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Economic Evaluation of Energy Efficiency Labelling in Domestic Appliances: the Spanish Market

Ibon Galarraga º* and Josu Lucas º

This paper estimates the economic value that consumers place on energy efficiency (EE) labels for appliances in the Spanish market. It uses the hedonic method to calculate the price premium paid in the market for that attribute isolated from others. Furthermore, the Quantity Based Demand System (QBDS) is applied to calculate the own and cross price elasticities of demand for both EE appliances and others. These elasticities are useful for improving the design of policies to promote EE. The paper looks at three different appliances marketed in Spain during 2012: washing machines, fridges and dishwashers.

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1. Introduction

There is a substantial body of literature dealing with the importance of energy efficiency (Abadie and Galarraga 2012). At EU level Directive 2012/27/EU on energy efficiency reinforces the necessity of reaching the objective of a 20% increase in energy efficiency by 2020. Energy labels are one of the options used to promote energy efficiency and several papers have addressed the role that labels play in changing consumer behaviour (Banerjee and Salomon, 2003, Mills and Schleich, 2010). Previous contributions have developed the technique of combining hedonic methods[1] with demand systems to estimate the price premium paid for energy efficiency and price elasticities of demand for labelled and non-labelled goods (See Galarraga et al. 2011a and 2011b). In this paper we report new estimates for the household appliance (washing machines, refrigerator and dishwashers) market in Spain applying the proposed methodology. Households represent about 16.7% of total final energy consumption in Spain; 13% of that figure corresponds to domestic appliances (IDAE, 2010). The data for these calculations were collected in January 2012 from 11 different retailers in 6 regions of Spain: Galicia, the Basque Country, Valencia, Seville, Madrid and Barcelona.

2. Results

2.1 Washing Machines

The data contain 1,876 observations for washing machines. 27 producers sell 39 different brands of washing machines on the Spanish market. Table 1 below shows the variables taken into account in this analysis. Other variables have been excluded because of lack of information for some models (power, residual humidity, controls), or because they were not found to be significant in the first estimations (energy and water consumption). As a result, 1,814 observations have eventually been used. Table 2 shows the main descriptive statistics for each variable.

[1] For a review of other studies which use the hedonic method see (Chin, 2003)

Table 1. Variables selected and their description

Variable	Description
Price (P)	Measured in Euros
Location dummy (L1-L6)	If this location=1; otherwise=0
Retailer dummy (R1-R11)	If this retailer=1; otherwise=0
Brand dummy (B1-B39)	If this brand=1; otherwise=0
Energy labelling dummy (A*)**	If energy labelling is A*** =1; otherwise=0
Spin Drying Performance A dummy	If sdpA=1; otherwise=0
Spin Drying Performance B dummy	If sdpB=1; otherwise=0
Spin Drying Performance C dummy	If sdpC=1; otherwise=0
Spin Drying Performance D dummy	If sdpD=1; otherwise=0
Spinspeed	Measured in revolutions per minute
Height	Measured in milimetres
Width	Measured in milimetres
Depth	Measured in milimetres
Capacity	Measured in kilograms
Colour white dummy	If white=1; otherwise=0

Table 2. Main descriptive statistics[2]

Variable	Mean	Standard Deviation	Min	Max
P	477.449	173.668	179.000	1895.00
A* **	0.104478	0.305961	0.000000	1.00000
sdpA	0.0656182	0.247681	0.000000	1.00000
sdpB	0.497289	0.500128	0.000000	1.00000
sdpC	0.417028	0.493201	0.000000	1.00000
sdpD	0.0168113	0.128599	0.000000	1.00000
spinspeed	1135.90	153.460	500.000	1600.00
Height	849.329	8.63272	800.000	965.000
Width	574.240	62.6717	400.000	686.000
Depth	572.213	37.6484	425.000	785.000
Capacity	7.09600	1.15656	5.00000	12.0000
White	0.893801	0.308176	0.000000	1.00000

[2] The descriptive statistics about the location, the retailer and the brand can be found in Table A1 in Annex 2.

The average price is €477.44, 10.44% of the washing machines in the sample have class A*** labelling, while 91% have class B or C in spin drying performance. Their average height is 849mm; the average width is 574mm; the average depth is 572mm; and 89.38% of washing machines are white.

To estimate the effect of energy efficiency on price, a hedonic pricing model is applied using the log-linear functional form, as follows:

$$lprice_i = \alpha + \sum_{1}^{N} \beta_i X_i + u \qquad (1)$$

where lprice is the log of the price, Xi is a vector that contains the independent variables which show the attributes of the washing machines and ε is an error term. The Ordinary Least Square (OLS) method is used with robust White standard deviations to avoid possible problems of heteroscedasticity. The main results are shown in Table 3.

Table 3. Model estimation[3]

	Coefficient	
const	**7.25951**	***
	(0.597484)	
sdpB	**-0.100122**	***
	(0.0287652)	
sdpC	**-0.133373**	***
	(0.035283)	
sdpD	**-0.11889**	**
	(0.0473514)	
Spinspeed	**0.000271783**	***
	(6.53098e-05)	
height	**-0.00201544**	***
	(0.000673553)	
width	**-0.00110405**	***
	(9.26362e-05)	
depth	**0.000607877**	***
	(0.000159054)	
capacity	**0.119305**	***
	(0.00635293)	
white	**-0.193398**	***
	(0.0143089)	
A* **	**0.0415435**	***
	(0.0127833)	

R-squared	0.765241	R-squared corrected	0.757068

[3] The estimated values for the variables Location, Retailer and Brand dummies can be found in Table A2 in Annex 2..

