The effect of energy labelling on consumers purchasing decision for appliances: a field trial in Spain

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Introduction I

- **Energy efficiency (EE)** has become one of the principal instruments for reducing household energy consumption

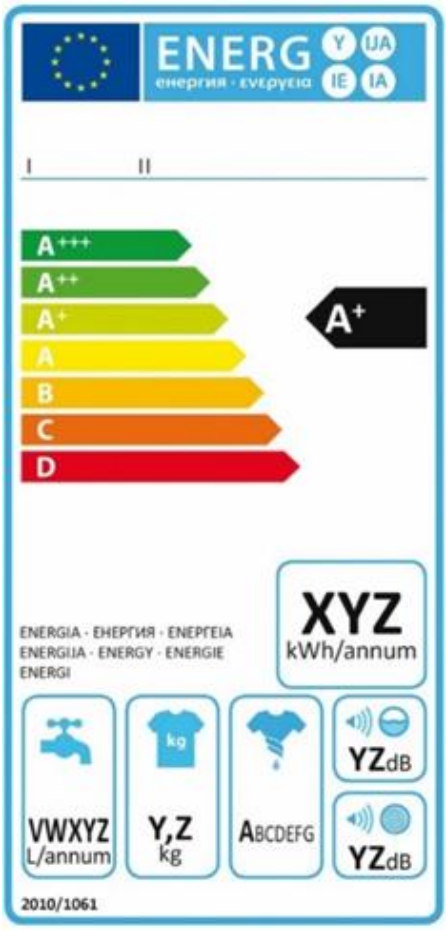
- Although EE may offer economic and environmental benefits (e.g. cost reductions, decrease in carbon emissions), there is an apparent underinvestment → ***EE gap or paradox***

- Most common policy instrument for reducing the EE gap (informational failures): **EE labels**

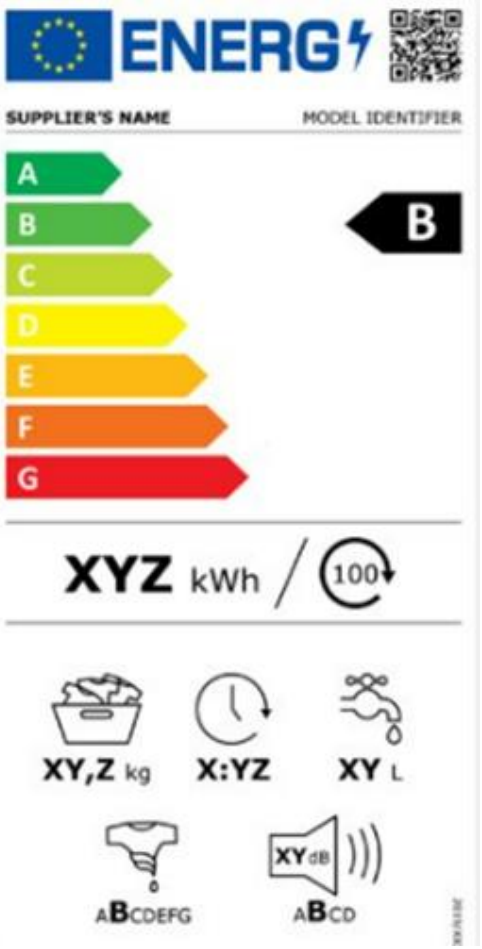
See Failures EE gap

European EE labels (appliances)

- **What?** EE level, energy consumption (kWh/year) and other technical attributes



EE label for wasching-machine till february 2021



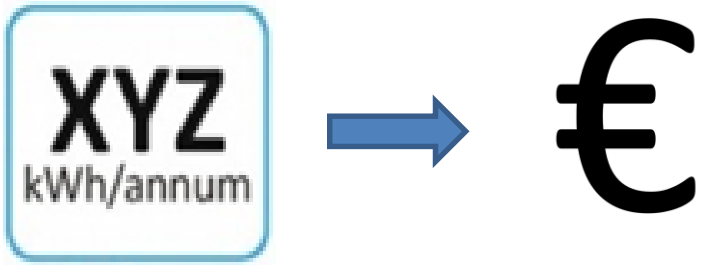
EE label for wasching-machine from march 2021

Motivation

- Effective EE labels → individuals must be **aware** of its existence, must **understand** the information provided, must **trust** it and **must find the information useful**

