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The value of residential energy efficiency in interior Alaska: A hedonic pricing analysis

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ABSTRACT

Residents of Interior Alaska are faced with a cold climate and relatively high energy prices, which results in high home energy expenditures. Increasing the energy efficiency of the housing stock can help reduce household energy expenditures. Following a spike in oil prices in 2008, legislation was passed, which created the Home Energy Rebate Program. Homeowners participating in the program were eligible to receive up to a $10,000 rebate for preapproved home energy efficiency improvements. This paper examines the effect of the Home Energy Rebate program on the selling prices of single-family residences in the Fairbanks North Star Borough from 2008 through 2015 using a hedonic pricing analysis. The results show that homes that completed the Home Energy Rebate program in the Fairbanks North Star Borough sell for a 15.1–16.5% price premium over similar homes that did not complete the program, which indicates that investments in residential energy efficiency are compensated. This is the first study to examine the impact of energy efficiency on house prices in a market with a subarctic climate.

1. Introduction

Energy inefficient homes are expensive to heat because more energy is required to maintain a comfortable indoor temperature due to heat escaping through the building fabric. Residents of Fairbanks, Alaska have home energy expenditures nearly four times greater than the national average due to the combination of relatively high energy prices, the subarctic climate, and an aging housing stock (AHFC, 2014). Households in cold climates use more energy than households in warmer climates (Sivak, 2013). The disparity in residential energy use can largely be attributed to demand for space heating (Considine, 2000). In Fairbanks, approximately 80% of total residential energy use is dedicated to space heating, compared to the national average of 42% (Alaska Energy Authority, 2012; Energy Information Administration (EIA), 2013). Residential energy efficiency improvements can help reduce home energy costs, but these improvements are often expensive to undertake. For example, the average cost of replacing a boiler for an average-sized home in Fairbanks is nearly $14,000 (Meyer et al., 2011).

The cost associated with residential energy efficiency improvements may serve as a deterrent for some homeowners. Policymakers in Alaska recognized this problem and passed legislation creating the Home Energy Rebate (Rebate) program. The primary policy objective of the program was to reduce residential energy costs by incentivizing homeowners to invest in energy efficiency improvements. The program provided participating homeowners with up to a $10,000 rebate for preapproved energy efficiency improvements.

In addition to reducing home energy expenditures, energy efficiency improvements may increase the selling price of a home. A potential buyer in the market for a home should be willing to pay an energy efficiency premium either equal to or less than the present value of the expected energy savings over the buyer's anticipated tenure in the home. Prior studies have found a positive relationship between the energy efficiency of a property and its transaction price (Laquatra et al., 2002; Nevin and Watson, 1998).

This study is the first to estimate the impact of the Rebate program on house prices in Alaska, and also the first study on whether energy efficiency measures are capitalized into house prices in a market with a subarctic climate. Drawing on transactions data from 2008 to 2015, the effect of the Rebate program on transaction prices of single-family homes the Fairbanks North Star Borough (Fairbanks) is assessed using the hedonic pricing framework. Identifying properties that participated in the Rebate program provides an opportunity to investigate the impact of energy efficiency improvements on home prices in Fairbanks. Although the specific energy efficiency measures undertaken by

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program participants are not known,[1] all Rebate program participants completed energy efficiency retrofits. While this study is specifically about the price premium resulting from participation in the Rebate program, these results may be more generally applicable to all residential properties that have received energy efficiency retrofits within Fairbanks. The use of a hedonic model allows for the estimation of the marginal price for energy efficiency improvements to be isolated.

The remainder of the paper is structured as follows: Section 2 reviews the previous literature. Section 3 provides background information on the study area, the impact of the oil price spike of 2008 and the Rebate program. The methods and regression model are described in Section 4. Section 5 describes the data used in the analysis, followed by the results in Section 6. The conclusion and policy implications are covered in Section 7.

2. Literature review

The energy crisis of the 1970s served as a catalyst for studies on residential energy conservation and energy efficiency. As energy prices rapidly increased, many scholars focused on the energy consumption behavior and psychology of the residential sector. Seaver and Patterson (1976), Seligman and Darley (1977), and Becker (1978) investigate the impact of feedback on residential energy consumption. Yates and Aronson (1983) argue that the social psychological aspect of residential energy conservation should be considered when designing public policy. Blumstein et al. (1980) explore the social and institutional barriers to energy conservation.

Sharp increases in fuel prices may push households into fuel poverty. A household is considered to be in fuel poverty if it spends more than 10% of its income on energy services, which include energy for space heating, electricity, domestic hot water, and cooking (Boardman, 1991). An alternative definition of fuel poverty states a household is in fuel poverty if it cannot afford adequate warmth (Bradshaw and Hutton, 1983). Fuel poverty is the result of low incomes, high fuel prices, and an energy-inefficient housing stock (Boardman, 2010). Negative health outcomes associated with fuel poverty include excess winter deaths and morbidity from illnesses that are exacerbated by the cold such as heart attacks, strokes, and respiratory diseases (Boardman, 2010). Residential energy efficiency programs can help reduce rates of fuel poverty because increasing the energy efficiency of home requires homeowners to purchase less fuel to keep the home at a comfortable temperature.