*** Indicates significant at 1% significance level **Indicates significant at 5% significance level * Indicates significant at 10% significance level

The results show a significant, positive effect of class A*** labelling on price, measured at 0.0415, which means that washing machines with A labelling cost 4.15% more than the others. For an average price of €477, this implies that the monetary value of A labelling is €19.79.

Another variable of interest is spin drying performance, which is significant, and seems to have a mean difference of 10% between classes A and B, and 13% between classes A and C.

This analysis can be completed by estimating the elasticities of washing machines with class A***, and the rest with lower energy efficiency. The Quantity Based Demand System (QBDS) is used for this purpose as explained in Galarraga et al (2011a). (See Annex 1).

This model treats the market for appliances as divided into two sorts of goods which are substitutes. One good, L, is the appliance with high energy efficiency and the other good, O, is the appliance with low energy efficiency. Taking into account the presence rates of each sort of appliance in the market, and the share of expenditure that households devote to the purchase of appliances, the expenditure shares of each good can be calculated. These shares, obtained using data from the Instituto Nacional de Estadística, INE[4], are:

WO=0.00152 WL=0.00018 WX=0.9983

An income elasticity of 0.4 is considered, following Dale and Fujita (2008), who suggest that the income elasticity of demand for domestic appliances could be close to 0.5, and Golder and Tellis (1998), who measure it for dryers at 0.26. Additionally, it is also assumed that the own price elasticity for low energy efficient washing machines is in the range of -0.5 to -1.75. The results of the estimation are presented in Table 4.

Table 4. Own and cross elasticitiesof demand (washing machines)

	QDBS (Income elasticity = 0.4)		
Price Elasticity of demand own O/O	**cross O/L**	**own for "L"**	**cross L/O**
-0.5	0.1000	-1.2444	0.8444
-0.75	0.3500	-3.3556	2.9556
-1	0.6000	-5.4667	5.0667
-1.25	0.8500	-7.5778	7.1778
-1.5	1.1000	-9.6889	9.2889
-1.75	1.3500	-11.8000	11.4000

[4] www.ine.es

As can be observed, high energy efficiency washing machines are more elastic than low efficiency ones. The own elasticity of demand for high energy efficiency machines is in the range from -1.2 to -11.8, and the impact of a one per cent change in the price of low efficiency washing machines on the demand for high efficiency washing machines ranges from 0.84 to 11.4, depending on the assumed own-price elasticity of demand for low energy efficiency appliances.

2.2 Refrigerators

The data cover 2209 refrigerators produced by 33 different manufacturers and sold by 47 different brands. The variables included are shown in Table 5 below. The percentage of fridges with A*** class in the sample was very low (0.18%) and thus A** and A*** have been merged into a single High Class A.

Table 5.Variables selected and their description

Variable	Description
Price (P)	Measured in Euros
Location dummy (L1-L6)	If this location=1; otherwise=0
Retailer dummy (R1-R11)	If this retailer=1; otherwise=0
Brand dummy (B1-B39)	If this brand=1; otherwise=0
Energy labelling dummy AHigh (A*+A**)**	If energy labelling is A*** or A** =1; otherwise=0
Height	Measured in millimetres
Width	Measured in millimetres
Depth	Measured in millimetres
Colour white dummy	If white=1; otherwise=0

The descriptive statistics can be observed in Table 6. The average price of a refrigerator is €684, but the range is wide, almost €2,467. The percentage of refrigerators with High Class A is 6.30%, and 54.94% are white.

Table 6. Main descriptive statistics[5]

Variable	Mean	Standard Deviation	Min	Max
P	684,454	298,699	132,000	2799,00
Height	1820,76	224,731	500,000	2067,00
Width	614,153	79,6390	440,000	960,000
Depth	631,225	41,7874	440,000	770,000
White	0,549431	0,497664	0,000000	1,00000
AHigh	0,0630672	0,243139	0,000000	1,00000

[5] The descriptive statistics about the location, the retailer and the brand can be found in Table A3 in Annex 2.

Table 7 shows the results of the estimation.

Table 7.Model estimation[6]

	Coefficient	
const	**3.72337**	***
	(0.128229)	
Height	**0.000550754**	***
	(3.74114e-05)	
Width	**0.0017101**	***
	(0.000144917)	
Depth	**0.00133327**	***
	(0.000292875)	
White	**-0.147167**	***
	(0.00881035)	
AHigh	**0.12633**	***
	(0.0245919)	

R-squared	0.795812	R-squared corrected	0.789523

*** Indicates significant at 1% significance level **Indicates significant at 5% significance level * Indicates significant at 10% significance level

The results show that the AHigh label is on average 12.63% more expensive than the low class energy efficiency label for refrigerators. For an average price of €684, this means that the price premium of high energy efficiency is €86.39 in the case of refrigerators.