- Crucial factors:
  - **The type of information** (energy consumption in kWh/year, monetary information, emissions ↓…)
  - **The way the information is provided** (EE scale, colours used, horizontal or vertical scale…)

- **Providing monetary information about the energy consumption is effective?**



See summary of literature

Objective

- To test the effectiveness of providing monetary information (**lifetime energy savings**) at the point of sale to promote the purchase of energy efficient household appliances in Spain

- **How? Field experiment**

- **Why a field experiment?** A **real situation** (real purchasers and real purchases)

Design

- **26 small retailers in Spain**: the Basque Country, Navarre, Cantabria and Aragón

- When? **February – July 2018**

- Appliances under study (most common appliances in Spanish households): **washing machines, fridges and dishwashers**

Treatments

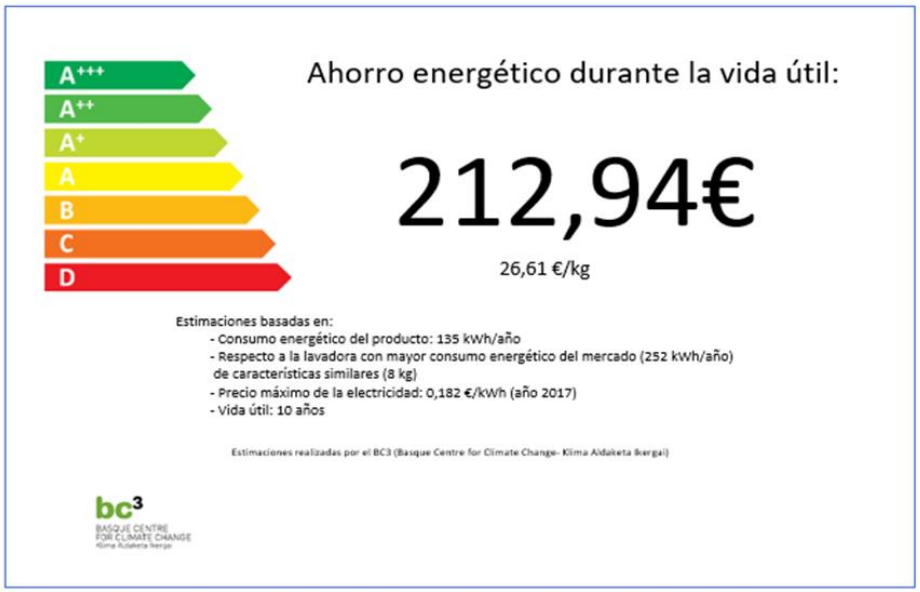
	Treatment 1	Treatment 2	Treatment 3	Control
Description	**Monetary label** showing lifetime energy savings in € (placement at visible point in physical stores)	**Sales staff** provide the monetary information (but removing the aforesaid monetary label) See the training of the sales staff	**Monetary label** showing lifetime energy savings in € **+** Information from **sales staff**	**Business as usual**
Period	5th February – 4th April 2018	5th April – 3rd June 2018	4th June – 31st July 2018	5th February – 31st July 2018
Number of stores	In total **14 stores:** Basque Country (11), Cantabria (1), Aragón (1), Navarre (1)			In total **12 stores**: Basque Country (8), Aragón (2) and Navarre (2)

Monetary label – Lifetime energy savings (LES)

$$\boldsymbol{LES = (MEC - EC) * ep_{2017} * L}$$

- MEC is the maximum energy consumption for that product category
- $\boldsymbol{EC}$ is the energy consumption of an specific product,
- $\boldsymbol{ep_{2017}}$ is the maximum energy price of 2017 (0.182 €/kWh)
- **L** is the lifetime of the product (10 years)

Monetary label - Example



Lifetime energy savings: €212.94.

Estimates based on:

(i) energy consumption of the product: 135 kWh/year;

(ii) highest energy consumption for a washing machine in this product category (8 kg): 252 kWh/year;

(iii) maximum electricity price (2017): €0.182/kWh;

(iv) lifetime: 10 years.

