INSPIRING IDEAS AND TALENT

The Effects of Energy Literacy and Household Income on Consumer Choice of Energy-Efficient Appliances – Insights from a Multi-Country Discrete Choice Experiment and Welfare Analysis

Marie-Charlotte Guetlein[a], Corinne Faure[a], Joachim Schleich[a,b], Gengyang Tu[c]

[a] Grenoble Ecole de Management, Grenoble, France
[b] Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany
[c] University of Exeter, UK

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FSR Climate Annual Conference
Florence
28/29 November 2019

ASSOCIATION AMBA ACCREDITED · AACSB ACCREDITED · EFMD EQUIS ACCREDITED

This research was funded by the European Union's Horizon 2020 Framework Programme under the project CHEETAH – Changing Energy Efficiency Technology Adoption in Households

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Introduction

Policy instruments to increase household adoption of energy-efficient appliances include

- Mandatory energy labels
- Rebate programs
- Minimum energy performance standards
- …

Rationale:

- Energy and climate policy targets
- Energy efficiency paradox: households refrain from investing in energy efficient technologies even though these appear to be cost efficient (e.g., Jaffe and Stavins, 1994, Allcott and Greenstone, 2012)

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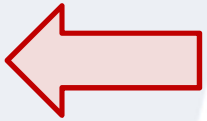
Objectives

- WTP for appliances with higher energy class
- Welfare effects of a phase-down of inefficient technologies
- Impact of rebates for efficient appliances



Low energy literacy

Low income

Method: Discrete choice experiment on refrigerator purchase decisions

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Related literature

- DCEs on energy-efficient appliance purchase decisions
  - Revelt and Train (1998), Shen and Shio (2009), Ward et al. (2011), Jeong and Kim (2015), Heinzle and Wüstenhagen (2012), Jain et al. (2018)
- Energy literacy
  - Zografakis et al. (2008), Brounen et al. (2013), Blasch et al. (2018a)
- Impact of rebate programs at the individual level
  - Galarraga et al. (2013), Davis et al. (2014), Boomhower and Davis (2014), Datta and Gulati (2014), Datta and Filippini (2016), Houde and Aldy (2014)

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Outline

1. Experimental Design
2. Econometric Analysis
3. Results
4. Policy Implications

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Experimental Design

- CAWI among households in eight EU member states (FR, DE, IT, PL, RO, ES, SE, UK)
- Representative samples in terms of gender, age, income, and regional population dispersion.
- Stated preference discrete choice experiment (DCE) on refrigerator purchase decisions
- Individual and household characteristics, including energy literacy
- Mixed logit analysis; interaction terms with income and energy literacy dummies
- Post-estimation analysis (WTP, choice probabilities, CV)

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Experimental Design

Levels of different attributes considered in the refrigerator CE

Attribute	Levels
Size	220 L, 240 L, 260 L, 280 L, 300 L, 320 L
Energy class	A^{+}, A^{++}, A^{+++}
Warranty	2 years; 4 years; 6 years
Customer rating	3.5/5 stars; 4.0/5 stars; 4.5/5 stars
Purchase price	250 €, 350 €, 450 €, 550 €, 700 €, 850 €
Rebate	0 €, 25 €, 50 €, 100 €[a]

[a] Rebates were only offered for refrigerators with energy class A^{+++}.

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Experimental Design

Framing

Imagine that **your refrigerator has broken down and you need to buy a new one.** On the following pages, we will show you different refrigerator purchase options. We would like to know **which refrigerator you would choose, if these were your only options.**

Please assume that all refrigerator options fit properly in your kitchen and are currently available in colour and finish of your choice.

The refrigerators only differ on the following attributes**:**

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Econometric Methods

- Mixed logit with interactions

$$U_{njt} = \beta_{n,1} priceb + \beta_{n,2} size + \beta_{n,3} warranty + (\beta_{n.4} + \beta_5 highlit + \beta_6 highinc) \times A2 + (\beta_{n,7} + \beta_8 highlit + \beta_9 highinc) \times A3\_0 + (\beta_{n,10} + \beta_{11} highlit + \beta_{12} highlit) \times A3\_sub + \beta_{n,13} star4 + \beta_{n,14} star45 + \varepsilon_{njt}$$

- WTP

- Compensating variation (Small and Rosen 1981)

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Results

	France	Germany	Italy	Poland	Romania	Spain	Sweden	UK
net price	-0.0087***	-0.0059***	-0.0053***	-0.0049***	-0.0047***	-0.0060***	-0.0085***	-0.0091***
highinc_A2	0.0911	-0.5731*	0.2167	0.9250***	0.0868	0.0908	-0.1853	-0.4166
highinc_A3_0	0.1144	-0.3649	-0.5339	0.6902*	0.3215	-0.4257	-1.1573***	-0.1326
highinc_A3_sub	0.1269	0.1837	0.6122*	0.9968***	0.4712*	0.6843**	0.2798	0.3635
highlit4_A2	0.2177	-0.0982	0.4205*	0.2701	-0.0789	-0.0094	0.2506	0.3767
highlit4_A3_0	0.6979**	0.4446	0.4176	0.8048**	0.5460*	-0.0763	0.6334*	0.3160
highlit4_A3_sub	0.5787**	-0.2134	-0.0533	0.4822*	0.1714	0.3843	0.3619	0.3969*
size	0.0062***	-0.0015	0.0117***	0.0107***	0.0060***	0.0124***	0.0146***	0.0107***
warranty	0.2227***	0.2190***	0.1779***	0.2652***	0.2330***	0.1924***	0.3605***	0.2376***
A2	0.5203*	1.0143***	0.2528	-0.4963	0.8087***	0.5160	0.8249***	0.4886
A3_0	0.5296	0.5904	1.3802***	-0.3002	0.5270	1.6195***	2.0456***	1.1321***
A3_sub	0.8416***	1.0901***	1.3292***	0.3398	1.4205***	0.7522**	1.4106***	0.2027
star4	0.4068***	0.3617***	0.4842***	0.5691***	0.5029***	0.5023***	0.8222***	0.6649***
star45	0.3104***	0.1207	0.5307***	0.6660***	0.5353***	0.3809***	0.8821***	0.6573***
N	9248	7008	6640	7888	9504	7248	9584	7856

