HOW CAN WE UNTAP THE ENERGY SAVING POTENTIAL OF HOUSEHOLDS?

INSIGHTS FROM HOUSEHOLD PREFERENCES FOR ALTERNATIVE MEASURES

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CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Introduction

- The EU has committed to reduce **greenhouse gas emissions by at least 55% by 2030,** compared to 1990 levels
- The EU will have **to increase the share of renewable** energy mix and **to reduce overall consumption *via* energy efficiency and savings**
- The **household sector** plays a crucial role, given that it is responsible for **17.1% of Spanish final energy consumption**
- Main areas of households energy consumption: **heating, lighting or the use of appliances** and that related to **transport** by any means
- Household energy savings by improving **energy efficiency** or by **behavioural changes** in energy use

Objective & Methodology

- The paper investigates **households' preferences for different energy saving measures** related to both **energy efficiency** and **behavioural changes**
- We use a **stated preference approach** to investigate **household preferences for alternative energy saving measures**
- **Data** coming from an **online survey** carried out by a **market research firm** in **February 2020** for a representative **sample of 401 households in Aragon**
- Two types of behaviours were identified from the literature review:
  - investments in energy efficient devices and home insulation
  - energy saving measures in everyday life

Objective & Methodology (2)

Table 1: Definition of households energy-saving measures

ABBREVIATION	DEFINITION
Windows & doors	Replacing **windows and doors** with more insulating ones
Energy-efficient appliances	Installing more **energy-efficient appliances** (A+++ rating)
Temperature at home	Keep **temperature** at home at the recommended levels in all seasons
Turning off devices	**Turning off** lights and electronic **devices** when not in use.
Replacing light bulbs	**Replacing** traditional **light bulbs** with more energy-saving LEDs
Washer appliances	Using **washer appliances** (dishwasher, laundry...) full & in ECO program
Refrigerators & freezers	Temperature regulation in **refrigerators and freezers**

Objective & Methodology (3)

- The analysis was done through the **Best Worst Method** (BWM) trying to obtain the **relative importance** that individuals assign to energy efficient and saving energy measures
- Respondents are asked to **choose the best and the worst** measures in a series of questions that contain a combination of the seven measures

Table 2: **Example** of a Best-Worst question

The most important		The least important
	Replacing **windows and doors** with more insulating ones Keep the **temperature at home** at the recommended levels in winter and summer **Replacing** traditional **light bulbs** with more efficient and energy-saving LEDs	

Objective & Methodology (4)

- To understand the heterogeneity of individuals, the Random Parameter Logit model (RPL) and the latent class modelling (LCM) were considered
- The LCM was selected because preferences are not unique to each individual and are different across classes
- Individuals' preferences are homogeneous within each class, but vary among classes

Results

Table 3 reports characteristics of **sample** and Aragon population. The sample is close to **Aragon** and to Spanish population, implying that the results are able to be inferred to **Spanish population**

Table 3. Socioeconomic variables of the sample (401, Aragon and Spanish population

Variable	Definition	Sample	Aragon	Spain
Gender	Men (dummy) (%)	49.4	49.3	49
Age (sample average)	Age (continuous)	46.4	44.8	43.9
Household size (average)	Number of people	2.8	2.4	2.5
Net monthly personal income	Income (above sample average, %)	37.9	n.a.	n.a.
Highest level of education achieved	Primary studies (%)	13.2	25.2	25.5
	Secondary studies (%)	63.3	46.1	46.3
	University degree (%)	23.4	28.7	28.1

Results (2)

Table 4. Statistical indicators for determining the optimal number of individuals' classes

Classes	Parameters (P)	Log Likelihood at convergence (LL)	AIC[a]	AIC3[b]	BIC[c]	ρ**2[d]	Negentropy statistic[e]
1	6	-4,851.58	9,715.17	9,721.17	4,859.39	0.031	-
2	12	-4,728.74	9,481.47	9,493.47	4,744.36	0.054	0.623
3	**18**	**-4,663.91**	**9,363.82**	**9,381.82**	**4,687.34**	**0.066**	**0.689**
4	24	-4,608.01	9,264.03	9,288.03	4,639.25	0.076	0.72

Notes: [a] Log-likelihood at convergence; [b] Akaike information criterion; [c] Bozdogan Akaike information criterion; [d] Bayesian information criterion; [e]Akaike likelihood ratio index.