See Average lifetime energy savings per product category and technical characteristics

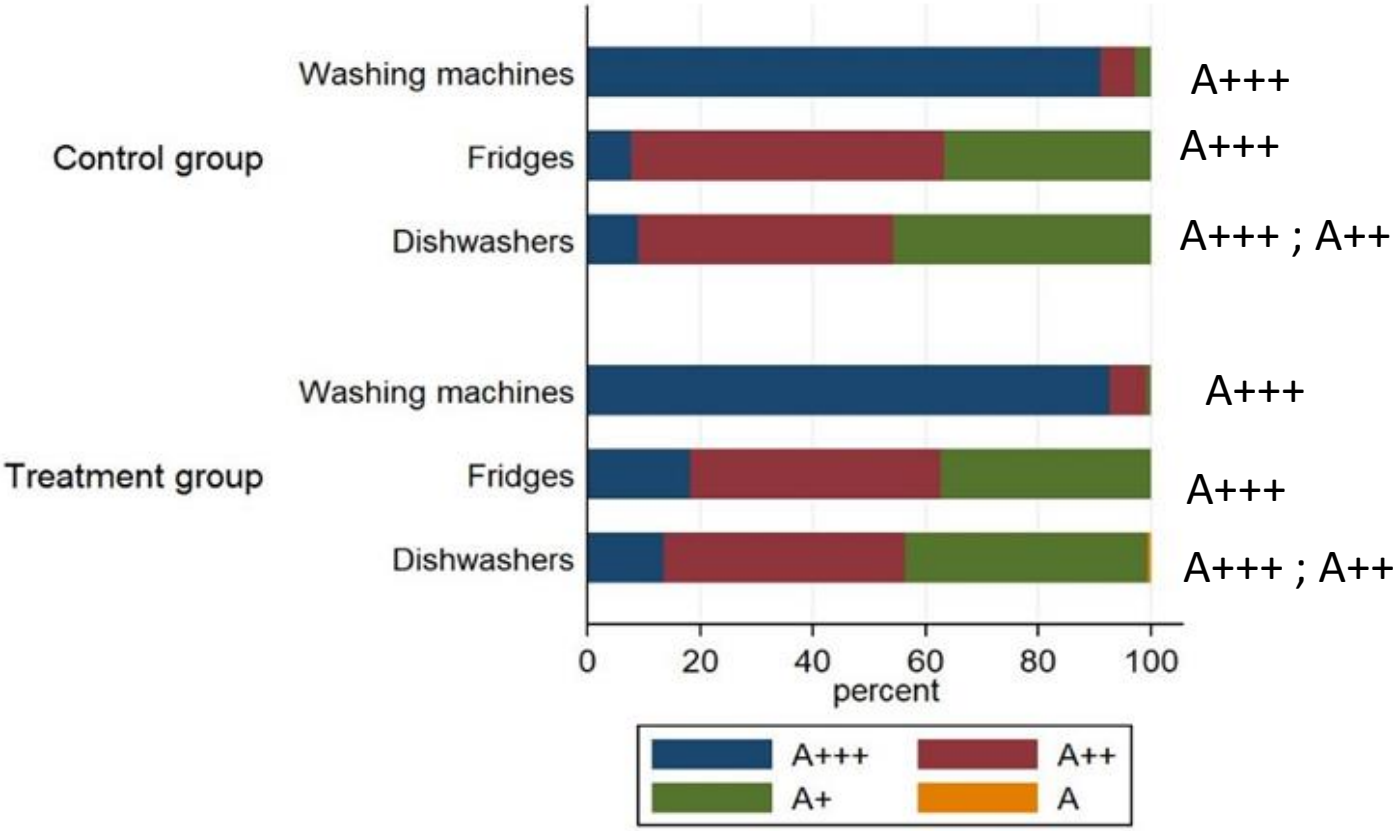
Data

	Washing-machine	Fridge	Dishwasher	Source
Technical info.		Date and place		Retailers
		Brand		
		Model		
Energy related info.		EE level		Internal database
		Annual energy consumption		
Attributes	Capacity (kg)	Volume e of the fridge	Capacity (mm)	Internal database
	Type of embedding	Volume of the freezer	Type of embedding	
	Water consumption	Height	Water consumption	
	Price	Type of embedding	Type of embedding	
	Price discount	Price	Price	Retailers
		Price discount	Price discount	Retailers
Socio-economic info.		Gender		Short survey at the point of sale (see short questionnaire)
		Age		
		Zip code		
		Income per capita		Statistical Institutes
Sales	1599 (51.63%)	976 (31.51%)	522 (16.86%)	Retailers

See the percentage appliances sold during the experiment per product category, brand, gender and age range