In response to the energy crisis, various retrofit programs aimed at reducing household energy consumption were implemented across the United States. As these programs became more popular, concern grew over whether they actually delivered energy savings. Two early studies on this subject include Sebold and Fox (1985), who were concerned that the standard approach for estimating the energy savings of conservation measures was inadequate and Hirst (1986), who measured the actual energy savings in electrically-heated homes in the Pacific Northwest after they were retrofitted through a utility-sponsored weatherization program. More recently, Fowlie et al. (2015) investigated the energy savings resulting from Weatherization Assistance Program retrofits in Michigan. The authors find that upfront investment costs are more than double the energy savings. One explanation for actual energy savings falling short of predicted energy savings is the rebound effect, which occurs when a households increase their energy consumption in response to the lower unit cost of energy resulting from an increase in energy efficiency (Greening et al., 2000; Gillingham et al., 2009). However, studies indicate that the rebound effect is not very large and is often overstated (Gillingham et al., 2013, 2016). The discrepancy between predicted and realized fuel savings is more likely due to engineering models overestimating energy savings (Fowlie et al., 2015).

Growing concern about carbon emissions and global climate change have rekindled interest in energy efficiency and sustainable real estate. Dinan and Miranowski (1989) conducted one of the earliest studies examining the effect of energy efficiency on residential property sale prices using the hedonic regression analysis framework. They find that fuel savings resulting from energy efficiency improvements were capitalized into housing values in Des Moines, Iowa. The creation of various energy efficiency certifications have made it easier to study the relationship between energy efficiency and property prices. These certifications include the Energy Star and LEED certification programs in the United States, energy performance certificates (EPCs) in European markets, and Green Mark certification in Singapore. Studies on both commercial and residential property markets show a positive relationship between energy efficiency certifications and property sale and rent prices (Wiley et al., 2010; Eichholtz et al., 2010; Addae-Dapaah and Chieh, 2011; Fuerst and McCallister, 2011; Deng et al., 2012; Reichardt et al., 2012; Bond and Devine, 2016; Bruegge et al., 2016; Chegut et al., 2016; de Ayala et al., 2016; Walls et al., 2017).

The studies of greatest relevance to this research are those exploring the relationship between residential energy efficiency and home prices in other cold climate regions, most of which focus on Scandinavian housing markets. Cerin et al. (2014) examine the impact of EPCs on property prices in Sweden and find that a 1% increase in the energy performance of a property was associated with a modest 0.06% increase in the transaction price of the property. Using home sales in Stockholm, Sweden, Mandell and Wilhelmsson (2011) find that homebuyers have a positive willingness to pay for home attributes that reduce energy and water consumption. Harjunen and Liski (2014) find that homebuyers in the Finnish cities of Helsinki, Espoo, and Vantaa are willing to pay a 6% premium for district heating[2] over electric heating. The price premium is very similar to the capitalized energy savings resulting from the use of district heating over electric heating. Also examining Finland, Fuerst et al. (2016) find that apartments in Helsinki with the highest three energy ratings are associated with a price premium of 3.3%. However, when detailed neighborhood characteristics are included in the model specification, the premium drops to 1.5%. Like the broader literature, these cold climate studies indicate that homebuyers are willing to pay a price premium for energy efficient properties.

3. Background

3.1. Study area

The Fairbanks North Star Borough (Fairbanks), which is located in the Interior region of Alaska, is the study area. The borough has a land area of over 18,900 square kilometers (7300 square miles) and a population of approximately 98,000 residents (U.S. Census Bureau, 2015). The City of Fairbanks is the largest city in the borough with approximately 32,000 residents. Fairbanks has a subarctic climate characterized by long, cold winters, which typically last from mid-October to mid-April, and short, warm summers. The city has an average annual temperature of −2.4 °C (27.7° F) (Alaska Climate Research Center (ACRC), 2016). It is not uncommon for the temperature to fall to −40 °C (-40° F) during the winter months. Fairbanks is located approximately 320 km (200 miles) south of the Arctic Circle at latitude 64.8 degrees north. The high latitude of the city results in extreme fluctuations in daylight hours across the seasons. On the summer solstice, Fairbanks receives nearly 22 h of sunlight, while on the winter

[1] The data provided by the Cold Climate Housing Research Center did not state the specific energy efficiency improvements made by Rebate program participants.

[2] District heating is defined as, “the distribution of heat by steam or otherwise from a central plant to buildings more or less widely distributed” (Merriam-Webster, 2017).