- LL, AIC, AIC3, and BIC decreased sharply in the first three classs and then stabilize
- the $\bar{\rho}^2$ increased up to the 3 classes specification and less when considering 4
- The Negentropy statistic reached a high value with the 3-class model, indicating an important separation between classes
- Compared to the 3-class model, the4-class model did not provide additional insights regarding the profiles between classes, therefore we focus our analysis on this model

Results (3)

Table 5. Estimated parameters for electricity saving actions in households - LCM				
		Latent classes		
Energy-saving actions	*One segment model*	*High potential energy savers*	*Convenience seekers*	*Financially constrained*
Windows & doors	0.730 (14.76)***	2.330 (8.95)***	0.966 (4.85)***	0.009 (0.06)
Energy efficient appliances	0.711 (14.41)***	1.050 (6.09)***	1.173 (5.66)***	0.470 (4.28)***
Temperature at home	0.707 (14.32)***	1.512 (6.66)***	0.700 (3.80)***	0.425 (4.88)***
Turning off devices	0.505 (10.37)***	0.927 (5.41)***	- 0.644 (-2.62)***	0.892 (7.87)***
Replacing light bulbs	0.408 (8.40)***	0.801 (4.04) ***	- 0.273 (-1.64)	0.594 (5.22)***
Washer appliances	0.384 (7.90)***	0.310 (2.14)**	0.901 (4.48)***	0.261 (3.18)***
Flat (%)*	79.3	85.3	73	78.9
Dwell ownership (%)*	78.3	76.7	87	74.6
Age (average)	46.4	46.0[a]	49.9[b]	44.8[a]
Male (%)**	49.4	51.7	59	42.7
University degree (%)*	23.4	33.6	21	18.4
Class size	*100%*	*29.5% (6.12)****	*24.9% (5.02)****	*45.7% (8,92)****

Results (4)

- The **one segment model** (100% of the sample):

  - ✓ All estimated parameters were positive and statistically different from zero at the 1% significance level.
  - ✓ All energy saving measures were positively rated compared to the *regulation refrigerators and freezers,* the benchmark measure and the least valued one
  - ✓ Most valued were those that entailed some economic expenditure : *windows & doors*, *energy efficient appliances and temperature at home*
  - ✓ Less preferred measures were related to electricity use behaviour, such as *turning off devices*, followed by *replacing light bulbs* and *washer appliances*
  - ✓ All those measures had very different estimated parameters, meaning that individuals expressed different preferences for them

Results (5)

- **The High potential energy savers:**

  - ✓ With the 29.5% of the sample, this class is characterized by very strong preferences for all proposed measures

  - ✓ The group with the greatest potential to implement energy-saving measures in the home in the short and long term

  - ✓ The most salient characteristics of households belonging to this class are that they are the ones that reside mostly in flats

  - ✓ The other two classes, **Convenience seekers** and **Financially constrained** show very different preferences for energy saving measures

Results (6)

- **The Convenience seekers:**
  - ✓ This second class clearly prefers options that do not imply a change in behaviour and would rather invest in measures that allow them to continue with the usual lifestyle
  - ✓ This class represents approximately one quarter of the sample
  - ✓ Estimated coefficients for investment related measures are significantly higher than behavioural interventions
  - ✓ They negatively value *turning off devices* and are indifferent to *replacing light bulbs* by LEDs
  - ✓ This class is characterised by being the group of respondents most living in a detached house, with the highest average age, highest number of homeowners and with less women

Results (7)

- The **Financially constrained**
  - ✓ This class represents nearly half of the sample
  - ✓ Households belonging to this group are more attracted to measures that do not require investment even if they imply a change in behavior
  - ✓ This group is characterised by being the youngest, with the highest presence of women, the lowest level of education and the lowest proportion of homeowners

Concluding remarks

- Based on our results, it could be considered to target energy saving measures to the different profiles found:
  - ✓ Behavioural measures should target younger households that still rent
  - ✓ Campaigns to improve the energy efficiency of homes and appliances should target older homeowners
  - ✓ Subsidies for the replacement of household appliances and investments should be targeted at households with financial constraints
  - ✓ Other households with fewer constraints are likely to make the investments without the financial incentive just to maintain their current lifestyle

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¡Muchas gracias por su atención!

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