Statistics

Percentage of appliances sold per energy efficiency level during the experiment in the control and treatment stores



Binary response models

The probability of buying a highly energy-efficient appliance depending on the ***treatments, technical attributes, socio-economic factors and some interaction effects***:

See distribution of the appliances sold during the experiment

- **For wasching-machines:**

→ 1 if EE = A^{+++}; 0 otherwise

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Trat1 + \beta_3 Trat2 + \beta_4 Trat3 + \beta_5 Capacity + \beta_6 TypeofEmbedding + \beta_7 WaterConsumption + \beta_8 Price + \beta_9 Trat1 * Price + \beta_{10} Trat2 * Price + \beta_{11} Trat3 * Price + \beta_{12} Income + \beta_{13} Income^2 + \beta_{14} Trat1 * Income + \beta_{15} Trat2 * Income + \beta_{16} Trat3 * Income + e$$

See descriptive statistics for the washing-machine model

- **For fridges:**

→ 1 if EE = A^{+++}; 0 otherwise

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Trat1 + \beta_3 Trat2 + \beta_4 Trat3 + \beta_5 VolumeFridge + \beta_6 VolumeFreezer + \beta_7 Price + \beta_8 Trat1 * Price + \beta_9 Trat2 * Price + \beta_{10} Trat3 * Price + \beta_{11} Income + \beta_{12} Income^2 + \beta_{13} Smallcity + \beta_{14} Bigcity + \beta_{15} AgeUnder30 + \beta_{16} AgeBetween30and45 + \beta_{17} AgeOver60 + e$$

See descriptive statistics for the fridge model

- **For dishwashers:**

→ 1 if EE = A^{+++} or A^{++}; 0 otherwise

$$P(y = 1 \mid X) = \beta_1 + \beta_2 Trat1 + \beta_3 Trat2 + \beta_4 Trat3 + \beta_5 Width + \beta_6 NumberServices + \beta_7 WaterConsumption + \beta_8 Price + \beta_9 \mathrm{Trat1} * \mathrm{Price} + \beta_{10} \mathrm{Trat2} * \mathrm{Price} + \beta_{11} \mathrm{Trat3} * \mathrm{Price} + \beta_{12} \mathrm{Income} + \beta_{13} \mathrm{Income}^2 + \beta_{14} Smallcity + \beta_{15} Bigcity + +\beta_{16} Trat1 * Income + \beta_{17} Trat2 * Income + \beta_{18} Trat3 * Income + \beta_{19} AgeUnder30 + \beta_{20} AgeBetween30and45 + \beta_{21} AgeOver60 + e$$

See descriptive statistics for the dishwasher model

Washing machines	
Treatment 1 (=1 if the sale is under treatment 1)	0.0316* (0.0166)
Treatment 2 (=1 if the sale is under treatment 2)	-0.0985 (0.136)
Treatment 3 (=1 if the sale is under treatment 3)	-0.489 (0.303)
Capacity (kg)	0.0349*** (0.00763)
Type of embedding (=1 if free installation)	0.145*** (0.0381)
Water consumption (L)	-2.82e-05*** (6.19e-06)
Price (€)	3.92e-05 (3.06e-05)
Treatment 1 * Price	-7.35e-05* (4.30e-05)
Treatment 2 * Price	3.23e-05 (4.30e-05)
Treatment 3 * Price	2.14e-05 (4.65e-05)
Income (€)	-5.16e-07 (3.46e-06)
Income² (€)	0 (8.31e-11)
Treatment 1 * Income	-1.09e-06 (1.82e-06)
Treatment 2 * Income	1.29e-06 (1.49e-06)
Treatment 3 * Income	3.99e-06** (1.69e-06)
Number of observations = 1,350	
Log likelihood = -200.57817	
Pseudo R^2 = 0.3271	

Only treat. 1 (monetary label) effective →

- Mental fatigue of sales staff
- Little incentive to encourage to purchase A^{+++} (most already A^{+++})

Capacity (+)
Free installation (+)
Water consumption (-)

