The Economic Consequences of Local Gas Leaks: Evidence from Massachusetts Housing Market

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1. Overview

Reducing methane emissions is a key near-term policy lever to slow rates of warming while pursuing CO2 reductions through low-carbon electricity and decarbonizing energy end uses via electrification and energy efficiency (Denis et al., 2015; Hultman et al., 2019). Academics and policymakers are increasingly focused on controlling methane emissions, but national policy is primarily focused on upstream emissions. Emissions from local distribution and end-uses have received less attention, yet they can be critical for meeting state and local climate policy targets. In areas with aging natural gas distribution pipelines, including major cities along the U.S. East Coast, gas leaks can be a major source of greenhouse gas emissions (Plant et al., 2019). For example, in Massachusetts (MA), gas leaks account for approximately 10% of greenhouse gas emissions (McKain et al., 2015). Natural gas pipelines with high fixed costs and wide coverage can be very difficult to completely replace or phase out in the short term. Several recent state laws focus on reporting and repairing gas leaks. However, the total number of leaks reported by MA utilities, and total estimated emissions from the gas system in the Boston area, have not declined (Sargent et al., 2021). While the costs of repairing gas leaks are reasonably well quantified, the value communities place on these repairs is poorly understood. An optimal environmental regulation depends on the extent to which individuals value environmental improvements as benefits (Greenstone and Jack, 2013; Ito and Zhang, 2020). The potential benefits of repairing gas leaks include avoiding climate change, damage to trees, financial losses, and in some cases explosion risks. Estimating these benefits is a challenging question with great policy relevance.

This study provides the first empirical evidence on the impact of leaks in natural gas distribution pipelines on nearby home prices. Using high-resolution geographical data on property transactions in Massachusetts and a difference-in-differences design, we find that gas leaks significantly reduce nearby home prices by 2.61% ($11,700) on average. Our estimations are robust to different buffer lengths of treatment and control groups. Damage to local greenery plays an important role in the negative impact of gas leaks on nearby home prices. The impact is economically and statistically significant for houses with high surrounding tree cover and not significant for houses with low surrounding tree cover. We fail to detect a significant difference in the impact before and after an information shock of a deadly natural gas accident. Our estimated benefits of fixing gas leaks are larger than the average costs per repair reported by utilities in Massachusetts, which supports policymakers and environmental organizations' actions to reduce methane emissions from gas distribution pipelines.

2. Data and Research Approach

We obtained utility-reported, state-wide data on gas leaks from the Massachusetts Department of Public Utilities File Room (Commonwealth of Massachusetts, 2021). We obtained the Zillow's Assessor and Real Estate Database (ZTRAX) from the Zillow Group (Zillow Research, 2020) to observe building attributes and property transactions. To support the mechanism analysis in our study, we utilize the Global Tree Cover (GTC) data (Hansen et al., 2013) to measure tree coverage around the buildings in our sample.

When there is a gas leak close to a house, homebuyers could smell the natural gas because mercaptan is added into the natural gas by utilities. Mercaptan smells like Sulphur, or rotten eggs, and helps residents identify gas leaks easily. Even though some consumers may not smell the gas, they could notice the dead trees or other plants killed by nearby gas leaks. Using high resolution spatial data, we apply the Difference in Differences (DID) method to estimate the impact of gas leaks on nearby house sales prices based on a repeated-sales sample. The treatment group consists of houses with a nearby gas leak. According to the ZTRAX database, the lot size of a typical house in areas with gas leaks in MA is about 1,200 square meters, which equals to the area of a circle with a radius of 20 meters. In our baseline analysis, we define the "nearby gas leaks" as leaks within 20 meters of houses and assume that home prices can only be influenced by "nearby gas leaks". For each leak, we apply a matching algorithm based on longitudes and latitudes to find all the residential buildings within 20 meters of the leak. Then, in our baseline analysis, the house closest to the leak enters the treatment group. Houses within 20 meters to 500 meters of the leak are chosen to be the control group. The treated houses were sold at least once before the occurrence of a gas leak and once within the occurrence of a gas leak. The control houses were also sold at least twice during a similar time window of treated houses. We applied a two-way fixed effects (generalized DID) model by regressing the log of home prices on treatment dummy, building age, individual fixed effects, and time fixed effects.