Similarly, the expenditure shares obtained from the percentages of refrigerators in the sample and the data from the INE are:

WO=0.001301 WL=0.0000985 WX=0.9986

In the case of refrigerators an income elasticity of demand of 0.4 is considered, and an own price elasticity of demand for low energy efficiency refrigerators in the range of -0. 5 to -1. The results can be observed in Table 8. The QBDS imposes some restrictions on the model that require a different range of values to be assumed. This restriction can be relaxed with the use of the Almost Ideal Demand Model (AIDS) originally developed by Deaton and Muellbauer (1980) as explained in Galarraga et al (2011b).

[6] The coefficients related to the location, the retailer and the brand can be found in Table A4 in Annex 2.

Table 8. Own and cross elasticities of demand

	QDBS (Income elasticity = 0.4)		
Price Elasticity of demand own O/O	**cross O/L**	**own for "L"**	**cross L/O**
-0.5	0.1000	-1.7208	1.3208
-0.75	0.3500	-5.0228	4.6228
-1	0.6000	-8.3249	7.9249

2.3 Dishwashers

The number of dishwashers in the sample is 1034, although only 988 were found to be suitable for the analysis. The variables used are described in Table 9.

Table 9.Variables selected and their description

Variable	Description
Price (P)	Measured in Euros
Location dummy (L1-L6)	If this location=1; otherwise=0
Retailer dummy (R1-R11)	If this retailer=1; otherwise=0
Brand dummy (B1-B39)	If this brand=1; otherwise=0
Energy labelling dummy AHigh (A*+A**)**	If energy labelling is A*** or A** =1; otherwise=0
Acoustic power (AcPow)	
Width	Measured in millimetres
Depth	Measured in millimetres
Number of cutleries (NCut)	
Number of programs (NProg)	
Colour white dummy	If white=1; otherwise=0

The percentage of dishwashers in the sample with A*** class is only 0.39%, which is too low to provide good estimates. For that reason a pooled class, AHigh, was created which merges classes A** and A***.

Table 10 shows the main descriptive statistics for each variable. As can be seen, the average price is €482, while the range is about €1,119. Also, the percentage of dishwashers with class Ahigh is 5.51%. Moreover, 57% of the dishwashers in the sample are white.

Table 10.Main descriptive statistics[7]

Variable	Mean	Standard Deviation	Min	Max
P	482.039	459.000	199.000	1378.00
A high	0.0551257	0.000000	0.000000	1.00000
AcPow	49.4136	49.0000	41.0000	57.0000
Width	573.385	600.000	446.000	640.000
Depth	595.590	600.000	450.000	710.000
NProg	5.43254	5.00000	3.00000	13.0000
NCut	11.8820	12.0000	6.00000	15.0000
White	0.570450	1.00000	0.000000	1.00000

The estimation results are shown in Table 11.

Table 11. Model estimation[8]

	Coefficient	
const	**8.43836**	***
	(0.262729)	
AcPow	**-0.0295622**	***
	(0.00290575)	
Width	**-0.0013798**	***
	(0.00017369)	
Depth	**-0.000956752**	***
	(0.000280104)	
NCut	**0.041252**	***
	(0.00786865)	
White	**-0.131303**	***
	(0.00901895)	
NProg	**0.0203996**	***
	(0.00706321)	
AHigh	**0.0403683**	**
	(0.0200753)	

R-squared	0.823932	R-squared corrected	0.813915

*** Indicates significant at 1% significance level **Indicates significant at 5% significance level * Indicates significant at 10% significance level

Thus, the dishwashers that have A High class are on average 4.03% more expensive than others with classes A or A*, all else being equal. For an average price of €482 this means that the value of this class of energy efficiency is €19.42.

[7] The descriptive statistics about the location, the retailer and the brand can be found in Table A5 in Annex 2.
[8] The coefficients related to the location, the retailer and the brand can be found in Table A6 in Annex 2.

The expenditure shares calculated are:

WO=0.001606 WL=0.000094 WX=0.9983

The income elasticity of demand considered is 0.4 while the price elasticities of demand for low efficiency dishwashers could be anything from -0.5 to -1.25 as the literature suggests (Jain and Rao, 2005 and Golder and Tellis, 1998). The results can be observed in Table 12.

As can be seen, the own elasticity of demand for high energy efficiency dishwashers ranges from -2.1 to -14.9. Moreover, the impact of a one per cent change in the price of low efficiency dishwashers on the demand for high energy efficiency dishwashers ranges from 1.7 to 14.5.

Table 12. Own and cross elasticities of demand

	QDBS (Income elasticity = 0.4)		
Price Elasticity of demand own O/O	**cross O/L**	**own for "L"**	**cross L/O**
-0.5	0.1000	-2.1085	1.7085
-0.75	0.3500	-6.3798	5.9798
-1	0.6000	-10.6511	10.2511
-1.25	0.8500	-14.9223	14.5223

3. Conclusions

This paper shows price premium and elasticity estimates for 3 types for household appliance on the Spanish Market. It follows the methodology discussed at length in Galarraga (2011a and 2011b). These new calculations help to validate the proposed methodology and can be used for policy analysis purposes.