Price (-) when Treat. 1 (monetary label) applied
Small

Income (+) when Treat. 3 (mix) applied

Fridges	
Treatment 1 (=1 if the sale is under treatment 1)	0.0998 (0.149)
Treatment 2 (=1 if the sale is under treatment 2)	0.486** (0.204)
Treatment 3 (=1 if the sale is under treatment 3)	0.371* (0.208)
Capacity- Volume of the fridge (L)	0.00184*** (0.000334)
Capacity- Volume of the freezer (L)	0.000671 (0.000776)
Price (€)	0.000316*** (7.40e-05)
Treatment 1 * Price	-7.57e-05 (9.35e-05)
Treatment 2 * Price	-0.000245*** (8.15e-05)
Treatment 3 * Price	-0.000195** (9.10e-05)
Income (€)	1.11e-05 (1.46e-05)
Income^2 (€)	-3.01e-10 (3.33e-10)
Small city (=1 if the sale occurred in a small city)	-0.0197 (0.0269)
Big city (=1 if the sale occurred in a big city)	0.0294 (0.0181)
Age under 30 (=1 if the consumer is less than 30 years old)	0.0155 (0.0672)
Age 30 - 45 (=1 if the consumer is between 30 and 45 years old)	-0.0252* (0.0153)
Age over 60 (=1 if the consumer is more than 60 years old)	-0.0241 (0.0162)
Number of observations = 827 Log likelihood = -211.76056 Pseudo R^2 = 0.3785	

- **Treat. 2 (intervention of sales staff)** and **Treat. 3 (intervention of sales staff combined with the monetary label)** → **effective**
- Treat. 3 (mix) less effective → **"mental fatigue"**

Capacity of fridge (+)
Price (+) → high-efficiency fridges most expensive

- Average price of A^{+++} = €956.52
- Average price of A^{++} = €704.81

See average prices

People aged between 30-45 (-) → childbearing age (less income available)

- Average price of A^{+++} = €956.52
- Average price of A^{++} = €704.81

Dishwashers	
Treatment 1 (=1 if the sale is under treatment 1)	-0.651 (0.574)
Treatment 2 (=1 if the sale is under treatment 2)	-0.333 (0.854)
Treatment 3 (=1 if the sale is under treatment 3)	0.212 (0.425)
Width (=1 if the size is 600 mm)	0.548** (0.251)
Number of services	0.149** (0.0652)
Water consumption (L)	-0.00191*** (0.000233)
Price (€)	0.000350 (0.000521)
Treatment 1 * Price	0.00109 (0.00105)
Treatment 2 * Price	0.000286 (0.000883)
Treatment 3 * Price	0.00141* (0.000823)
Small city (=1 if the sale occurred in a small city)	0.0540 (0.128)
Big city (=1 if the sale occurred in a big city)	-0.0239 (0.0936)
Income (€)	-5.75e-06 (6.05e-05)
Income ^{2} (€)	1.69e-10 (1.33e-09)
Treatment 1 * Income	1.69e-06 (2.76e-05)
Treatment 2 * Income	8.07e-06 (2.80e-05)
Treatment 3 * Income	-4.47e-05* (2.43e-05)
Age under 30 (=1 if the consumer is less than 30 years old)	-0.0102 (0.377)
Age 30 - 45 (=1 if the consumer is between 30 and 45 years old)	-0.116 (0.113)
Age over 60 (=1 if the consumer is more than 60 years old)	-0.173* (0.101)
Number of observations = 421; Pseudo R^2 = 0.7166	

None of the treatments seems to be effective

- not so worried about EE; not consider a necessary appliance (dishwashers purchased = 16.86%)

see % of appliances sold

600 mm width (+)
Number of services (+)
Water consumption (-)

Price (+) when Treat. 3 (mix) applied → high-efficiency dishwashers most expensive

- Average price of A^{+++} = €705.71
- Average price of A^{++} = €483.24

See average prices

Buyers over 60 (-) → older people tend to invest less in EE (time to recover investment?)

Conclusions I

- Providing **lifetime energy savings information** can be **effective** in promoting the purchase of high energy-efficient (A^{+++}) **washing machines and fridges** in Spain

  - Waching-machine → just monetary label (mental fatigue + most already A^{+++})

  - Fridges → sales staff + monetary labels & sales staff (connected 24x7)

- **For dishwashers none of the treatments** seem to have been **effective** (not primary / necessary appliance) see % of appliances sold

Conclusions II

- **Monetary information** could be **useful for particular appliances** but not for all household appliances

- **Different monetary labels** could be proposed **for each appliance type**, taking into account:
  - the peculiarities of each product category (consumer preferences, habits, use)
  - the socio-economic profile of consumers
  - the country of implementation
  - the type of monetary information provided (savings Vs. cost)

See limitations

Thank you!

