Price Premium for High-Efficiency Refrigerators and Calculation of Price-Elasticities for Close-Substitutes: Combining Hedonic Pricing and Demand Systems

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Ibon Galarraga, David Heres Del Valle and Mikel González-Eguino*

Abstract

This article uses the hedonic pricing method to estimate the price premium paid for the highest energy-efficiency label (A+) in the refrigerators market of the Basque Autonomous Community (Spain). The estimated figure is 8.9% of the final price or about 60 euro, which represents one third of the energy savings that a consumer gets during the lifetime of a refrigerator with the highest energy-efficiency label. This figure is then combined with the linear version of the Almost Ideal Demand System (LA/AIDS) to obtain own and cross-price elasticities of demand. The information presented here is useful for policy design and analysis. The results indicate that the demand for refrigerators with the highest energy-efficiency label is highly sensitive to price variations.

JEL: C13, C21

Keywords: demand systems, hedonic pricing, energy efficiency labelling, household appliances

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1. Introduction

The energy sector accounts for 84% of global carbon dioxide (CO2) emissions and 64% of the world's greenhouse-gas (GHG) emissions, and it is at the heart of the transformation needed to move towards a low carbon economy (IEA 2009). Energy efficiency policies are essential to reduce GHG emissions and save resources. The International Energy Agency (IEA) states that energy efficiency measures can reduce up to 10-15% of global CO2 per year at no additional cost (IEA 2009). Among the existing abatement options, the replacement of old appliances is considered by some as the most cost-effective short term measure (McKinsey 2009). However, private investments in energy efficiency that at first glance might seem economically worthwhile are not always undertaken. The so-called energy efficiency paradox (Jaffe et al. 2004, Linares and Labandeira 2010) can be explained by existing barriers such as insufficient information, principal-agent problems, lack of access to capital or divergences between social and private discount rates. Understanding these barriers and what hinders widespread consumption of highly efficient appliances is very important for the design of effective policies.

Energy labelling is an interesting measure to overcome the lack of information barrier by providing consumers the necessary information. In fact, the use of information on energy and other resources consumption in household appliances in the European Union (EU) was regulated in early 1990s by the Council Directive 92/75/ECC and the following amending acts.[1] Since 2008 there exists a Proposal for a Directive of the European Parliament and of the Council on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (COM 2008a).

These days, energy labelling is acquiring a major importance in the light of the Climate and Energy package of the EU (COD 2008, and COM 2008b) that sets a target for reducing energy consumption by 20% by 2020 and an objective of 27% energy savings in the residential sector compared to 1990 (European Council 2006). It is fairly recent that information contained in the labels has been used to support other energy efficiency polices such as direct subsidies to consumers purchasing efficient appliances which are usually more expensive than less efficient ones.

[1] Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances.

Many studies have dealt with the role of different labels in promoting environmentally friendly goods (Rex and Baumann 2007, Amstel et al 2008, Galarraga, 2002). Within the economic literature, questionnaire information has been extensively used to elicit the price premium embedded in environmentally-friendly goods (Galarraga 2002, Smith 1990, and Levin 1990). The relatively recent emergence of this type of goods' differentiation is one of the reasons why market data are commonly not readily available for analysis. In the particular case of durables, publicly available data on prices and consumption for labelled ones are not yet available in many countries.

With regards to energy efficiency, previous literature on the effects of efficiency or different energy labels on the price of appliances is not abundant and still inconclusive. Farinelli et al (2005), for instance, analyse the "White and Green" certificates under the EU SAVE Programme using technical–economic models of the MARKAL family. They show that by 2020 it is possible to increase energy efficiency up to 15% at no significant cost (and even more if externalities are taken into account) arguing that energy certificates have a major role to play in this. Boyd et al (2008) analyse the labelling program set up by the Environmental Protection Agency in 1992, the so-called ENERGY STAR, US using a specific energy performance indicator.