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ANNEX 1. Quantity Based Demand System, QBDS

It is supposed that the market of one appliance is divided in two types of appliances: those with “high label” of energy efficiency, and others with “low label”. The rest of the characteristics of the machines are equal. So in this case the following variables are defined:

V_i: demand of quality i (energy efficiency) of good V (appliance) in comparable units. That is,

P_i:price of quality i of good V.

M: total expenditure.

P: aggregate price of good V

w_j: expenditure share of good V.

Then the demand for quality i of good V is defined as

$$\frac{V_i}{V} = \beta_i(\frac{P_i}{P})^{-\infty} \qquad (2)$$

Where $\beta_i \geq 0$ is a constant, and $\alpha \geq 0$ is the price sensitivity parameter.

Further it is defined a price index P as,

$$P = \prod_i P_i^{s_i} \qquad \text{where } s_i \geq 0 \text{ and } \sum s_i = 1 \qquad (3)$$

And the aggregate demand for all quality types as

$$V = A\left(\frac{P}{M}\right)^{-\mu} \qquad (4)$$

s_i is the weight for quality i good in the price index for good V. A>0 is a constant and μ is the expenditure sensitivity parameter for the aggregate demand for the good.

It can be confirmed that the demand for each quality i for good V is homogenous of degree zero in prices and income and that the price elasticity $\in_{ii}$is given by

$$\in_{ii} = -\alpha + (\alpha - \mu)s_i \qquad (5)$$

And the cross price elasticity for good i with respect to the price of good j, ϵ_{ij}, is given by

$$\epsilon_{ij} = (\alpha - \mu)s_j \qquad (6)$$

Finally it is noted that the Slutsky equation requires

$$\frac{s_j}{s_i} = \frac{w_j}{w_i} \qquad (7)$$

Which can be satisfied locally by selecting the values of s appropriately.

If now it is differentiated the budget constraint with respect to M, it is obtained the additivity condition;

$$\sum_i w_i e_i = 1 \qquad (8)$$

This system is similar to the Deaton & Muellbauer's (1980) AIDS demand system, but in that case it is not defined in terms of expenditure shares, but quantity shares. It has the limitation of requiring that quantities be broadly comparable, but the advantage of working with this system is that subgroups of close substitutes are easier to handle, and one can derive plausible own and cross price elasticities from limited data.

Although the QBDS is easier and less demanding than the AIDS, it also has to meet an additional condition; the income elasticity for close substitute goods has to be the same. It is reasonable to expect that all the cross price elasticities of close substitutes are positive. Thus, one can derive the following conditions from the homogeneity restriction:

If $e_i > |e_{ii}|$ then $\sum_j e_{ij} < 0$ for all $j \neq i$. Therefore at least one of the cross price elasticities has to be negative, and

If $e_i < |e_{ii}|$ then $\sum_j e_{ij} > 0$ for all $j \neq I$, and thus, all the cross price elasticities could be positive.

This condition could be simplified by the fact that information on the composite good is not required. Having $e_i < |e_{ii}|$, which can be further simplified to $\overline{\alpha} > \mu$ is enough to have positive cross price elasticities for all close substitutes. In sum, this implies that the income elasticity of demand has to be smaller than the own price elasticity of demand of one of the substitute goods in absolute value.

ANNEX. 2

Table. A1 Main descriptive statistics for location, retailers and brand (Washing machines)

Variable	Mean	Standard Deviation
L1 Galicia	0.146055	0.353256
L2 Basque Country	0.179104	0.383542
L3 Valencia	0.188166	0.390949
L4 Seville	0.170576	0.376238
L5 Madrid	0.162047	0.368592
L6 Barcelona	0.154051	0.361094
T1 Alcampo	0.0954158	0.293867
T2 MediaMarkt	0.337420	0.472956
T3 Carrefour	0.123667	0.329289
T4 Worten	0.135394	0.342236
T5 Miro	0.0890192	0.284847
T6 Eroski	0.0570362	0.231974
T7 Bermudez	0.0175906	0.131493
T8 Saturn	0.0549041	0.227854
T9 ElCorteInglés	0.0714286	0.257608
T10 Expert	0.00159915	0.0399680
T11 Milar	0.0165245	0.127515
M1 AEG-ELECTROLUX	0.0405117	0.197209
M2 ANSONIC	0.000533049	0.0230879
M3 ANTARTIK	0.000533049	0.0230879
M4 APELL	0.00159915	0.0399680
M5 HOTPOINT-ARISTON	0.0218550	0.146249

M6 ASPES	0.0106610	0.102728
M7 BALAY	0.0602345	0.237984
M8 BEKO	0.000533049	0.0230879
M9 BENAVENT	0.000533049	0.0230879
M10 BOSCH	0.0730277	0.260251
M11 CANDY	0.0559701	0.229925
M12 CARREFOUR HOME	0.00692964	0.0829776
M13 COMFEE	0.00106610	0.0326424
M14 CORBERÓ	0.00213220	0.0461388
M15 DAEWOO	0.0255864	0.157940
M16 DE DIETRICH	0.00159915	0.0399680
M17 ECRON	0.00213220	0.0461388
M18 EDESA	0.0463753	0.210353
M19 ELEGANCE	0.00852878	0.0919813
M20 ESVAM	0.00266525	0.0515709
M21 EUROTECH	0.000533049	0.0230879
M22 FAGOR	0.131663	0.338214
M23 HAIER	0.00426439	0.0651803
M24 OTSEIN HOOVER	0.0565032	0.230952
M25 HOOVER	0.00159915	0.0399680
M26 ELECTROLUX	0.0437100	0.204504
M27 INDESIT	0.0581023	0.233999
M28 KUNFT	0.00159915	0.0399680
M29 LG	0.0746269	0.262858
M30 MIELE	0.0223881	0.147981
M31 PANASONIC	0.00319829	0.0564780