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Extra slides

Limitations & caveats

Many factors uncontrollable due to the design of the experiment, the human factor or factors related to retailers…

- Time effects?
- Potential mental fatigue of sales staff & retailers?
- Lack of more info. from buyers (household income level, education, attitudes, habits, if they had correctly understood the lifetime energy savings information, brand-loyalty, first buyers or not…)
- Purchasers actually received the information related to an appliance in one treatment and purchased the product in another treatment?
- Sales staff always provided the lifetime energy savings information during Treatment 2 and Treatment 3?
- Internal management of the retailers (some retailers have few appliances on display due to a lack of space)

The main failures and factors that explain the EE gap

Failures		Factors promoting the EE gap
(i) Market failures	a. Informational failures	a1. Asymmetric and/or incomplete information
		a2. Hidden and transaction costs
		a3. Myopia
	a. Other market failures	b1. Lower-than-efficient energy prices
		b2. Slowness of technological adoption
		b3. Capital market imperfections
		b4. Principal agent problem (e.g. Split incentives problem)
(i) Behavioural failures		a. Inattention
		a. Decision-making heuristics and biases
(i) Other factors		a. Social norms
		a. Procrastination
		a. Personal experience

Source: Solà, M.d.M., de Ayala, A., Galarraga, I. and Escapa, M. (2021). Promoting energy efficiency at household level: a literature review. *Energy Efficiency* 14, 6 (2021)

Summary of literature on EU energy label effectiveness for household appliances

Articles	Information related to energy consumption	Effectiveness of the energy scale	Other	Result
Allcott and Knittel (2017)	Annual cost information			No effect
Allcott and Sweeney (2016)			Annual savings information vs. rebates	Effective if savings information is combined with information from sales staff
Asensio and Delmas (2016)			Year cost/savings information vs. health information	Health related information is more effective
Bull (2012)			Information on losses avoided	Lifetime energy cost is effective
Carroll et al. (2016a)	Five-year energy cost information			No significant impact
Deutsch (2010)	Life cycle cost information			Small reduction in energy use
Heinzle and Wüstenhagen (2012)		A^{+++}-A scale vs. A-D scale		A-D scale more effective
Heinzle (2012)			Operating costs vs. energy use	Operating costs is more effective
Kallbekken et al. (2013)	Lifetime energy cost information			Effective for tumble driers
Min et al. (2014)	Annual operating cost information			No effect
Stadelmann and Schubert (2018)	Cost and savings information			Effective for tumble driers; No effect for freezers
Waechter et al. (2015)		Energy efficiency scale vs. energy consumption		No effect, consumers do not always choose the most energy-efficient product

The training of the sales staff

1. Introduction. Basic knowledge of EE. What is EE? Different energy efficiency levels.
2. How are the energy efficiency levels of the appliances under study (washing machines, fridges and dishwashers) calculated?
3. Why are there appliances which have the same energy efficiency level but different energy consumptions?
4. What are the main assumptions made in estimating average energy consumption under the EU energy efficiency label?
5. How are monetary lifetime energy savings estimated for each appliance (washing machine, fridge, dishwasher)?
6. What energy price is used for these estimations?
7. What lifetime is used in estimating monetary lifetime energy savings?

Statistics I

Average lifetime energy savings per product category and technical characteristics

Appliance		Average LES
Washing machine	6 kg	105.70€
	7 kg	126.95€
	8 kg	175.64€
	9 kg	116.80€
	10 kg	110.56€
Fridge		305.65€
Dishwasher	450 mm	86.78€
	600 mm	95.42€

Note: LES are not comparable among them (LES are estimated for each product category and technical characteristics)

