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Factors influencing German house owners' preferences on energy retrofits

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HIGHLIGHTS

- Survey data of 400 owner-occupiers from Germany is analyzed.
- Drivers and barriers for the adoption of building energy retrofits are identified.
- Descriptive and econometric results underline the importance of economic factors.
- The simulated incentive effect of expert recommendations is notable in magnitude.
- Professional energy advice thus may help to stimulate energy retrofit activities.

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ABSTRACT

In this paper, we identify key drivers and barriers for the adoption of building energy retrofits in Germany, which is promoted by public policy as an important measure to address the future challenges of climate change and energy security. We analyze data from a 2009 survey of more than 400 owner-occupiers of single-family detached, semidetached, and row houses in Germany, that was conducted as a computer-assisted personal interview (CAPI). In the survey, respondents were asked directly for reasons for and against retrofitting their homes, but also faced a choice experiment involving different energy retrofit measures. Overall, we find that house owners who are able to afford it financially, for whom it is profitable, and for whom there is a favorable opportunity are more likely to undertake energy retrofit activities. The latter point seems to be of particular importance in explaining the persistent low retrofit rate in Germany. Our results suggest that professional energy advice could stimulate the demand for building energy retrofits.

1. Introduction

Driven by the high energy demand for electricity, heating, and cooling, the building sector is a major consumer of fossil fuels and a major emitter of greenhouse gases (IEA, 2011). This holds particularly true for industrialized countries such as Germany, where, for example, almost one-third of total energy supply is consumed in residential buildings, primarily for space and water heating. From a purely engineering perspective, the potential to reduce both Germany's fossil fuel use and greenhouse gas emissions by replacing old heating equipment and improving thermal insulation of the existing building stock is considerable. Between 1989 and 2006 less than 30% of all possible energy-efficient renovations were implemented in Germany's residential buildings built between 1900 and 1979 (BMVBS, 2007). And in spite of the increasing importance of renewable energy sources, almost every second residential heating system in Germany is fueled by natural gas, while approximately another three in ten use fuel oil (BMVBS, 2007). The German government seeks to exploit this potential in order to achieve its climate protection goals and to secure future energy supply. In addition to regulations that specify energy efficiency requirements for existing buildings being renovated or reconstructed, such as the Energy Savings Ordinance (EnEV), there are public funding programs in place that provide grants and low-interest loans for energy retrofitting activities. However, the political success in terms of raising the retrofit rate has been rather limited so far. This indicates that economic, technical, and behavioral factors influencing retrofit decisions are still not well understood and not properly addressed by current policy design.

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In this paper, we analyze data from a 2009 survey of German house owners both descriptively and econometrically. The aim is to learn more about reasons and motivations that encourage house owners to carry out building energy retrofits as well as on barriers against such investments. The survey data include responses to a choice experiment involving energy retrofits for existing houses. We analyze them by using both standard and mixed logit regression of choice outcome on experimental attributes as well as individual and building characteristics. Based on the estimated mixed logit (error component) model, we simulate the incentive effects of different policy options, such as public subsidies for such measures and energy tax increases.

This paper, therefore, contributes to the existing literature on preferences for energy-saving measures in residential buildings. An early study by Cameron (1985) using individual household data from the U.S. focused on energy retrofits such as insulation and storm windows. Through simulations based on a fitted nested logit model, she found the demand for retrofits to be responsive to retrofit costs, relative energy prices, and income. More recently, some studies provided empirical evidence for Switzerland (Alberini et al., 2013; Banfi et al., 2008; Jakob, 2006, 2007). Jakob (2007) undertook a comprehensive analysis of drivers and barriers to retrofit decisions of single-family house owners using survey data. He found that energy-efficient renovations are driven to a large extent by technical (e.g. lifetime of façade or roof) and occasional factors (e.g. building or roof space extensions), rather than income, age, or education. Banfi et al. (2008) conducted a choice experiment with Swiss apartment tenants and house owners in order to study the willingness-to-pay (WTP) for energy-saving measures. In the experiment, respondents could choose between their actual situation and a hypothetical alternative differing in the level of insulation of windows and façade, the presence of a ventilation system, and the price (monthly rent for apartments, purchase price for houses). The obtained WTP estimates are relatively high, but do not differentiate between the various kinds of benefits of the considered energy-saving measures (i.e. cost savings, increases in comfort, and environmental benefits). However, in contrast to our study presented here, Banfi et al. (2008) did not include any socioeconomic variables in their final binary logit model, while the multinomial logit model used by Jakob (2007) lacks detailed information on the renovation alternatives themselves. The study that is most closely related to ours is that by Alberini et al. (2013), who surveyed Swiss owner-occupiers of single-family, semidetached, and row houses that had not been renovated since 1996. The choice sets used in their choice experiment contained two unlabeled energy retrofit alternatives and the status quo. They found those respondents who expect significant increases in oil prices and those who consider climate change as an important reason for doing retrofits to be less likely to opt for the status-quo alternative. Socioeconomic variables, however, had no significant effect on respondents' choices.