M32 SAIVOD	0.00746269	0.0860868
M33 SAMSUNG	0.0570362	0.231974
M34 SIEMENS	0.0479744	0.213769
M35 SMEG	0.00373134	0.0609869
M36 TEKA	0.00799574	0.0890844
M37 WHRILPOOL	0.0708955	0.256719
M38 ZANUSSI	0.0410448	0.198447
M39 BECKEN	0.00266525	0.0515709

Table. A2 Estimations for location, retailers, and brand (Washing Machines)

Variable	Coefficient	Stand.Dev	t-statistic	p	
L2 Basque Country	0.0389672	0.0134474	2.8977	0.00381	***
L3 Valencia	0.00789793	0.0123531	0.6393	0.52268	
L4 Seville	0.0253121	0.012861	1.9681	0.04921	**
L5 Madrid	-0.0136283	0.0143559	-0.9493	0.34259	
L6 Barcelona	0.0215557	0.0133776	1.6113	0.10729	
T2 MediaMarkt	-0.00436503	0.0124692	-0.3501	0.72633	
T3 Carrefour	-0.0055628	0.0163044	-0.3412	0.73301	
T4 Worten	-0.00372588	0.0140642	-0.2649	0.79110	
T5 Miro	0.0984963	0.016526	5.9601	<0.00001	***
T6 Eroski	0.0587101	0.0156516	3.7511	0.00018	***
T7 Bermudez	0.0639205	0.0295434	2.1636	0.03063	**
T8 Saturn	-0.0574855	0.0188037	-3.0571	0.00227	***
T9 ElCorteInglés	0.135949	0.0192525	7.0613	<0.00001	***
T10 Expert	0.107293	0.200332	0.5356	0.59232	
T11 Milar	0.0786691	0.0395448	1.9894	0.04682	**

M3 ANTARTIK	-0.320229	0.0303396	-10.5548	<0.00001	***
M4 APELL	-0.308838	0.0760774	-4.0595	0.00005	***
M5 HOTPOINT-ARISTON	-0.167652	0.040607	-4.1287	0.00004	***
M6 ASPES	-0.172976	0.0347359	-4.9797	<0.00001	***
M7 BALAY	-0.0806951	0.0298303	-2.7051	0.00689	***
M8 BEKO	-0.242431	0.0481439	-5.0356	<0.00001	***
M9 BENAVENT	-0.404878	0.0516738	-7.8353	<0.00001	***
M10 BOSCH	0.0514238	0.0305293	1.6844	0.09228	*
M11 CANDY	-0.109325	0.0300999	-3.6321	0.00029	***
M12 CARREFOUR HOME	-0.268835	0.0366859	-7.3280	<0.00001	***
M13 COMFEE	-0.563127	0.0307365	-18.3211	<0.00001	***
M14 CORBERÓ	-0.131661	0.032358	-4.0689	0.00005	***
M15 DAEWOO	-0.268479	0.0343806	-7.8090	<0.00001	***
M16 DE DIETRICH	0.100114	0.0871205	1.1491	0.25065	
M17 ECRON	-0.306936	0.0381686	-8.0416	<0.00001	***
M18 EDESA	-0.129944	0.0315743	-4.1155	0.00004	***
M19 ELEGANCE	-0.502077	0.0340738	-14.7350	<0.00001	***
M21 EUROTECH	-0.470297	0.0747785	-6.2892	<0.00001	***
M22 FAGOR	-0.0343031	0.0290377	-1.1813	0.23763	
M23 HAIER	-0.236081	0.0439073	-5.3768	<0.00001	***
M24 OTSEIN HOOVER	-0.0883697	0.0324471	-2.7235	0.00652	***
M25 HOOVER	-0.081751	0.100485	-0.8136	0.41601	
M26	0.0101975	0.0324502	0.3143	0.75337	

ELECTROLUX					
M27 INDESIT	-0.197175	0.0316602	-6.2278	<0.00001	***
M28 KUNFT	-0.422858	0.0984073	-4.2970	0.00002	***
M29 LG	-0.0182841	0.0382439	-0.4781	0.63264	
M30 MIELE	0.741765	0.0328626	22.5717	<0.00001	***
M31 PANASONIC	0.0302363	0.072096	0.4194	0.67498	
M32 SAIVOD	-0.264099	0.0354476	-7.4504	<0.00001	***
M33 SAMSUNG	-0.121172	0.0327049	-3.7050	0.00022	***
M34 SIEMENS	0.13547	0.0313373	4.3230	0.00002	***
M35 SMEG	0.17567	0.272811	0.6439	0.51971	
M36 TEKA	-0.0894386	0.0526742	-1.6980	0.08969	*
M37 WHRILPOOL	-0.0926054	0.0324102	-2.8573	0.00432	***
M38 ZANUSSI	-0.141419	0.0320704	-4.4097	0.00001	***
M39 BECKEN	-0.39816	0.0442046	-9.0072	<0.00001	***