Results

WTP results:

	France	Germany	Italy	Poland	Romania	Spain	Sweden	UK
highinc_A2	-	-97.14	-	188.78	-	-	-	-
highinc_A3_0	-	-	-	140.86	-	-	-136.15	-
highinc_A3_sub	-	-	115.51	203.43	100.26	114.05	-	-
highlit4_A2	-	-	79.34	-	-	-	-	-
highlit4_A3_0	80.22	-	-	164.24	116.17	-	74.52	-
highlit4_A3_sub	66.52	-	-	98.41	-	-	-	43.62
size (/L)	0.71	-	2.21	2.18	1.28	2.07	1.72	1.18
warranty (/year)	25.60	37.12	33.57	54.12	49.57	32.07	42.41	26.11
A2	59.80	171.92	-	-	172.06	-	97.05	53.69
A3_0	-	-	260.42	-	-	269.92	240.66	124.41
A3_sub	96.74	184.76	250.79	-	302.23	125.37	165.95	-
star4	46.76	61.31	91.36	116.14	107.00	83.72	96.73	73.07
star45	35.68	-	100.13	135.92	113.89	63.48	103.78	72.23

Results – welfare analysis (preliminary)

Input for calculating average choice probabilities under a "current market" scenario:

	Option A (A+)	Option B (A++)	Option C (A+++)
Size (L)	300	300	300
Warranty (years)	2	2	2
Energy class	A+	A++	A+++
Customer rating	4.0	4.0	4.0
Price (€)[a, b]	272-498	432-710	631-902

[a] Data from GfK https://www.gfk.com/

[b] Prices by country here

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Results

Average choice probabilities under a “current market” scenario:

	Option A (A+)	Option B (A++)	Option C (A+++)	Market share [a] A+	Market share A++	Market share A+++
FR	80%	17%	3%	81%	17%	1%
DE	54%	33%	13%	27%	54%	18%
IT	56%	22%	22%	63%	27%	8%
PL	43%	33%	25%	65%	29%	4%
RO	44%	37%	20%	88%	10%	0%
ES	54%	20%	26%	58%	31%	11%
SE	55%	21%	24%	42%	53%	5%
UK	79%	10%	10%	88%	9%	1%

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[a] Data from GfK https://www.gfk.com/

Results

CV ("current market scenario"→ "ban-on-A+ scenario"):

	CV
France	-180.52
Germany	-137.77
Italy	-130.84
Poland	-118.04
Romania	-103.72
Spain	-126.83
Sweden	-105.64
UK	-192.66

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Results

Who would be hit hardest by a ban on A+ appliances?

	CV higher energy literacy	CV energy literacy below median
France	-170	-196
Germany	-136	-141
Italy	-113	-153
Poland	-105	-150
Romania	-99	-109
Spain	-128	-124
Sweden	-91	-120
UK	-183	-216

	CV higher income	CV lowest income quartile
France	-176	-185
Germany	-145	-100
Italy	-136	-118
Poland	-104	-187
Romania	-98	-112
Spain	-130	-115
Sweden	-118	-75
UK	-201	-173

In red: difference is statistically significant

Results

How could the welfare loss be mitigated?

- Decrease in prices
- Increase in energy literacy

	CV higher energy literacy	CV energy literacy below median
France	-170	-196
Germany	-136	-141
Italy	-113	-153
Poland	-105	-150
Romania	-99	-109
Spain	-128	-124
Sweden	-91	-120
UK	-183	-216

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Results

How could the welfare loss be mitigated?

- Decrease in prices
- Increase in energy literacy
- Rebates?

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Results

Ban on A+ refrigerators + 10% rebate on A+++

	CV (ban only)	CV (ban + subsidy)
France	-180.52	-156.16
Germany	-137.77	-74.26
Italy	-130.84	-8.44
Poland	-118.04	-12.18
Romania	-103.72	-1.77
Spain	-126.83	-46.99
Sweden	-105.64	-46.12
UK	-192.66	-181.59

	Higher income	Lowest income quartile
France	-152	-161
Germany	-74	-76
Italy	11	-102
Poland	5	-109
Romania	9	-34
Spain	-32	-123
Sweden	-31	-81
UK	-183	-177

Conclusion

- Respondents typically prefer higher labelled refrigerators to refrigerators with lower energy classes
- Low energy literacy was found to substantially lower the willingness-to-pay for A^{++}- or A^{+++}-labelled refrigerators in five out of eight countries

➢ raising the level of energy literacy via education and information programs) may be an effective means.

➢ Ideally, such programs would be targeted at particular socio-economic groups.

- Rebates for A^{+++}-labelled refrigerators can be an effective measure to boost the adoption of A^{+++}-labelled refrigerators
  - – but less for low income households

➢ Providing a rebate for energy-efficient refrigerators may be regressive

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Thank you!

Grenoble Ecole de Management
12 Pierre Sémard
38000 Grenoble
France
Joachim.schleich@grenoble-em.com

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