Other studies concerning preferences for retrofit measures are available for Canada (Sadler, 2003), the Netherlands (Poortinga et al., 2003), South Korea (Kwak et al., 2010), and Sweden (Nair et al., 2010). And there are also a few German studies on this topic, mainly concerned with WTP (Achtnicht, 2011; Grösche and Vance, 2009). Using both standard and mixed logit specifications, Grösche and Vance (2009) analyzed revealed preference data from a sample of single-family house owners, and estimated the households' WTP per kWh saved. However, the costs and energy savings associated with the respective retrofit measure (i.e. roof insulation, façade insulation, windows replacement, heating equipment replacement, and combinations thereof) had not been directly observed, but rather had to be estimated by the authors. Therefore, engineering calculations as well as information on regional wages and material costs were employed. Achtnicht (2011) was the first to explicitly include environmental benefits of building energy retrofits in a choice experiment study. Respondents had to choose between a heating and an insulation solution for their home, where resulting CO_2 savings were one distinguishing feature. In that choice context, Achtnicht studied the effect of CO_2 savings and found it to differ by retrofit option. His results suggest that German house owners have a positive WTP for reducing CO_2 emissions only if the reduction comes from changing the heating system.

The present paper is a continuation of Achtnicht (2011). It uses choice data from the same survey, but the underlying choice sets are expanded by the option of staying with the status quo (using responses to a follow-up question after each choice scenario). By taking the status-quo option into account, we are able to address further research questions. Instead of asking what makes one energy-saving measure preferable to another, we can now identify key drivers and barriers for their adoption—to retrofit, or not to retrofit, that is the question, so to speak. Hence, this study is distinct from research that investigates the mere choice between competing energy-saving measures. Also, by involving thermal insulation measures, it differs from the related strand of literature that solely focuses on preferences on residential heating systems (see Michelsen and Madlener, 2012, 2013, for recent contributions and references).

The remainder of the paper is structured as follows. Section 2 describes the survey data (2.1) and gives a brief theoretical background on the discrete choice models used for the analysis (2.2). The empirical results are presented in Section 3, with the findings from the descriptive statistical analysis discussed in Section 3.1, the parameter estimates in Section 3.2, and the simulation results in Section 3.3. The final Section 4 concludes and discusses some implications of our findings.

2. Data and methods

2.1. Survey design and sample

The data set analyzed in this paper consists of survey responses of more than 400 owner-occupiers of single-family detached, semidetached, and row houses in Germany;[1] it represents a subsample of a representative survey of German households undertaken in June 2009. The survey was carried out by the market research company GfK in two stages: after recruiting individuals with telephone interviews, they were visited at their homes for computer-assisted face-to-face interviews (CAPI method). During the telephone screening, the individuals had been explicitly asked whether they are involved in the household's energy-related decisions, such as the choice of electricity supplier or heating technology. Only those who affirmed such an involvement were finally recruited and interviewed. The interviews took about 50–60 min on average, and made use of a structured questionnaire. This contained mostly closed questions about attitudes towards the environment, the household's energy use, housing conditions, socioeconomics, and demographics, as well as an energy-related choice experiment.

The choice experiment, the centerpiece of the survey, involved hypothetical building energy retrofits. Respondents could either choose a modern heating system or an improved thermal insulation for their house. Note that neither the concrete energy source for the heating measure nor the part of the house for the insulation measure was specified in the experiment. Instead, respondents were asked to imagine the technology option they would like to have for

[1] In the following, we will refer to them briefly as house owners or respondents. Note that the considered house types account for 59% of the total residential living space and 48% of the residential units in Germany (IWU, 2011).

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