HOUSEHOLD WILLINGNESS-TO-PAY FOR ENERGY SAVINGS AND THE ROLE OF RETROFIT GRANTS

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Overview

In our research, we explore home retrofits as a strategic method for households to lower energy expenses through improved efficiency. The significance of energy efficiency in residential areas goes beyond mere cost savings; it also reduces reliance on fossil fuels, thereby enhancing energy security and protecting the environment. In Slovenia, similar to other developed countries, the residential sector consumes a substantial amount of energy, mainly for space heating and hot water. Therefore, upgrading insulation and heating systems in existing buildings is essential for reducing national energy consumption.

Over the past two decades, the Slovenian government has actively supported these retrofit activities through financial incentives, such as low-interest loans and grants, with a notable program initiated in 2008. A critical aspect of evaluating the effectiveness of these policies is understanding homeowners' Willingness to Pay (WTP) for energy savings from retrofitting. This analysis is vital for assessing the extent of free-rider effects, where households undertake energy-saving measures they would have implemented regardless of subsidies, a concept thoroughly discussed by Train (1994). Despite the importance of evaluating publicly funded programs, there has been limited examination of WTP estimates for energy savings and their implications for free ridership. Previous studies suggest that the proportion of free riders in residential energy efficiency programs varies widely, ranging from 40% to 96% (Grösche & Vance, 2009; Nauleau, 2014; Collins & Curtis, 2019).

Our study has two main objectives: first, to identify the factors influencing home retrofits and estimate the marginal WTP for energy savings; second, to assess the impact of free-rider effects on the social benefits of the subsidy program. This study utilizes a unique dataset of over 10,000 Slovenian households surveyed in 2010, 2014, and 2019, which includes actual investment costs for four retrofit measures, estimates of the resulting energy savings, and detailed data on building characteristics and households' sociodemographic profiles. In our study, the observed retrofit costs represent the actual expenses incurred by households for their chosen retrofit options, as recorded in the administrative dataset. For other options, the costs are estimated, differing from the approach of using attribute levels from a choice experiment as seen in some other studies (Grösche & Vance, 2009; Olsthoorn et al., 2017). Our dataset covers four energy-saving retrofit measures: façade insulation, replacement of traditional heating systems, replacement of windows and doors, and installation of heat pumps.

Methods

In our study, we applied random utility theory to investigate Slovenian households' WTP in energy conservation. This theory effectively predicts choices by comparing the benefits of different retrofitting options. To enhance our analysis, we combined actual data on households' energy efficiency actions with hypothetical scenarios of potential retrofit choices. This approach builds on Cameron's (1985) model, which examined household behaviour regarding energy efficiency retrofits using a nested logit model to evaluate the effectiveness of financial incentives for retrofitting. Our dataset includes real survey data on retrofit investments made by households and simulated data representing various available retrofit options. This simulated data approximates what homeowners might estimate from consultations or available retrofit guides.

We utilized a conditional logit model , carefully chosen for its effectiveness in analysing various factors that influence retrofit decisions, such as cost, potential energy savings, building features, and socio-demographic elements. The goal is to gain a comprehensive understanding of household behaviours concerning energy conservation and to assess the impact of subsidization policies. In our research, households were presented with a choice among sixteen retrofit options, representing all possible combinations of four retrofit measures, including the option not to retrofit at all. For each option, we modelled the likelihood of a household selecting a given alternative, considering the attributes of each option that contribute to the household's utility. We calculated the average marginal willingness-to-pay for households that undertook a retrofit, which was then multiplied by the quantified energy efficiency improvement (in kWh/year) of that retrofit. Additionally, we identified the extent of free-riding based on a comparison between a household's WTP and the total costs of retrofit, following the methodology outlined in Collins & Curtis (2019).

Preliminary results

As expected, factors such as costs and estimated energy efficiency improvements significantly influenced retrofit decisions in conditional logit model. Investment costs had a negative impact on the likelihood of choosing a retrofit, while the anticipated energy savings positively influenced this choice. Additionally, interaction effects related to building and household characteristics (such as building type, floor area, age, income, energy expenditures, and past retrofit activities) showed the expected effects. The preliminary results suggest that preference heterogeneity regarding the expected costs and energy efficiency improvements is minimal. Consequently, when calculating WTP using fixed effect coefficients, the conditional logit model provided consistent results.

Further examination of the coefficient estimates revealed notable variations in preferences based on different household characteristics. Generally, higher costs reduced the probability of selecting a retrofit. However, households with previous retrofit experience were less deterred by higher costs compared to those retrofitting for the first time. In contrast, households with higher incomes, those living in older buildings, and those with higher energy expenditures showed a greater inclination towards more expensive options (typically involving more retrofit measures). Moreover, higher expected energy savings were positively correlated with single-family homes, larger floor areas, and previous retrofitting, and negatively correlated with the age of the building, aligning with expectations.

The preliminary results show households are willing to pay on average €0.354 per kWh per year. However, this willingness varies significantly between income groups. Households in the lowest income group are willing to pay €0.253 per kWh per year, while those in the highest income group are willing to pay €0.496 per kWh per year. This indicates that higher-income households are more willing to invest in energy renovations. The study also explores the concept of free-riding, which refers to the percentage of households whose WTP exceeds the actual costs of renovation. On average, the free-riding share is 33.5%. Interestingly, there is a positive correlation between income and the free-riding share. In the lowest income group, the free-riding share is 22.7%, whereas in the highest income group, it rises to 37.1%. This suggests that higher-income households are more likely to benefit from renovations without bearing the full cost.

Furthermore, the research highlights significant differences in both WTP and the free-riding share across various renovation options. For instance, the free-riding share for facade insulation investments is 12.7%, while it is much higher at 50.8% for the replacement of traditional heating systems. The replacement of windows and/or doors has a free-riding share of 8.3%, and investing in a heat pump has a free-riding share of 35.9%. These variations indicate that the type of renovation significantly impacts households' WTP and the extent of free-riding.

Conclusions

The Slovenian grant scheme, initiated in 2008, aims to reduce energy consumption and enhance energy efficiency in residential buildings. This study assesses households' WTP (i.e., willingness to invest) in these improvements and examines the extent of free-riding, which refers to retrofits that would have been carried out even without the grants. Such analysis is crucial for evaluating the cost-effectiveness of the grant scheme. The findings indicate that households with higher incomes not only demonstrate a greater WTP compared to those with lower incomes but also show a slightly higher rate of free-riding. The WTP results are somewhat consistent with previous studies, although they are higher than those reported by Collins & Curtis (2019) at €0.127 per kWh/year but lower than those by Grösche & Vance (2009) at €1.97 per kWh/year. The observed free-riding rate of 33.5% aligns with international findings, as highlighted by studies such as Alberini et al. (2014), Grösche & Vance (2009), Nauleau (2014), and Olsthoorn et al. (2017).

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