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The impacts of underground petroleum releases on a homeowner's decision to sell: A difference-in-differences approach

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ABSTRACT

Actual and perceived damages from environmental disamenities can disrupt a utility maximizing household's otherwise optimal decision of when to sell their home. This study examines this relatively under-investigated topic with an empirical application to petroleum releases from leaking underground storage tanks, like those commonly found at gas stations. The ubiquity and relative homogeneity of this disamenity facilitates a difference-in-differences methodology. The results reveal that the timing of home sales is impacted by leak and cleanup events at these disamenities; leading to both selling sooner and delaying a sale, depending on the event, presence of the primary exposure pathway, and the quality of the home. The implications of these results are discussed.

1. Introduction

Local environmental disamenities such as waste disposal sites, brownfields, Superfund sites, industrial factories, and underground storage tanks (UST) that hold hazardous substances, present a variety of undesirable characteristics such as displeasing aesthetics, noise, and odors. Most notably, due to the toxic nature of the materials commonly used, stored, or disposed of, local disamenities also present the possibility of accidental releases that can negatively impact the environment and the health of residents in the surrounding community.

The impacts on households living near these types of local disamenities are often inferred through hedonic price models, which estimate the reduction in the price of houses within a certain distance of the disamenity (e.g., Muehlenbachs et al., 2015; Zabel and Guignet, 2012). However, in this study we make the point that the common interpretation of hedonic property value study results, by assuming no frictions in the housing market and by treating homeowners as absentee landlords, overlooks temporal behavioral responses by selling households due to unforeseen changes in the attributes describing their home. For instance, homeowners may decide to delay the decision to sell their house when they learn of an environmental disamenity near them. This change in behavior signals a change in welfare, that (when present) could be overlooked by conventional hedonic property value studies.

This study examines how the timing of residential sales is impacted by the presence of a leaking underground storage tank (LUST). USTs are used to store gasoline, diesel fuel, kerosene, and other hazardous substances at gas stations and other commercial and industrial facilities. The primary threat from a LUST is contamination of groundwater –the source of drinking water for nearly half of all Americans (US EPA, 2015). LUSTs

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tend to be less high-profile than other environmental disamenities. The media often does not even cover LUSTs because they are a highly localized disamenity and tend to impact only a few households living in very close proximity. However, LUSTs are numerous and widespread. As of the end of FY2015 there were over 71,800 LUSTs awaiting to be cleaned up in the U.S alone. The ubiquitous nature of LUSTs not only creates a compelling context to examine the potential impact of environmental disamenities on the timing of households' decisions to sell, but also facilitates a cogent statistical identification strategy.

Two suburban counties in the State of Maryland are used as a case study in this paper –Baltimore and Frederick.[1] The data under analysis encompass a panel of comprehensive information on residential parcels each year from 2000 to 2007 in the two counties. These counties represent an illustrative setting to study the impacts from LUSTs because from 1996 to 2007 petroleum releases were discovered at 106 USTs –that represent 5.4% of the total UST facilities in the area. News reports suggest homeowners are concerned that they will be unable to sell their homes as a consequence of these releases (e.g. Lenhart, 1998; Leslie, 2007). The identification strategy in this paper relies on a quasi-experiment comparing homes located near a LUST (the treated group) and homes near a comparable set of non-leaking USTs (the control group). We examine the effects from three different "treatment" events –the discovery of a release, the ongoing cleanup of a release, and the completion of cleanup and closure of a leak investigation. The outcome variable under analysis is the annual probability of a sale. This probability is time dependent, meaning that the probability a homeowner sells his/her home varies depending on how long they have lived there, among other things. Discrete time duration models are equipped to handle this dependency by modelling the probability of sale conditional upon a household not previously selling their current home (see Harrell, 2015). By exploiting temporal and spatial variation in the discovery of a leak, a spatial difference-in-differences approach is undertaken (Horsch and Lewis, 2009).

The results suggest that the release of contaminants and subsequent cleanup activities at these LUST sites do impact the timing of sales for homes located within 500 meters (m). These impacts are heterogeneous and vary with the presence of the primary exposure pathway (potable water from private groundwater wells), and quality of the home.

The use of duration models to investigate features of the housing market is longstanding (e.g. Zuehlke, 1987; Haurin, 1988; Carrillo and Pope, 2012; De Wit and Van der Klaauw, 2013). However, two features set this study apart from previous applications. First, this study contributes to understand the understudied impacts from local environmental disamenities on the timing of residential transactions. Second, this study does so through a difference-in-differences strategy –which to our knowledge is the first study to do so in this context.