More specifically for house hold durables, Mills and Schleich (2010) surveyed the relevance of class-A energy label attribute in the choice of five major household appliances for Germany. They found that residential characteristics and regional electricity prices increase the propensity to purchase a class-A appliance but that socio-economic characteristics have little impact. Sammer and Wüstenhagen (2006) explored how energy labels affect consumers´ purchasing decisions for washing machines using choice-based conjoint interviews in Switzerland. They found that brands are much more relevant than energy-efficiency attributes. However, consumers were willing to pay a premium of 30% for the energy efficiency represented by a label. Shen and Saijo (2009) conducted a choice experiment in Shanghai, China to examine whether the energy label affects the choice of air conditioners and refrigerators. The authors concluded that consumers have a greater incentive to pay for appliances they use more frequently and not so much for the associated energy savings. Other studies such as Markandya et al. (2009) have looked at the incentives to promote the use of energy-efficient labels comparing policy instruments such as subsidies and taxes. That study would have greatly benefited from having values for price elasticities of demand as the ones calculated in section 3 of the present study.

A common ground for the previous literature on energy efficiency and appliances prices is that they are not based on market data or revealed-preference approaches. They are instead based on direct or stated-preference methods in which individuals are faced with hypothetical situations. On the other hand, indirect (i.e., behavioural or revealed-preference methods) approaches such as the hedonic price technique have been extensively used to estimate the monetary value of environmental amenities in other markets. In the case of durable goods such as automobiles, Griliches (1961) was an early application of the method in the context of adjusting price indexes for quality changes. Atkinson and Halverson (1985) applied the hedonic method to obtain estimates of the fuel efficiency demand in cars, while the objective in Couton et al. (1996) was to estimate hedonic prices for different environmental-related characteristics of cars. For the case of non-marketable environmental attributes, the technique was surveyed by Palmquist (1999). Other studies for non-durable goods include Delmas and Grant (2010), Nerlove (1995), Oczkowski (1994, 2001) and Galarraga and Markandya (2004).

At the best of our knowledge, there are no applications of the hedonic method for the case of energy label and household appliances.[2] Nevertheless, such type of studies would be of great value to complement, and compare to, the results from survey-based analyses.

The first part of this paper estimates the price premium paid for the most energy-efficient labels in the refrigerators market using the hedonic price technique. This technique allow us to estimate, *ceteris paribus*, a proxy of what consumers pay for this single characteristic of the good. The case of the household electrical appliances renewal program is analysed in the Basque Autonomous Community (BAC), Spain.[3] The program is part of the Spanish Energy Saving and Efficiency Action Plan that sets a minimum of 50 euro as a lump sum subsidy to consumers (both public or private) willing to purchase the most energy-efficient durables, i.e. labelled as class A+. [4] The program starts at the beginning of the year with an approved budget and it is run until a certain date or until the budget is finished. Therefore retailers are not certain about how long the program will last for and in fact, no certainty exists either

[2] In a study aimed at evaluating the impact of mandated energy standards on the prices of refrigerators, Greening et al. (1997) found a very small contribution of the annual energy consumption on the price after controlling for other characteristics. Our study differs from theirs not only on the purpose, region and period analysed, but on the attribute of interest. In our case the energy-efficiency attribute is more salient given the labels for different energy consumption classes.

[3] This program is managed by the Institute for Energy Diversification and Saving (IDAE) www.idae.es

[4] As the program is run by the Government of each of the Autonomous Communities the amount of the actual subsidy can vary from 50 to 95-100 euro depending on the region analysed.

regarding how (or if) the program will be run in the near future. The discount is applied by the retailer over the final price at the time of purchase.

The second part of the study is devoted to the calculation of own and cross-price elasticities with the use of the conditions of the Linear Almost Ideal Demand System (LA/AIDS). This demand system derived from consumer theory has been extensively used to econometrically obtain elasticities from data on household expenditures. The conditions imposed by the system are adopted to obtain a set of elasticities taking a fraction of them from previous literature, while prices and expenditure shares are collected from other data sources. The information provided by a full set of own and cross-price elasticities is crucial for both an optimal design of the policy and to support any fine tuning and revision of the policy outcome.