Table. A3 Main descriptive statistics for location, retailers and brand (Refrigerators)

Variable	Mean	Standard Deviation
L1 Galicia	0,169760	0,375507
L2 Basque Country	0,194658	0,396027
L3 Valencia	0,197374	0,398107
L4 Seville	0,149842	0,356997
L5 Madrid	0,144862	0,352041
L6 Barcelona	0,143504	0,350665
T1 Alcampo	0,0746944	0,262957
T2 MediaMarkt	0,344047	0,475164
T3 Carrefour	0,103667	0,304897

T4 Worten	0,137619	0,344577
T5 Miro	0,106836	0,308974
T6 Eroski	0,0452694	0,207941
T7 Bermudez	0,0267089	0,161268
T8 Saturn	0,0674513	0,250859
T9 ElCorteInglés	0,0701675	0,255487
T10 Expert	0,00226347	0,0475328
T11 Milar	0,0212766	0,144338
M1 AEG-ELECTROLUX	0,0334993	0,179977
M2 HOTPOINT-ARISTON	0,00769579	0,0874072
M3 ASPES	0,00497963	0,0704065
M4 BALAY	0,0534178	0,224916
M5 BECKEN	0,00407424	0,0637140
M6 BEKO	0,00135808	0,0368355
M7 BOSCH	0,0760525	0,265142
M8 CANDY	0,0389316	0,193476
M9 CARREFOUR HOME	0,0104120	0,101529
M10 COMFEE	0,000452694	0,0212766
M11 CORBERÓ	0,00633771	0,0793750
M12 DAEWOO	0,0348574	0,183460
M13 DE DIETRICH	0,00407424	0,0637140
M14 ECRON	0,00769579	0,0874072
M15 EDESA	0,0602082	0,237926
M16 ELECTROLUX	0,0461747	0,209911
M17 ELEGANCE	0,00769579	0,0874072
M18 ESVAM	0,00181077	0,0425243

M19 EUROTECH	0,00543232	0,0735205
M20 EXQUISIT	0,000452694	0,0212766
M21 FAGOR	0,107288	0,309550
M22 HAIER	0,0113173	0,105803
M23 HISENSE	0,00135808	0,0368355
M24 HOOVER	0,00407424	0,0637140
M25 INDESIT	0,0633771	0,243695
M26 KUNFT	0,00316885	0,0562160
M27 KYMPO	0,000452694	0,0212766
M28 LG	0,0941603	0,292118
M29 LIEBHERR	0,0679040	0,251638
M30 MIELE	0,0135808	0,115769
M31 MYBALAY	0,00181077	0,0425243
M32 NORWOOD	0,000905387	0,0300828
M33 PANASONIC	0,00226347	0,0475328
M34 SAIVOD	0,00543232	0,0735205
M35 SAMSUNG	0,0683567	0,252414
M36 SEVERAL	0,00181077	0,0425243
M37 SEVERIN	0,00181077	0,0425243
M38 SHARP	0,000905387	0,0300828
M39 SIEMENS	0,0507017	0,219437
M40 SMEG	0,00814848	0,0899208
M41 TEKA	0,00679040	0,0821422
M42 TENSAI	0,000452694	0,0212766
M43 VANGUARD	0,000452694	0,0212766
M44 WESTWOOD	0,000905387	0,0300828

M45 WHITE WESTINGHOUSE	0,00362155	0,0600838
M46 WHIRLPOOL	0,0493436	0,216633
M47 ZANUSSI	0,0239928	0,153061

Table. A4 Estimations for location, retailers, and brand (Refrigerators)

Variable	Coefficient	Stand.Dev	t-statistic	p	
L2 Basque Country	0,0632133	0,0178257	3,5462	0,00040	***
L3 Valencia	0,0321248	0,0139628	2,3007	0,02150	**
L4 Seville	0,0341917	0,0141975	2,4083	0,01611	**
L5 Madrid	0,0431768	0,0169523	2,5470	0,01094	**
L6 Barcelona	0,0413875	0,0149085	2,7761	0,00555	***
T2 MediaMarkt	0,0407181	0,0213245	1,9095	0,05634	*
T3 Carrefour	0,0299728	0,0232492	1,2892	0,19747	
T4 Worten	0,0396041	0,0225399	1,7571	0,07905	*
T5 Miro	0,0909524	0,0235457	3,8628	0,00012	***
T6 Eroski	0,0150963	0,0298867	0,5051	0,61353	
T7 Bermudez	0,0720643	0,0364132	1,9791	0,04794	**
T8 Saturn	0,0293243	0,0257403	1,1392	0,25474	
T9 ElCorteInglés	0,181768	0,0283183	6,4187	<0,00001	***
T10 Expert	0,161605	0,103329	1,5640	0,11797	
T11 Milar	0,0390694	0,0353885	1,1040	0,26971	
M2 HOTPOINT-ARISTON	-0,419308	0,081028	-5,1748	<0,00001	***
M3 ASPES	-0,307396	0,0356946	-8,6118	<0,00001	***
M4 BALAY	-0,178103	0,027889	-6,3861	<0,00001	***
M5 BECKEN	-0,457842	0,0338363	-13,5311	<0,00001	***