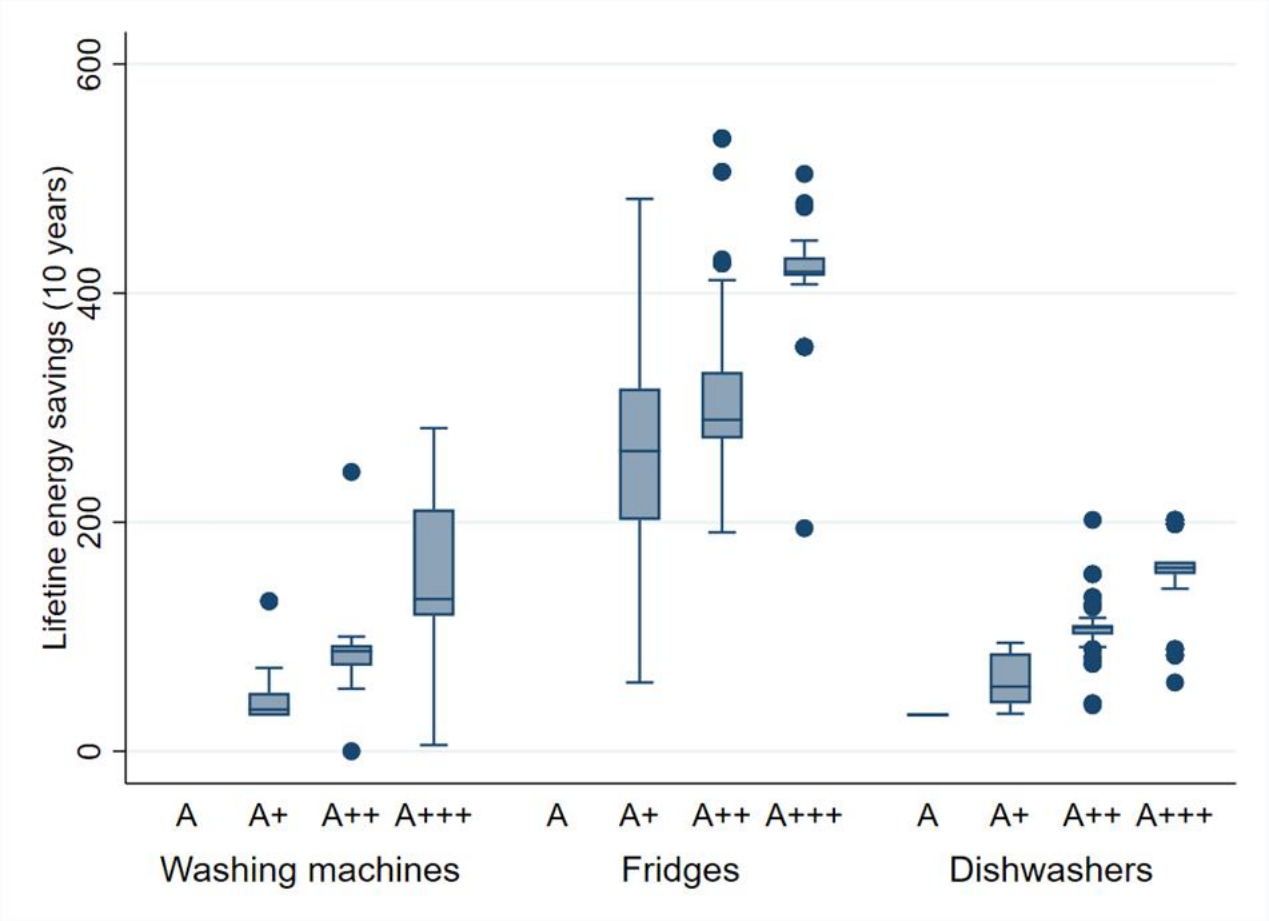
Statistics II

Percentage of appliances sold per product category, brand, gender and age range

	Washing machines	Fridges	Dishwashers
Sales %	51.63%	31.51%	16.86%
1st brand	Bosch (16.39%)	Bosch (15.88%)	Bosch (15.33%)
2nd brand	AEG (13.51%)	Siemens (10.96%)	AEG (15.13%)
3rd brand		Liebherr (10.86 %)	Balay (14.56%)
Rest brands	Rest (<10%)	Rest (<10%)	Rest (<14%)
Male	658 (41.15%)	459 (47.03%)	248 (47.51%)
Female	934 (58.41%)	515 (52.77%)	273 (52.30%)
Both	7 (0.44%)	2 (0.20%)	1 (0.19%)
18 - 30 years	28 (1.76%)	21 (2.15%)	12 (2.30%)	
31- 45 years	388 (24.33%)	228 (23.36%)	138 (26.44%)
46 – 60 years	703 (44.01%)	396 (40.57%)	213 (40.80%)
More than 60 years	477 (29.91%)	331 (33.91%)	159 (30.46%)