The final section of the paper lists some limitations of the study and presents conclusions and policy recommendations.

2. Estimating the price-premium for the most energy-efficient refrigerators

The data used in the hedonic estimation was collected in December 2009 from nineteen different retailers that include a representative number of malls, small town-shops and medium size specialised stores in the three provinces of the BAC.[5] Importantly, at the time of the data collection the subsidy scheme for that year was not running. The number of refrigerator models displayed in the stores was 404 representing 42 different brands produced by 26 different producers.

Due to missing or incorrect information the analysis was restricted to a final sample of 676 observations (out of 788 originally contained in the dataset).[6] A total of 65, most of them indicator, variables were used to explain the natural logarithm of the price in euro of the different refrigerators sold in the market. A description and summary of the variables used to estimate the hedonic price function are respectively given in Tables 1 and 2. From the latter,

[5] As each autonomous community manages its own version of the IDAE general program the amount of subsidy varies slightly among regions. Therefore it is reasonable to only focus on one of the markets that are affected by the instruments, in this case the Basque market. The Centre for Energy and Mining Savings and Development (CADEM) runs the program locally.

[6] The dataset contained other valuable information such as type of motor, fridge/freezer arrangement, controls, alarms and other amenities that were however not reported for a large share of the models and therefore were discarded from the analysis. The price of one refrigerator was misreported with a price above 9000 euro. The number of observations exceeds the number of models because some could be foun
d in more than one store. As it will be explained the study controls for store type and location.

the mean price is 658 euro and 24% of the refrigerators in the sample have the A+ label. Furthermore, almost 70% come with a defrost mechanism, 2% can be integrated into the wall, and 32% are not white.

Table 1. Description of explanatory variables

Variable	Description
aplus	Equal to 1 if label is A+; 0 if other
volum	Volume of the refrigerator in cubic meters
integ	Equal to 1 if refrigerator can be integrated into the wall; 0 otherwise
dfros	Equal to 1 if refrigerator has a defrosting mechanism; 0 otherwise
color	Equal to 1 if refrigerator is of color other than white; 0 otherwise
Store	8 dummies equal to 1 if refrigerator is sold in a given type of retailer; 0 otherwise
Location	10 dummies equal to 1 if refrigerator is sold in a given location; 0 otherwise
Brand	42 dummies equal to 1 if refrigerator is of a given brand; 0 otherwise

Table 2. Summary statistics

	Mean	Std. Dev.	Min	Max
price	657.59	323.29	119.00	2130.00
aplus	0.24	0.43	0.00	1.00
volum	692.30	171.46	105.75	1285.20
integ	0.02	0.14	0.00	1.00
dfros	0.69	0.46	0.00	1.00
color	0.32	0.46	0.00	1.00

The number of observations is 676. Descriptive statistics for type of store, location, and brand are also available from the authors upon request.

Given the dichotomous nature of all but one of our explanatory variables, different functional forms were not explored and the simple log-linear model below was estimated,

$$lprice_i = \alpha + x_i ' \beta + z_i ' \delta + \varepsilon_i \qquad (1)$$

where $lprice_i$ is the natural logarithm of the price of the i^{th} refrigerator, α is a constant, x_i and z_i are vectors respectively containing the characteristics of the refrigerator and those of the store in which it is sold. The vector of coefficients associated with the explanatory variables are β and δ and the error ε_i is assumed to be uncorrelated with x_i and z_i.

