1. Overview

In order to achieve cost-effective deep decarbonization of the economy, the government should promote the electrification of most fossil fuel-burning applications such as space heating. The primary source of fuel for space heating currently is carbon-emitting natural gas in the U.S.. Deep decarbonization requires both cleaner electricity grid and electrification of space heating. Heat pumps offer a feasible and energy efficient way for the electrification of space heating and have been identified by policy makers as a crucial technology for decarbonization. Despite of the important role of heat pumps, in most U.S. regions the penetration of heat pumps is still low. Policy makers need to adopt effective policy instruments to promote the diffusion of this important decarbonization technology. This study finds a positive price premium brought by heat pumps, which can be useful for the government to apply an informational program to promote the installations of heat-pumps and facilitate electrification to reach deep decarbonization.

A number of studies provide evidence on the price premium of residential properties after installing solar panels (e.g., Hoen et al., 2013; Dastrup et al., 2012). Several other studies look at the capitalization of residential energy efficiency investments into property values and these studies generally examine the impact of energy efficiency rating or green-building labeling (e.g., Walls et al., 2017; Deng at al., 2012), but not on specific types of technologies. This study provides the first empirical evidence of the impact of heat-pump adoption on housing prices based on a nation-wide Zillow panel dataset including over 150 million residential properties in the U.S.

This study has three main research objectives. First, we provide a nation-wide and regional-specific estimations of price premiums resulted from heat pump installations. Second, we examine the heterogeneity of the price premiums by investigating influencing factors. Third, we compare the price premium with estimated installation cost, environmental benefit and bill saving brought by heat pumps.

2. Data and Research Approach

Data: The main data source came from Zillow, a real estate database company. The data includes building characteristics (e.g. heating types) for each house from six assessments conducted from 2016 to 2018, and historical transaction records since 1920 across the U.S.. We can identify the heat pump installations by comparing the difference in heating types between two consecutive assessments. If the heating type in the later assessment is heat pump, then a house installed the heat pump during the time window between the two assessments. Based on the heat pump installation dates, we can then categorize the transaction prices as either pre- or post-treatment prices. The control group consists of the houses using the most common traditional heating system (Electric, Gas, Oil, Coal, etc.) and were sold at least twice during a similar data window. In order to make the sales dates of the control group close to those of the treatment group, we limit the second sales dates of the control group after 2016. After applying our treatment and control group selection criteria, we obtain 14,475 houses in the treatment group and 2,253,510 houses in the control group across the country.

Methods: We use Difference-In-Difference (Two-Way Fixed Effects Model), in conjunction with Coarsen Exact Matching (CEM). We first apply CEM by state level to construct proper control and treatment groups, using a rich set of property characteristics as matching variables (year built, year remodeled, building quality, number of stories, number of rooms, number of bed-rooms, number of bathrooms, building area, land assessed value, pool, and site.
characteristic). Then using the matched control and treatment groups, we run the following DID specification (Two-Way Fixed Effects Model):

\[ Y_{it} = \beta D_{it} + \alpha V_{it} + \eta_i + \sigma_s \theta_t + \mu_t + \epsilon_{it} \]

where \( Y_{it} \) is the sales price of house \( i \) in time \( t \) (day of sample). \( D_{it} \) is the treatment variable, which takes the value one when house \( i \) has installed heat pump systems in time \( t \). \( D_{it} \) takes value one only if house \( i \) is in the treatment group and in the post-treatment period. \( V_{it} \) is a vector of observable time-variant control variables, such as financial factors, monetary policies, demographic features, and the influence of political parties. \( \eta_i \) is the individual property fixed effects, \( \sigma_s \theta_t \) is state-by-year fixed effects, \( \mu_t \) is month-of-year fixed effects, and \( \epsilon_{it} \) is an idiosyncratic error term.

We also adopt multiple machine learning methods including Ridge, Lasso and Bagging Trees as robustness checks.

3. Research Results

Our estimated average treatment effect on the treated is 7.44% nation-wide, meaning a positive price premium brought by heat pumps. We also find that regional personal income and population density exert negative and positive effects on the price premium, respectively. In terms of geographical heterogeneity, we find that the distribution of price premium is severely imbalanced across regions. Pacific and South Atlantic enjoy a highly significant positive price premium (6.4% and 11%), while other regions remain ambiguous, which is consistent with the geographical distribution of estimated net benefits (avoided environmental damage and energy bill saving) of switching to heat pumps with the current electricity grid. More importantly, we find that the price premiun of homes with heat pumps is much larger than the heat-pump installation cost, which could be valuable for homeowners when deciding whether to install heat pumps. A significant positive price premium reduces the consumer risk of not being able to recover their investments when selling their houses.

4. Implications

Our results are valuable for homeowners or house purchasers when deciding whether to install heat pumps or buy a house with a heat pump system. A positive price premium reduces the consumer risk of not being able to recover their investments when selling their houses. It is also useful for policymakers to encourage the heat pump installation through an informational program which provides information about the positive price premium brought by the heat pumps. In addition, our results are useful for local fiscal authorities to calculate the property tax base. Our finding of geographical heterogeneity indicates different implications for investors and policymakers in different regions.

Selected References