Statistics III

Distribution of the household appliances sold during the field trial



Statistics IV

Average prices per product category, energy efficiency level and treatment group

Washing machine	A^{+++}	A^{++}	A^{+}	A	Overall
Treatment 1	471.96€ N=238	410.85€ N=20	565€ N=1	.	472.28€ N=253
Treatment 2	494.49€ N=327	422.20€ N=20	594€ N=2	.	490.92€ N=349
Treatment 3	479.85€ N=217	477.46€ N=15	.	.	472.28€ N=253
Control	438.16€ N=584	441.05€ N=38	296.05 N=17	.	434.55€ N=639
Overall	464.16€ N=1366	436.37€ N=93	339.30€ N=20	.	460.72€ N=1479
Fridge	A^{+++}	A^{++}	A^{+}	A	Overall
Treatment 1	1136.93€ N=31	759.62€ N=64	436.60€ N=59	.	710.57€ N=154
Treatment 2	977.38€ N=37	795.01 N=76	446.31€ N=68	.	701.29€ N=181
Treatment 3	827.89€ N=25	685.05€ N=97	421.76€ N=75	.	602.94€ N=197
Control	847.93€ N=29	662.49€ N=195	465.76€ N=125	.	607.47€ N=349
Overall	956.52€ N=122	704.81€ N=432	446.40€ N=327	.	643.75€ N=881
Dishwasher	A^{+++}	A^{++}	A^{+}	A	Overall
Treatment 1	755.60€ N=5	545.81€ N=34	481.09€ N=26	459€ N=1	534.89€ N=66
Treatment 2	792.43€ N=19	495.93€ N=36	418.78€ N=32	334€ N=1	530.05€ N=88
Treatment 3	748.35€ N=11	472.21€ N=41	448.16€ N=40	.	494.77€ N=92
Control	587.40€ N=20	461.27€ N=97	427.24€ N=85	.	459.44€ N=202
Overall	705.71€ N=55	483.24€ N=208	437.98€ N=183	396.50€ N=2	491.68€ N=448

Statistics V

Descriptive statistics of variables used in the model for washing-machines

Washing machines	Number of observations	Mean	Standard deviation	Min	Max
Energy savings (€)	1599	149.965	52.13268	0	282.1
Efficiency (=1 if appliance is A^{+++})	1599	.91995	.2714555	0	1
Price (€)	1479	460.7262	180.7984	186	1508.87
Size of washing machine	1599	7.595997	.7115243	6	10
Type of embedding (=1 if free installation)	1599	.873671	.3323237	0	1
Water consumption (in L)	1576	9948.778	765.5639	7400	12900

Statistics VI

Descriptive statistics of variables used in the model for fridges

Fridges	Number of observations	Mean	Standard deviation	Min	Max
Energy savings (€)	972	305.6589	75.16341	60.06	535.08
Efficiency (=1 if appliance is A^{+++})	975	.1435897	.3508532	0	1
Price (€)	881	643.7569	275.6021	198	2345
Volume of fridge (in L)	975	221.0185	40.16718	98	380
Volume of freezer (in L)	967	80.34023	16.95284	16	119
Small town (=1 if seller is from a small town)	976	.1956967	.3969395	0	1
Big city (=1 if seller is from a big city)	976	.4723361	.4994901	0	1

Statistics VII

Descriptive statistics of variables used in the model for dishwashers

Dishwashers	Number of observations	Mean	Standard deviation	Min	Max
Energy savings (€)	522	93.00828	36.77416	30.94	202.02
Efficiency (=1 if appliance is A^{+++})	522	.1168582	.3215594	0	1
Price (€)	448	491.6848	175.3597	202.75	1399
Size (=1 if the size is 600mm)	522	.7203065	.4492791	0	1
Number of services	522	12.22031	1.963029	9	16
Water consumption (in L)	522	2944.954	380.4774	2100	4200
Small town (=1 if seller is from a small town)	522	.2318008	.4223872	0	1
Big city (=1 if seller is from a big city)	522	.4176245	.4936407	0	1

Short questionnaire

Store: _____

Date: _____

Type of appliance:

- ☐ Washing machine
- ☐ Fridge
- ☐ Dishwasher

Model: _____

1. Post code of your habitual residence: __ __ __ __ __ __
2. Gender:
   - ☐ Male
   - ☐ Female
3. Select your age range:
   - ☐ 18-30 years
   - ☐ 31- 45 years
   - ☐ 45- 60 years
   - ☐ More than 60 years