Table 3. Regression output

Dependent variable: *lprice*	
aplus	0.0890***
	(0.0220)
volum	0.0016***
	(0.0001)
integ	0.1453**
	(0.0554)
dfros	0.0887***
	(0.0240)
color	0.1888***
	(0.0186)
const	5.2235***
	(0.0763)
N	676
R-squared	0.8580

Standard errors in parentheses

*p<0.10, **p<0.05, ***p<0.01

Table 3 reports the results from the estimation of (1) by Ordinary Least Squares (OLS) with heteroskedastic-robust standard errors. Information about the market shares of each of the models was not available and therefore no sampling weights are incorporated into our estimation. Although this precludes us from extrapolating our results to the entire population of refrigerators sold in the region, a structural interpretation is valid. That is, the estimated effects of the explanatory variables on the price of the refrigerators in the sample are unbiased. The resulting R-squared (0.86) suggests that the model fits the data and explains a large share of the variation in price. We also estimated a linear model (i.e., with the dependent variable in levels) which provided identical results for most of the variables in the model including the effect of the variable of interest, aplus. We opted for the log-lin model because it better fitted the data showing an R-squared twice as large as that from the linear model.

After controlling for other characteristics of the appliance, including the brand of the refrigerator and store-specific variables, the statistically significant coefficient for *aplus* is 0.089. Everything else equal, this means that the price of a refrigerator showing an A+ energy-efficiency label would be 8.9% higher than that with an A label. For an estimated average price of refrigerators of 658 euro, only increasing efficiency and therefore the label from A to A+, would increase the price by 58.5 euro. Note that while the minimum subsidy regulated by the Royal Decree is 50 euro[7], the authorities at the BAC subsidise up to 70 euro (and 105 euro in some special cases).

Table 3 also shows that the coefficients for other characteristics are statistically significant and have the expected signs. For instance, larger refrigerators are more expensive, while refrigerators with defrosting mechanism and with colour other than white respectively have prices 8.9% and 19% higher everything else equal. Built-in refrigerators (integ=1) carry a price-premium of 14.5% over those that cannot be integrated. Not reported here, most of the store-related and brand coefficients are also significant at the 1% level. The full set of estimates is available from the authors upon request.

If it is considered that appliances with different energy labels result in different energy costs throughout the lifecycle of the good, it is possible to estimate how much the net saving is. This figure could also be interpreted as a for an energy savings premium. That is the amount that a consumer in a situation free from any of the barriers to adoption in Jaffe et al. (2004)

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[7] Royal Decree 208/2005, 25 February 2005, on electrical appliances and electronic devices and the management of their wastes.

would be expected to pay for a fridge with a higher-efficiency label. As shown in Table 4, over the lifetime of a refrigerator the total discounted savings of substituting an A labeled fridge for an A+ labeled one is 163 euro. This has been calculated taking into account average energy consumption, average cost of the energy and the energy savings. This energy savings premium accounts for 24% of the average price. Indeed, a figure significantly higher (three times) than the market premium estimated with the hedonic method. Nevertheless, as previous research has shown, private discount rates can be higher due to a myriad of factors including the uncertainty about future energy prices. This in turn would reduce the present value of the net savings.

Table 4: Energy Savings and price premiums for refrigerators with different labels (€)

Class	Energy Consumption in 15 years (kWh)	Average Total Cost in 15 years	Total Savings if substitute by A+	Energy Savings Price Premium
A++	2956	414	-152.5	-21.2%
A+	4138	579	0	-
A	5420	759	163.4	24.8%
B	6406	897	294.5	35.7%

Source: Calculations based on data from IDAE (2007)

Note. Average energy consumption and 0.14€ per kWh are considered. The discount rate is 5%. The price premium is calculated dividing total discounted savings during the lifetime (15 years) of the refrigerator by the average cost of that type of refrigerator.

3. Calculation of own and cross-price elasticities for the most energy-efficient refrigerators

Information about price differentials between highly energy efficient and other refrigerators is undoubtedly useful for energy policy formulations. However, a complete welfare assessment would necessitate estimates of price elasticities for the different types of refrigerators. That is, measures of the sensitivity of demand for the most energy-efficient refrigerators with respect to their own price as well as to the price of other less energy-efficient refrigerators. Ideally, policy makers would use a demand-supply system to evaluate policies such as differential taxation or infrastructure support to suppliers of energy efficient refrigerator. However, given the data available, this paper can only provide information on the demand side.

