Overview

Various countries and states have implemented restrictive regulations affecting unconventional hydraulic fracturing activities. Further, this industry brings jobs and incomes that are important political platforms for policy makers (Marchand and Weber, 2017). Consequently, these fracturing activities are controversial. Current literature that investigates fracturing effects on outcomes such as infant birth weight, asthma, and hospitalizations that reflects the public concern that extraction activities have negative externalities associated with them. In this paper, we consider the concern that fracturing activities lead to more carcinogenic radon gas in nearby buildings. We utilize a proprietary dataset from the Pennsylvania Department of Environment Protection (PA DEP) that records the universe of radon readings across the state. Further, we geocode these readings and spatially compare them to well locations from the PA DEP. Our empirical approach allows for continuous treatment (number of wells) that also varies in intensity (distance to wells). Further, our model controls for duration of exposure (time since wells were drilled). This flexibility allows any potential effect of fracturing to vary non-linearly with both the distance between the well and test site and, holding distance constant, the time between drilling and testing. This approach builds on several rigorous studies of localized effects of fracturing (Muehlenbachs et al., 2015; Currie et al., 2017; Hill, 2018).

Our analysis reveals no cause for concern, with precisely estimated zero effect of a nearby well in our main model. Energy firms disproportionately drilled wells in places with higher pre-existing radon levels. This fact, if ignored, makes it appear that wells within two kilometers increase indoor radon levels but wells drilled at least three kilometers away do not. Exploiting variation in the timing of drilling, however, shows that recently-drilled wells and soon-to-be-drilled wells have a similar statistical relationship with radon levels in nearby buildings.

Our paper is organized in the following manner: section 2 provides a background on fracking and radon activities while section 3 details our empirical methods. Section 4 describes our data, section 5 summarizes descriptive statistics, and section 6 discusses our findings. Lastly, section 7 details reproduction difficulty and section 8 concludes.

Methods

In our first specification, we employ an ordinary least squares regression that does not take into account well-siting being correlated with radon levels. We specify this equation to be:

$$\ln(\text{radon}_{it}) = \sum_{d=0}^{19} \beta_d \text{WellsAfter}_{it}[d,d+1] + \mathbf{X}_{it} \gamma + \varepsilon_{it}$$

Where the “WellsAfter$_i$[d,d+1]” variable corresponds to the number of wells that are drilled within 1 km of distance, d, by the day of the radon test. To account for well-siting, we expand on this model to allow another variable, “Wells$_i$[d,d+1]” that controls for the number of wells that are EVER drilled within 1 km of distance, d.

$$\ln(\text{radon}_{it}) = \sum_{d=0}^{19} \alpha_d \text{Wells$_i$}[d,d+1] + \sum_{d=0}^{19} \beta_d \text{WellsAfter$_i$}[d,d+1] + \mathbf{X}_{it} \gamma + \varepsilon_{it}$$

This additional variable allows drilling activity to be correlated with pre-existing radon levels (i.e. that higher level of radon will have higher levels of fracturing throughout our study period). These models do not identify the causal effect of wells, so we continue our analysis by analyzing dynamic effects. The equation we use is:

$$\ln(\text{radon}_{it}) = \sum_{d=2}^{18} \alpha_d \text{Wells$_i$}[d,d+2] + \sum_{d=2}^{18} \beta_d \text{WellsAfter$_i$}[d,d+1] + \sum_{p=-8}^{8} \beta_p \text{Wells$_{it}[0,2]$}^p + \mathbf{X}_{it} \gamma + \varepsilon_{it}$$

FRACKING AND INDOOR RADON: SPURIOUS CORRELATION OR CAUSE FOR CONCERN?

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The additional term, “Wells_{it}^{\beta_{8}[0,2]}”, ranges from $\beta_{8}[0,2]$ to $\beta_{8}[0,2]$. The negative subscripts capture the extent to which drilling occurred in areas with more radon while the positive subscripts reflect the spurious relationship AND any causal effect. Significant differences in the coefficients indicate a short-term causal effect.

In order to properly account for the spatial and temporal variation in our data, we utilize a difference-in-differences (DID) model, however our dynamic specification (equation 3) relies on slight variations of the traditional DID to allow for both continuous treatment and treatment intensity.

**Results**

We find that, in our simplest specification (equation 1), each well drilled within 2 km is associated with a 0.9% increase in radon. This is significant at the 10% level. Our specification that allows for well siting to be correlated with pre-existing radon levels (equation 2), we find that the marginal effects of an additional well are equivalent and not significantly different from 0. Lastly, when estimating the causal relationship between radon and fracking (equation 3), we find that the difference in the coefficients on “Wells_{it}^{\beta_{8}[0,2]}” is not significantly different from 0.

**Conclusions**

We build on and extent the spatially-precise methods of recent studies of localized effects of unconventional oil and gas wells. Our methods fully exploit the rich spatial and temporal data on wells and radon tests. Our estimates provide strong evidence that fracking in Pennsylvania has not affected radon levels in nearby homes. The initial estimate that we present is a result of a common endogeneity problem: buildings with wells within 2 km had higher pre-existing radon levels compared to buildings with wells three or four kilometers away.

**References**