Under this baseline specification, we make an assumption that the prices of houses that are 20 meters away from the leak are not influenced by the leak. To test this important assumption and relieve the concerns about choosing group buffer lengths, we conduct additional robustness checks by altering the boundaries of the treatment and control groups. Results show that our estimations are robust to changing treatment and control group buffers.

3. Baseline results

We find that the gas leaks, including all the grades, reduce the nearby houses' prices by 2.61% (or $11,700) on average, and the result is statistically significant at a 10% level. Grade 2 leaks significantly reduce home prices by about 11%. Grade 3 leaks only decrease the home prices by 1.97% and this result is not statistically significant. We did not report the results of grade 1 leaks since grade 1 leaks were repaired immediately. One factor determining leak grade is how close a leak is to a building. Closer leaks are more likely to be grade 2 and also more likely to be detected by homebuyers. This could be one reason why grade 2 leaks' impact is much larger than the grade 3 leaks.

Different utilities may have different repair costs. We further estimate the impacts of gas leaks on home prices by different service territories of the three largest utilities (National Grid, Columbia, and Eversources) in MA. All grades of gas leaks in National Grid utility significantly reduce the nearby home prices by 4% at a 5% level. The gas leaks in the other two utilities do not have a significant impact on nearby houses' prices.

4. Mechanism Analysis

Local gas leaks impose four types of costs: methane emissions (and associated climate and air quality impacts), increased gas bills, tree and plant deaths, and potential explosions. The first two channels are unlikely to significantly affect home prices since the impacts of methane emissions are global, and an outside gas leak will not directly increase gas meter readings of a nearby household. Thus, the negative impact of gas leaks on home prices could be explained by two potential mechanisms: (1) Damage to local greenery (e.g., gas leaks kill nearby trees); (2) Potential explosions.

We test the first channel by collecting the Global Tree Cover data (Hansen et al., 2013) to measure local greenery around the buildings in our sample at a 30meters×30meters resolution. After controlling yearly household income, we find that the impact of gas leaks on home prices in communities with low tree cover is close to zero and the impact in communities with high tree cover is negative with both statistical significance and economic significance. This indicates that local greenery plays an important role in the impact of gas leaks on home prices.

To test the second channel, we compare the impacts of gas leaks on home prices before and after the unexpected, deadly Merrimack Valley gas explosions in MA on September 13, 2018. A large amount of media coverage was followed and this exogenous information shock could increase MA residents' perceived risk of gas leaks. After controlling household income and environmental campaigns, we do not find statistically significant evidence of a more negative impact on home prices after the information shock. Consumers' insignificant response could be due to that some homebuyers did not notice the gas leak when buying homes.

5. Conclusion and Implications

We conduct a back-of-envelope analysis to compare the benefits and costs of fixing gas leaks. Based on utility-reported data from the federal Pipeline and Hazardous Materials Safety Administration (Edwards et al., 2021), a total of 17,533 unrepaired leaks were reported in MA at the end of 2018, with an estimated repair cost of $59,260,458. Thus, the average cost per repair is $3,380, which is much smaller than the repairing benefits (measured by impacts on home prices).

This study has broad implications for gas leak repairs and home heating and cooking transitions, especially in cities along the East Coast with aging natural gas infrastructure. MA is a state with significant community engagement and policy action on gas leaks. Recently, MA has passed multiple major pieces of legislation on gas leak reporting and repair. Our results for MA provide evidence on the benefits of reducing gas leaks (through repair, replacement, or transition), which exceed the average cost of repair reported by utilities, contributing to active policy discussions in MA. Our findings can also be useful to other practitioners. Environmental organizations can use the estimated negative effect of gas leaks on home prices (consumers' lower bound of WTP for avoiding the leaks) as references when lobbying legislators and carrying out public campaigns. For homeowners, our results encourage them to report the gas leaks as soon as possible, to prevent economic losses. Our study has important implications for other locations with older natural gas distribution infrastructure (such as Washington, DC, and Philadelphia, PA) where leak and repair data are not publically available.