In this section the use of a demand system is reported for close substitutes following the approach presented in Galarraga and Markandya (2003). The method allows to estimate the own price elasticity for energy efficient refrigerator and the cross price elasticities between energy efficient and other refrigerators. The hedonic price premium for the A+ label refrigerators from the previous section is used along with some other information to obtain own and cross-price elasticities for A+ fridges. These are derived through a simple algorithm based on the conditions of the linear version of Deaton and Muellbauer's (1980) AIDS. This demand system has been extensively used to estimate demand for housing attributes (Parsons 1986), food (Molina 1993 and 1994, Blanciforti and Green 1983, and Fulponi 1989) and tourism services (Lanza 1998). Most of these studies provide estimates of the own and cross price elasticities for broad groups of goods, e.g. food, clothing, energy, etc. (Anderson and Blundell 1983); bread and cereals, fish etc. (Molina 1994). Other models that look at price elasticities of durables, such as Dale and Fujita 2008, do not provide estimates of cross price elasticities for close substitutes.

In the following the structure of the LA/LAIDS is presented:

The demand system is composed by refrigerators with A+ label (L), refrigerators with other energy label (O), and a composite good (X) that represents the rest of goods consumed by households. The demand functions (in expenditure shares) are defined as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln(M / P) \qquad \text{for } i,j = L, O, \text{ and } X \qquad (2)$$

where w_i is the expenditure share of good i and α_i, γ_{ij} and β_i are unknown parameters. P_j is the price of good j, M is total expenditure, and P is Stone's price (Stone 1954) index defined by[8],

$$\ln P = \sum_i w_i \ln P_i \qquad (3)$$

Three sets of conditions known as additivity, homogeneity and symmetry are imposed by the LA/AIDS,

[8] Moschini (1995) argues that the eqution only holds approximately.

$$\sum_i \alpha_i = 1, \ \sum_i \gamma_{ij} = 0, \ \sum_i \beta_i = 0 \qquad (4)$$

$$\sum_j \gamma_{ij} = 0 \qquad (5)$$

$$\gamma_{ij} = \gamma_{ji} \qquad (6)$$

The expenditure shares for each of the three goods are derived from market information collected in 2009 and data from the expenditure surveys from Eustat (2009)[9]. These expenditure shares are:

$$w_L = 0.00056; \ w_O = 0.00084; \ w_X = 0.99860$$

Note that using the price information from the hedonic function allows us to treat refrigerators with A+ energy label as one good and the rest of the refrigerators as another. If, instead, an average price of both types of refrigerator is used, differences in the rest of characteristics would not be controlled for and the estimates would reflect other differences such as quality, colour and brand among others. The hedonic pricing estimation showed that consumers pay 8.9% of the final price for the "A+ energy label" characteristic.[10]

Following Galarraga and Markandya (2003), in a system of 3 goods, there will be 12 elasticities to be determined. Taking 5 of them as given, a subset of 7 elasticities can be obtained by using the elasticities formulae provided in Table 5 together with the conditions in equations (4)-(6), as well as estimates of total expenditure, expenditure shares, and prices of the three goods in equations (2) and (3). Note that not all of the equations (4)-(6) are independent. In particular, symmetry and additivity conditions together yield the homogeneity conditions.[11]

[9] Expenditure shares for the two types of refrigerators were calculated using the information on market sales, the average price (with A+ and other label) and distributing the costs over the lifetime of a refrigerator.

[10] Had the mean price of A+ labeled fridges been compared with others the difference would have been almost 45%. As mentioned, however, this premium would also include effects from other characteristics.

[11] We have in principle 23 equations distributed as follows: 5 additivity, 3 homogeneity, 3 symmetry, and 12 elasticities. However, only the additivity condition involving the β's is used due to the mentioned dependencies, and because the α's are not needed to calculate elasticities. That leaves 19 equations and 24 unknowns since we are already assuming the values for the three w's. From the set of unknowns the ones that could be obtained from the literature or assumed are some of the elasticities because any speculation about the magnitudes of the rest of parameters would be difficult to justify.

