85	43	605	255	436
		After	117	201	790	850	2,487
Event 3	Increased notification and media attention	Before	38	26	141	532	1,035
		After	8	7	40	192	432
DeLeon Springs, FL							
Event 1	Leak discovered	Before	133	107	180	250	215
		After	412	130	136	176	408
Event 2	Cleanup approved, begins year later	Before	410	140	126	184	406
		After	306	144	138	146	348
Palm City Cluster, FL							
Event 1	Leak discovered	Before	322	542	966	1,138	1,011
		After	379	681	1,640	1,324	985
Event 2	Additional contamination discovered	Before	415	891	1,453	1,351	971
		After	464	951	2,062	1,413	1,264
Event 3	Partially removed from "imminent threat" status	Before	391	663	1,521	1,962	1,343
		After	200	455	861	1,128	658
Chillum, MD							
Event 1	Contamination plume migrated to DC	Before	194	706	1,261	1,725	2,036
		After	473	1,358	2,219	3,458	3,563
Upper Crossroads, MD							
Event 1	Leak case re-opened	Before	22	36	90	94	113
		After	47	77	182	213	190
Event 2	Public meeting and increased well testing	Before	50	78	198	227	203
		After	38	67	202	214	240
Jacksonville, MD							
Event 1	Leak discovered, emergency cleanup	Before	74	214	263	44	60
		After	49	98	177	282	329

Green Valley Citgo, MD							
Event 1	Leak discovered	Before	83	94	182	228	117
		After	100	69	113	181	124
Event 2	Notification sent to all residents within 1/2 mile	Before	-	-	-	-	-
		After	23	30	80	104	109
Hendersonville Corner Pantry, NC							
Event 1	Leak discovered	Before	65	200	149	287	549
		After	29	102	58	151	324
Event 2	Public water line extended	Before	-	-	-	-	-
		After	55	176	129	288	563
Montvale, NJ							
Event 1	Re-opened (old leak discovered)	Before	71	202	276	230	401
		After	73	172	191	160	248
Event 2	State mandated cleanup	Before	-	-	-	-	-
		After	164	395	409	377	617
Event 3	Widespread vapor concerns, RP purchased 5 homes	Before	181	396	433	388	569
		After	125	300	359	293	489
Suffolk, NY							
Northville Industries, NY							
Event 1	Cleanup complete	Before	74	348	519	1,101	1,370
		After	92	364	630	1,182	1,311
Smithtown Exxon-Mobil, NY							
Event 1	Leak discovered near previous release	Before	59	160	199	239	316
		After	196	612	726	997	1,159
Event 2	Cleanup complete	Before	-	-	-	-	-
		After	83	245	358	417	479
West Hempstead							
Event 1	MTBE detected in public water well	Before	367	785	1,992	2,525	3,636
		After	99	199	436	678	957
Event 2	New water supply well installed	Before	-	-	-	-	-
		After	233	477	1,094	1,795	2,358
Pascoag, RI							
Event 1	Leak discovered	Before	59	179	139	152	130
		After	83	190	127	124	115
Tuckahoe, VA							
Event 1	Leak discovered	Before	187	704	885	1,355	1,567
		After	136	289	357	491	566
Event 2	Cleanup complete	Before	-	-	-	-	-
		After	50	110	143	235	230
Pearl Street Gulf, VT							
Event 1	Leak discovered	Before	184	180	129	96	312
		After	129	106	96	83	257

Note: Color shades denote estimates from the same hedonic regression.