Only two studies have previously used duration models to examine the impacts of environmental disamenities on the selling time of residential properties.[2] Focusing on highway noise, Huang and Palmquist (2001) jointly estimate a hedonic price function and an equation explaining the duration a home is on the market. Their results suggest that highway noise negatively impacts prices, but has no effect on market duration. They speculate that the lack of effects on market duration may be due to two opposing forces. On one hand, a seller has a lower reservation value at higher levels of the disamenity, and is thus more likely to receive an acceptable bid for the home. On the other hand, buyers may be reluctant to bid on such a home, and so it is less likely to be sold. We posit that the extent of these opposing forces and the resulting net effects could vary across different types of homes. The heterogeneity in effects found and discussed later in this paper provide support to this argument. Consequently, a model that does not control appropriately for factors driving the heterogeneity of the effects might misleadingly suggest net zeros effects.

Depro and Palmquist (2012) estimate a discrete-time duration model to examine how changes in local ozone impact the probability that a household sells their home. They find that the annual probability of selling is 2.1% higher when ozone concentrations increase by 1 part-per-billion; and 0.5% higher when ozone concentrations decrease by 1 part-per-billion.

The identification strategy in this paper improves upon the strategies implemented in the two studies described above. Huang and Palmquist (2001) focus only on the time a home remains on the market. However, this focus is too narrow given that local disamenities likely impact a homeowner's decision to even put their home up for sale. By focusing on all residential parcels, including houses that were or were not on the market, this study examines the impact of a LUST on the annual probability of a sale.

Depro and Palmquist (2012) take a similar approach by examining the probability of sale among all residential parcels. However, given the context of that study, Depro and Palmquist (2012) carry out only a first "difference" in their identification strategy. They observe air pollution levels when a household first bought their home, and then again in each subsequent period, thus dealing with contemporaneous potential confounding effects only argumentatively. For example, air pollution levels may be correlated with traffic noise and other unobserved factors that could confound the results. The difference-in-differences strategy in this paper controls for potential contemporaneous confounding effects by identifying controls based on observable characteristics (see Horsch and Lewis, 2009; and Section 4 of this paper for details).

The next section provides a background on LUSTs. Section 3 presents a theoretical framework that provides the intuition of our focus on the probability of sale. Section 4 provides details on the identification strategy and empirical model. Section 5 describes the data under analysis. Sections 6 and 7, respectively, present the results and conclusions.

2. Background on LUSTs

In the United States (US) there are around 204,000 industrial and commercial facilities storing petroleum or other hazardous substances in underground storage tanks (US EPA, 2015). Occasionally, these tanks leak due to corrosion, cracks, defective piping, or spills during refilling and maintenance. Leaking contaminants can runoff into nearby waterbodies, and seep into the soil and groundwater. Human exposure to contaminants occurs primarily through consumption of contaminated groundwater (but potentially also through vapor migration and intrusion). Petroleum by-products such as benzene, toluene, ethyl benzene, and xylenes (BTEX) pose health risks, including cancer and adverse effects on the kidneys, liver, and nervous system (US EPA, 2012).

Petroleum products can also contain harmful additives, like Methyl tertiary butyl ether (MTBE), a former gasoline oxygenate and suspected carcinogen (Toccalino, 2005). In Maryland MTBE use was previously prevalent in order to comply with ground level ozone requirements under the Clean Air Act. It was not until the summer of 2006 that MTBE was fully replaced by ethanol as the primary gasoline oxygenate in Maryland (MDE, 2015).

All USTs in Maryland must be registered with the Maryland Department of Environment (MDE). There is a total of 1,954 UST facilities located in the two counties under study–Baltimore and Frederick. From 1996 to 2007, petroleum releases were discovered at 106 underground storage tanks located in these counties. A leak can be discovered through a variety of mechanisms, including failure of routine equipment compliance tests; discrepancies during petroleum inventory checks; routine groundwater monitoring; and complaints from nearby residents and business regarding vapor odors, or odd tasting/smelling water. In a

[1] The study excludes Baltimore City, which is a separate county from Baltimore County.

[2] See Knight (2008) for a review. There is also a small literature estimating these impacts on the transactions of industrial and commercial properties (e.g., Sementelli and Simons, 1997a; Simons and Sementelli, 1997b; Simons et al., 1999; Howland, 2004).