Table 5: Uncompensated Price and Income Elasticities Formulae

Elasticity	**Formulae**
Own price for good *i*	$\eta_{ii} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1$
Cross price *j* on good *i*	$\eta_{ij} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i}$
Income *y* on good *i*	$\eta_{iy} = 1 + \frac{\beta_i}{w_i}$

The evidence from the literature suggests that the price elasticities of demand for regular refrigerators (η_{OO}) are in the range of -0.25 and -0.75. In addition, an income elasticity (η_{OY}) of 0.8 is also within the ranges of other studies. (Revelt and Train 1997, Dale and Fujita 2008). Table 6 assumes equal income elasticities of both substitute goods while Table 7 allows for a 20% difference between both by assuming that A+ refrigerators could be considered closer to a luxury good when compared to the regular one.

Table 6: LA/AIDS Elasticity Estimates
(η_{OO}=(-0.25 to -0.75), η_{OL}=(0.01 to 0.1), $\eta_{OY} = \eta_{LY}$= 0.8, η_{Xx}=-1)

	η_{OL}					
	0.01		**0.05**		**0.1**	
η_{OO}	η_{LO}	η_{LL}	η_{LO}	η_{LL}	η_{LO}	η_{LL}
-0.25	0.015	-1.655	0.075	-1.775	0.150	-1.925
-0.5	0.015	-1.280	0.075	-1.400	0.150	-1.550
-0.75	0.015	-0.905	0.075	-1.025	0.150	-1.175

Note: The numbers in bold are the values assumed as given in the model.

It is assumed that the own price elasticity of demand for the composite (η_{XX}) equals -1. This value does not affect the relationship among the substitute goods and thus is taken as a neutral one. Lastly, the cross price elasticity of demand of regular and high energy-efficiency goods (η_{OL}) has been assumed to range from 0.01 to 0.10, similarly to other studies where the market for close substitutes is segmented (Galarraga and Markandya 2003). Other values can also be considered but it is very reasonable to assume that the own price elasticities of demand are much greater than the cross price elasticities among both substitutes. That is, that the expected impact of a price change in a good affects more its own demand than the price changes of the substitute good.

The results presented in Tables 6 and 7 show that A+ refrigerators are much more elastic than those with lower energy efficiency. For an own price elasticity of demand of regular refrigerators ranging from -0.25 to -0.75 and a cross price elasticity from 0.01 to 0.1, the own price elasticity of demand of A+ refrigerators ranges from approximately -0.9 to -2.1; an order of magnitude larger than the values for the other refrigerators own price elasticity. Other studies that have estimated elasticities for (very) close substitutes for the automobile, the computers market or imported versus national domestic goods, find a significant elasticity differences among the substitute goods. (Coad et al 2009, Bordley 1993, Stavins, J (1997) or Ivanova, 2005). Although these do not allow for direct comparison, the results presented in this paper are coherent with those.

Table 7: LA/AIDS Elasticity Estimates

(η_{OO}=(-0.25 to -0.75), η_{OL}=(0.01 to 0.1), η_{OY}=0.8, η_{LY}= 1, η_{Xx}=-1)

	η_{OL}					
	0.01		**0.05**		**0.1**	
η_{OO}	η_{LO}	η_{LL}	η_{LO}	η_{LL}	η_{LO}	η_{LL}
-0.25	0.150	-1.855	0.075	-1.975	0.150	-2.125
-0.5	0.150	-1.480	0.075	-1.600	0.150	-1.750
-0.75	0.150	-1.105	0.075	-1.225	0.150	-1.375

Note: The numbers in bold are the values assumed as given in the model.

Note that mathematically it is possible to assume values for other elasticities such as the cross price elasticities of the substitute goods with the composite good ($\eta_{XO,}$ $\eta_{OX,,}$ η_{LX} or η_{XL}) instead of the values for own price elasticity of demand for the substitute good (η_{OO}) and one of the cross price elasticities for close substitutes (η_{OL}). However, assuming values for the cross-price elasticities with the composite good to explain the relationship between the close substitutes results in unstable outcomes. This is a consequence of the magnitude of the expenditure share of the composite good and how this affects the relationship among the system of equations.

