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Energy Efficiency in Spanish Households

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Motivation

- Residential and commercial building sectors account for 20-40% of final energy consumption, and the stock of buildings will continue growing due to emerging countries.
- Energy demand could be reduced by implementing energy efficiency (EE) measures and with an energy-responsible behavior.
- However, multiple barriers prevent the application of these measures.
- Governments are implementing policies to promote energy efficiency in residential buildings.

Research question

- Understand what factors make Spanish households invest and behave in an energy efficiency way.
- Identify possible barriers for EE in the Spanish residential market with the purpose of policy design.
- Contribute to the current literature with the Spanish case.

Literature Review

| Paper | Country/State | Data | Explanatory var. | Method | Results |
|-----------------------------|---------------|---|---|---|--|
| Brechling and Smith (1992) | UK | 1986 English House Condition Survey | Loft and Wall insulation and double glazing | Logit | Income small effect. Other household's variables not effects. |
| Levinson and Niemann (2004) | US | Residential Energy Consumption Survey and the American Housing Survey | Heating temperature settings | OLS and selection probit | Elderly and the number of members have positive effect and HDD negative. |
| Davis (2010) | US | 2005, Residential Energy Consumption Survey | EE appliances and lighting | Linear probability model | Principal/agent problem |
| Maruejols and Young (2011) | Canada | 2003, Survey of Household Energy Use | Water savings, incandescent bulbs or heating temp. | Pooled and selection models and probit. | Income small effect of heating temp. but high effect for eco-friendly behavior. Structural char. Of the house are important. |
| Brounen et al., (2012) | Netherlands | 2011, Dutch National Bank Household Survey | Energy consumption awareness and temperatures. | OLS and logit | Income and age positive effect on heating temp. and pro-environmental attitude only for awareness of consumption. |
| Gillingham et al., (2012) | California | 2003, California Statewide Residential Appliance Saturation Study. | Heating and cooling temp. and insulation | Ordered probit and probit | Principal/agent problem, HDD and size negative effects. |

Data

- *'Encuesta Social: Hogares y Medio Ambiente, 2008'*. Unfortunately, this is a unique-year representative survey by the Spanish National Institute of Statistics.
- 26.689 households from the whole territory were interviewed.
- This survey provides data on households' characteristics, installed technologies, type of fuel, type of heating system, as well as, certain environmental behaviors.

Data

A major limitation of our data is the lack of information relative to the **ownership** of the house, the **age** of the house and the **energy consumption**.

- The first makes impossible the analysis of principal/agent problem. However, given the high ratio of ownership in Spain (for 2008, 82.2% of population was owner-occupied) we could consider the size of this limitation small.
- Unfortunately, we do not have data on the age and energy consumption of households what make us take this into account when interpreting the results, and consider matches with other data sources to complement the research in the future.

Summary of the Data

Main households' characteristics:

| Variable | Measurement | Obs. | Mean | s.d |
|-------------------|-------------------|-------|----------|--------|
| Prof. situation | Three-point-scale | 26031 | 1.78 | 0.88 |
| Education | Nine-point-scale | 26027 | 4.47 | 2.24 |
| #members | Number | 26031 | 2.67 | 1.25 |
| #members<16 | Number | 26031 | 0.38 | 0.73 |
| #members>65 | Number | 26031 | 0.47 | 0.72 |
| Income | Nine-point-scale | 26031 | 3.55 | 2.95 |
| Municipality size | Five-point-scale | 26031 | 2.77 | 1.64 |
| HDD | °C day | 25490 | 1727.418 | 468.30 |

Model and Results: EE investment

- The EE investments we consider are: **efficient appliances** (those with A or A+ label), **low consumption bulbs** and **double glazing**.
- We use logit models where the dependent variable is the probability of having installed one of the above measures.
- Moreover, we control for the type of fuel, the number of appliances and other variables as the size of the municipality.
- For the study of EE appliances, we follow Davis (2010) and reduce the sample to households who bought the appliances during the last 5 years.

Model and Results: EE investment

* means not significant for all specifications of the model

| Model | Logit | | | | Logit | Logit |
|---|--|--------------------|------|------------|-----------------------------|-------------------------------|
| | Appliances (bought in the last 5 years) | | | | Low consumption bulbs | double glazing |
| | Fridge | Washing machine | Oven | Dishwasher | | |
| prof. Situation (retired and unemployed) | - (retired) | . | . | . | - (unemployed) | - (unemployed and retired) |
| Educational level | . | +* | +* | . | + | + |
| #member>65 | . | - | -* | . | - | - |
| Income | + | +* | + | + | + | + |
| Environmental attitude | - | . | . | . | + | +* |
| Having the rest of the major appliances efficient | + | + | + | + | | |
| Have heating | | | | | | + |
| Have A/C | | | | | | + |
| Heating in most of the rooms | | | | | | + |
| Months using heating | | | | | | + |

+(-): means positive (negative) effect of the explanatory variable on the probability of success.

Model and Results: EE behavior

- Since heating is the largest share of residential energy use, we take temperature of the heating to study if households have EE behavior.
- We use ordered logit models controlling for the most important variables.
- Following Gillingham et al., 2012, and given the large temperature differences across Spanish regions, we compare our results using the full sample, with those resulting from a restricted sample, where warmer regions and households who use the heating less than 1 month per year are excluded.

Model and Results: EE behavior

*means it is not significant for the most restrictive samples

| model | Ordered Logit |
|--|---|
| | Heating temperature °C |
| Prof. Situation (retired and unemployed) | . |
| Educational level | . |
| #members | . |
| #children<16 | . |
| #member>65 | + |
| Income | + |
| Environmental attitude | - |
| HDD | - |
| type of fuel | - (wood, NG*, Liquid fuel*) |
| Type and fuel of heating system | - (gas and electric systems) + (heat pumps*) |
| Heating in most of the rooms | - * |

+(-): means positive (negative) effect of the explanatory variable on the probability of success.

Conclusions

- We contribute to the growing literature on EE with results for Spanish households.
- Regardless the lack of important data, most of our results coincide with previous literature.
- Results suggest that higher income levels are more likely to invest in EE but are less energy-responsible.
- The structure of the households matters for investment and behavior, while environmental attitude seems not to be always translated in EE investment.

Conclusions

- We coincide with those studies that have identified negative effects of HDD on the indoor temperature, meaning that colder regions set lower temperatures, probably associated with higher marginal costs.

Thank you for attention!



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