M6 BEKO	-0,397844	0,0570477	-6,9739	<0,00001	***
M7 BOSCH	-0,021943	0,028019	-0,7831	0,43363	
M8 CANDY	-0,287942	0,0312219	-9,2225	<0,00001	***
M9 CARREFOUR HOME	-0,491218	0,0383342	-12,8141	<0,00001	***
M10 COMFEE	0,427415	0,0496321	8,6117	<0,00001	***
M11 CORBERÓ	-0,493611	0,0341462	-14,4558	<0,00001	***
M12 DAEWOO	-0,472967	0,0316291	-14,9535	<0,00001	***
M13 DE DIETRICH	0,0835603	0,0497823	1,6785	0,09340	*
M14 ECRON	-0,5339	0,0551673	-9,6778	<0,00001	***
M15 EDESA	-0,302501	0,0278071	-10,8786	<0,00001	***
M16 ELECTROLUX	-0,0757218	0,0370042	-2,0463	0,04085	**
M17 ELEGANCE	-0,65165	0,0627134	-10,3909	<0,00001	***
M18 ESVAM	-0,64533	0,0395066	-16,3348	<0,00001	***
M19 EUROTECH	-0,548656	0,0427469	-12,8350	<0,00001	***
M20 EXQUISIT	-0,406128	2,9302	-0,1386	0,88978	
M21 FAGOR	-0,105422	0,0261036	-4,0386	0,00006	***
M22 HAIER	-0,513856	0,0695364	-7,3898	<0,00001	***
M23 HISENSE	-0,579277	0,137648	-4,2084	0,00003	***
M24 HOOVER	-0,4937	0,0981807	-5,0285	<0,00001	***
M25 INDESIT	-0,440609	0,0306288	-14,3854	<0,00001	***
M26 KUNFT	-0,551497	0,0400949	-13,7548	<0,00001	***
M27 KYMPO	-0,0733194	0,0287993	-2,5459	0,01097	**
M28 LG	-0,20566	0,0294761	-6,9772	<0,00001	***
M29 LIEBHERR	0,132956	0,0295279	4,5027	<0,00001	***

M30 MIELE	0,274463	0,0444984	6,1679	<0,00001	***
M31 MYBALAY	-0,373192	0,16085	-2,3201	0,02043	**
M32 NORWOOD	-0,59957	0,0692358	-8,6598	<0,00001	***
M33 PANASONIC	-0,0498537	0,0797589	-0,6251	0,53200	
M34 SAIVOD	-0,510927	0,145506	-3,5114	0,00046	***
M35 SAMSUNG	-0,205813	0,0309577	-6,6482	<0,00001	***
M37 SEVERIN	-0,257007	0,0733404	-3,5043	0,00047	***
M38 SHARP	-0,430325	0,0822236	-5,2336	<0,00001	***
M39 SIEMENS	-0,00517677	0,028145	-0,1839	0,85408	
M40 SMEG	-0,130258	0,103145	-1,2629	0,20678	
M41 TEKA	-0,331209	0,0683998	-4,8423	<0,00001	***
M43 VANGUARD	-0,248279	0,0479215	-5,1810	<0,00001	***
M44 WESTWOOD	-0,658148	0,140814	-4,6739	<0,00001	***
M45 WHITE WESTINGHOUSE	-0,278013	0,0554739	-5,0116	<0,00001	***
M46 WHIRLPOOL	-0,273367	0,0281256	-9,7195	<0,00001	***
M47 ZANUSSI	-0,246607	0,0330347	-7,4651	<0,00001	***

Table. A5 Main descriptive statistics for location, retailers and brand (Dishwashers)

Variable	Mean	Standard Deviation
L1 Galicia	0.133462	0.340238
L2 Basque Country	0.166344	0.372570
L3 Valencia	0.200193	0.400339
L4 Seville	0.148936	0.356198

L5 Madrid	0.181818	0.385881
L6 Barcelona	0.169246	0.375150
T1 Alcampo	0.0841393	0.277731
T2 MediaMarkt	0.332689	0.471404
T3 Carrefour	0.134429	0.341278
T4 Worten	0.116054	0.320445
T5 Miro	0.0918762	0.288991
T6 Eroski	0.0464217	0.210498
T7 Bermudez	0.0251451	0.156641
T8 Saturn	0.0676983	0.251349
T9 ElCorteInglés	0.0822050	0.274810
T10 Expert	0.00773694	0.0876614
T11 Milar	0.0116054	0.107153
M1 AEG-ELECTROLUX	0.0647969	0.246286
M2 APELL	0.000967118	0.0310985
M3 ASPES	0.0135397	0.115626
M4 BALAY	0.0764023	0.265769
M5 BOSCH	0.140232	0.347396
M6 BECKEN	0.00290135	0.0538120
M7 BLUESKY	0.000967118	0.0310985
M8 CANDY	0.0367505	0.188240
M9 CARREFOUR HOME	0.00773694	0.0876614
M10 CORBERÓ	0.00386847	0.0621067
M11 DAEWOO	0.00580271	0.0759909
M12 DE DIETRICH	0.00290135	0.0538120
M13 ECRON	0.0116054	0.107153