Another interesting feature of the results is that for the range considered in the own price elasticity of the *O* good, the change in the cross price elasticity between *L* and *O* is almost negligible.[12] The intuition is that the change in the price of a given good affects the demand of this good much more than the demand of the substitute one which represents an even smaller share in the budget.

The information presented in Tables 6 and 7 could be very useful for policy purposes as it allows the decision maker to more precisely calculate the levels at which different instruments need to be set in order to achieve specific policy objectives. Instruments such as taxes and subsidies certainly need this information in order to be optimized. Welfare analyses that aim at identifying which sectors are better and worse off from a given policy could also benefit from this information on own and cross-price elasticities of close substitutes.

4. Conclusions

Important global environmental problems such as climate change are nowadays driving energy efficiency policies due to the great energy savings that authorities worldwide are aiming for. The EU 20-20-20 energy and climate package is a good example of ambitious energy saving targets. In this context, energy labelling is also acquiring a major role. Regulated since early nineties, it is around 2008 that has been growing in importance as a useful policy instruments for other policies such as energy taxation or the subsidy schemes used in Spain.

This paper has collected an extensive sample from market transactions in December 2009 and studied the price premium for the most energy efficient refrigerators using the hedonic method. As quantities are simultaneously determined with prices, and as prices are influenced by both supply and demand factors, the technique provides a premium that is the result of the interaction of all these factors. Prices were collected at a time when the subsidy scheme for that year was not operating. This methodology can be complemented with the results obtained from questionnaire based studies and is relevant for policy-makers when designing energy policies.

[12] Although not reported in the papers, only the value for the fifth decimal changes.

Controlling for other important characteristics, this study estimates that the price premium paid in the market for refrigerators carrying the highest energy efficient label is close to 9% (or about 60 euro of the average final price). This result is already an interesting contribution to the labelling and energy efficiency literature as it allows for a direct comparison with results from contingent valuation methods and other studies.

The number is approximately one third of price premium defined as “energy savings” premium, that is, the premium that consumer would be willing to pay if the discounted annual savings during the lifetime of the refrigerator were considered (see Table 4). These results reflect very well the so-called energy efficiency paradox. Even in a case where energy labels help to overcome, partially at least, the lack of information or the existing other barriers, the consumer would still be far away of what s/he would be willing to pay if had known with certainty the amount saved over the lifecycle of the appliance. Perhaps including some information on the energy saved in monetary terms in the labels for appliances could help, although the accuracy of such an estimate would still be subject to consumption patterns and energy prices in the future.

The hedonic method has suggested that in the absence of this information on savings (and no other barriers such as severe budget restrictions) 60 euro should be enough to switch new-appliances-consumers to high energy efficient appliances. Note that the energy efficiency subsidy program at the BAC pays up to 70 euro (while a minimum of 50 euro is regulated for all Spain). It is not clear how the authorities arrived to this number which would certainly fall within a 95-percent confidence interval for *aplus* in Table 3. Due to its simplicity, economy of information, and transparency, the method applied in this paper could be considered in future decisions of this sort.

Preliminary information on the CADEM program[13] that has been running for three years, as well as the market data collected in 2009 for this study strongly suggest that the policy has been very successful so far. Nearly all of the household appliances sold in the market nowadays are labelled A or A+.

Finally, the information from the premium has been combined with the LA/AIDS to estimate own and cross price demand elasticities for refrigerators with different energy labels. The price elasticities calculated suggest that the demand for the most energy-efficient appliances

[13] Personal conversation with the General Director and Vice-President of the CADEM.

is much more elastic than the demand for the rest. In particular, the own price elasticity of demand for the most energy efficient refrigerators ranges from -0.9 to -2.1 when the own price elasticity of demand for the rest is in the range of -0.25 to -0.75. These results are important when considering energy efficiency policies as they allow for better supported welfare analyses.

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