M14 EDESA	0.0531915	0.224524
M15 ELECTROLUX	0.0705996	0.256279
M16 ELEGANCE	0.00290135	0.0538120
M17 FAGOR	0.168279	0.374294
M18 HOME CARREFOUR	0.00773694	0.0876614
M19 HOTPOINT ARISTON	0.00580271	0.0759909
M20 INDESIT	0.0454545	0.208400
M21 KUNFT	0.00290135	0.0538120
M22 LG	0.0232108	0.150645
M23 MIELE	0.0348162	0.183403
M24 NORDWOOD	0.000967118	0.0310985
M25 SAIVOD	0.00580271	0.0759909
M26 SAMSUNG	0.00580271	0.0759909
M27 SELECT LINE	0.0106383	0.102642
M28 SIEMENS	0.0473888	0.212572
M29 SMEG	0.0125725	0.111474
M30 TEKA	0.0203095	0.141125
M31 WHIRLPOOL	0.0609284	0.239315
M32 WHITE WESTINGHOUSE	0.00290135	0.0538120
M33 ZANUSSI	0.0483559	0.214621
M34 GAGGENAU	0.000967118	0.0310985

Table. A6 Estimations for location, retailers, and brand (Dishwashers)

Variable	Coefficient	Stand.Dev	t-statistic	p	
L2 Basque Country	0.0397859	0.0163064	2.4399	0.01488	**
L3 Valencia	0.0233408	0.0143378	1.6279	0.10389	
L4 Seville	0.0180421	0.0154505	1.1677	0.24322	
L5 Madrid	-0.00723976	0.0159277	-0.4545	0.64955	
L6 Barcelona	0.037197	0.0155497	2.3921	0.01695	**
T2 MediaMarkt	-0.00603457	0.0146125	-0.4130	0.67972	
T3 Carrefour	0.0693018	0.0190408	3.6397	0.00029	***
T4 Worten	-0.0152746	0.0192584	-0.7931	0.42790	
T5 Miro	0.0876567	0.0186384	4.7030	<0.00001	***
T6 Eroski	0.0745703	0.0187256	3.9823	0.00007	***
T7 Bermudez	0.14968	0.0315102	4.7502	<0.00001	***
T8 Saturn	-0.020249	0.020924	-0.9677	0.33343	
T9 ElCorteInglés	0.143218	0.0183941	7.7861	<0.00001	***
T10 Expert	0.0155095	0.082356	0.1883	0.85067	
T11 Milar	0.0970123	0.0410446	2.3636	0.01831	**
M2 APELL	-0.40673	0.0288589	-14.0937	<0.00001	***
M3 ASPES	-0.271245	0.0388819	-6.9761	<0.00001	***
M4 BALAY	-0.029393	0.0282604	-1.0401	0.29858	
M5 BOSCH	0.0478179	0.0280761	1.7032	0.08888	*
M6 BECKEN	-0.281433	0.0643438	-4.3739	0.00001	***
M8 CANDY	-0.130722	0.0470269	-2.7797	0.00555	***
M9 CARREFOUR HOME	-0.499412	0.0380564	-13.1229	<0.00001	***

M10 CORBERÓ	-0.427511	0.0545997	-7.8299	<0.00001	***
M11 DAEWOO	-0.45207	0.0572378	-7.8981	<0.00001	***
M12 DE DIETRICH	-0.147349	0.120745	-1.2203	0.22265	
M13 ECRON	-0.272183	0.054155	-5.0260	<0.00001	***
M14 EDESA	-0.131679	0.0308893	-4.2629	0.00002	***
M15 ELECTROLUX	0.0141147	0.0257229	0.5487	0.58333	
M17 FAGOR	-0.0273468	0.0259217	-1.0550	0.29171	
M18 HOME CARREFOUR	-0.484519	0.0414191	-11.6980	<0.00001	***
M19 HOTPOINT ARISTON	-0.187088	0.0553041	-3.3829	0.00075	***
M20 INDESIT	-0.290984	0.0345424	-8.4240	<0.00001	***
M22 LG	-0.1288	0.0580258	-2.2197	0.02668	**
M23 MIELE	0.506637	0.0408137	12.4134	<0.00001	***
M24 NORDWOOD	-0.529087	1.68797	-0.3134	0.75401	
M25 SAIVOD	-0.365334	0.0588595	-6.2069	<0.00001	***
M26 SAMSUNG	-0.0577015	0.0381582	-1.5122	0.13084	
M27 SELECT LINE	-0.603966	0.0345843	-17.4636	<0.00001	***
M28 SIEMENS	0.118675	0.0387393	3.0634	0.00225	***
M29 SMEG	-0.123677	0.0965571	-1.2809	0.20057	
M30 TEKA	-0.234249	0.0409149	-5.7253	<0.00001	***
M31 WHIRLPOOL	-0.129955	0.0305298	-4.2567	0.00002	***
M32 WHITE WESTINGHOUSE	-0.329099	0.147629	-2.2292	0.02604	**
M33 ZANUSSI	-0.157279	0.0298118	-5.2757	<0.00001	***
M34 GAGGENAU	-0.19252	0.0296483	-6.4935	<0.00001	***

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