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Household energy efficiency in Ireland: A replication study of ownership of energy saving items

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Abstract

Ownership of energy saving items in the home is surprisingly low in Ireland. Logistic regression analysis of data derived from a survey of households reveals significant reasons for not investing in such items. The reasons are somewhat similar to those found by Brechling and Smith for the United Kingdom. Lack of information, non-appropriability, small potential saving, restricted access to credit and transactions costs play an important role, leaving only a minority of non-owners who are model-inconsistent and who are possibly non-optimisers. Some policy implications are outlined.

JEL: L94; Q41

Keywords: Energy efficiency; Non-optimisers; Home

1. Introduction

There is consistent evidence from Minogue (1980), Pezzey (1984), Shorrock and Henderson (1990), the UK Energy Efficiency Office (1991), O'Rourke (1992) and McSharry (1993), summarised in Appendix A, that the installation of energy conservation items in the home is a good investment, with items such as loft insulation, hot water cylinder insulation and low energy light bulbs displaying excellent rates of return. Viewed as simple investments, they have net present values which are of the order of hundreds of pounds. Other measures, such as draught proofing, dry lining of walls, insulating curtains and, in some circum-

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stances, double glazing, also have profitable roles to play. Despite the worthwhile nature of these investments, possession of energy saving items in Ireland is surprisingly low, as described by Scott (1992).

Brechling and Smith (1992, 1994) noted that markets for these investments may be subject to various forms of market failure, which they investigated using the 1986 English House Condition Survey of just under 7000 households. We have replicated their investigation, with some modifications reflecting the data available to us. Our analysis is based on a survey of some 1200 householders, who were asked about the energy conservation measures in their homes, whereas the UK study used technical data from the 1986 English House Condition Survey.

The discussion starts in Section 2 with a roundup of the suspected reasons which might prevent people from investing in energy saving items — these reasons stem from the basic conditions that are required for a market to function correctly. A brief description of the survey is given in Section 3 and some of its findings are highlighted. Section 4 discusses the logistic regressions, which were undertaken to analyse ownership of conservation items, and gives an interpretation of results. Section 5, summary and conclusions, includes a list of policy suggestions.

2. Reasons why people might not invest in energy conservation

2.1 Information

People might not have information on the worthwhile nature of energy saving investments. The studies that show the high returns to investments could be said to be in the public domain in a restricted sense only. The calculation of potential for fuel savings is likely to be beyond the capability of the average householder. It is not even a calculation which households can become accustomed to undertaking, because it is unlikely to be done many times. Brechling and Smith (1992) avert to another information problem — that consumers use an inappropriate decision rule, by concentrating on the payback period, with little cognisance of the overall savings from then on. In any event, net present values are not generally to hand and might not be widely understood even if they were.

A further problem related to information is rooted in uncertainty and risk. The risks in this case would be the possibility that energy prices might slump, rendering the investment unprofitable, or the possibility that insulation in the home for some particular reason might not be effective. A further risk is that energy conservation technology might shortly improve, CFL bulbs being a case in point, such that investment should be delayed perhaps. Much energy conservation technology has reduced in price in real terms over the past decade or so. In addition people might anticipate that the government will award grants, which might be worth waiting for. However, none of these reasons, on its own, is likely to cause one actually to lose money on the investment.

Consumers may have difficulty in finding out how an energy saving item might

apply in the particular circumstances of the household, and in finding a reliable company to undertake the work. For various reasons the building industry itself has not advertised its services in energy conservation and would appear not to be attracted by relatively small, labour-intensive tasks.

2.2. *Appropriability*

It is not worth people's while to insulate their accommodation if they are renting it and/or are expecting to be moving out shortly because they would not be in a position to appropriate the benefits. Similarly, landlords may consider that expenditure on energy conservation will not be recouped because they will not be able to raise the rent. The finding by Brechling and Smith (1992), that occupants of rented accommodation were less likely to possess loft insulation (in the case of private renters), wall insulation or double glazing, is a consistent demonstration of this. Even house owners may feel that investment is unprofitable if they are about to sell and reckon that the selling price will not be sufficiently enhanced to cover the investment costs.

To some extent information is again at the root of the problem here. If all parties knew and agreed on the net present values of these investments, there would be no difficulty in selling them on. Another problem, bound up with appropriation, is the necessity for negotiation, verification and agreement on a price, which comes under the heading of transactions costs, to be dealt with below. Hence, appropriability is bound up with the need for information and with transactions costs.

2.3. *Savings potential*

The analyses that appraise investments in energy efficiency assume some typical level of energy consumption. However, if the household, for whatever reason, has small energy bills, the potential for saving is likely to be correspondingly small and the investment may not be profitable. In these circumstances less of an opportunity is missed and market failure may not strictly apply. Alternatively, ignorance may also play some part here, as an uninsulated house faces a high cost of comfort so that the area heated is restricted. There is then not much perceived scope for energy saving, though the perception may be misguided. Greater comfort might be possible for little extra cost overall.

In any event, it is likely that households that consume a lot of energy, for example because they have central heating or because they have a large internal space to heat, will have bigger opportunities to make savings from insulation and other energy conservation items. It is therefore to be expected that such households will be more likely to have invested in these items.

2.4. *Access to credit*

Appraisals of energy saving investments indicate that it would be worthwhile

borrowing the funds to undertake the insulation work, using a realistic going rate of interest, as seen from Appendix A. Low income per se should therefore not be a reason for failure to install energy conservation, though low income is frequently observed to be associated with low takeup. However, households in the low-income bracket would face rather higher rates of interest on borrowing, on account of their inability to offer collateral. They may in addition have an aversion to borrowing, as found by Salvage (1992), or not be familiar with the procedures for doing so, other than at punitive rates.

2.5. Transactions costs

There are several other reasons which would cause people to digress from standard optimising behaviour, even if they did have the necessary information. Undertaking energy efficiency investments entails more than just the obvious costs — other hidden costs are present, such as the time and effort required to organise the work to be done, and the prospect of possible mess and hassle. These come under the heading of transactions costs.

There is a further potential reason, which is not easily represented by a variable, which is that some people may simply not be optimisers. Indeed, as pointed out by Brechling and Smith (1992), people might be affected by other factors which we have not adequately identified. Staying with the five reasons listed above, these will be investigated as to their role in deterring people from investing in energy conservation. The investigation is based on the survey, a brief description of which now follows.

3. Survey of ownership of energy conservation items in the home

In November 1992 a survey of some 1200 households was undertaken to find out about their energy conservation behaviour. The Survey was appended to a monthly Consumer Survey, by TEAGASC and ESRI, of a nationally representative random sample of households, stratified by area, drawn from the electoral register, which yields regular information on socio-economic characteristics. Evidence that installation of energy savings items was quite low and comparisons of behaviour between the lowest income quartile and the remainder have already been described by Scott (1993, 1996). To set the context for the present study, we summarise the findings on ownership in Ireland in Fig. 1, graphed (a) by household income and (b) by level of education last attended by the head of household.

The figures show ownership of the main items listed in the questionnaire. These include loft or attic insulation (where applicable), insulation of the hot water cylinder (with a lagging jacket or other material), draught proofing of windows and doors, insulating curtains of thermal or metallic material, dry lining of walls, CFL or low energy light bulbs and double glazing. Respondents were recorded as having an item if they had any of it. Further qualitative information would have been

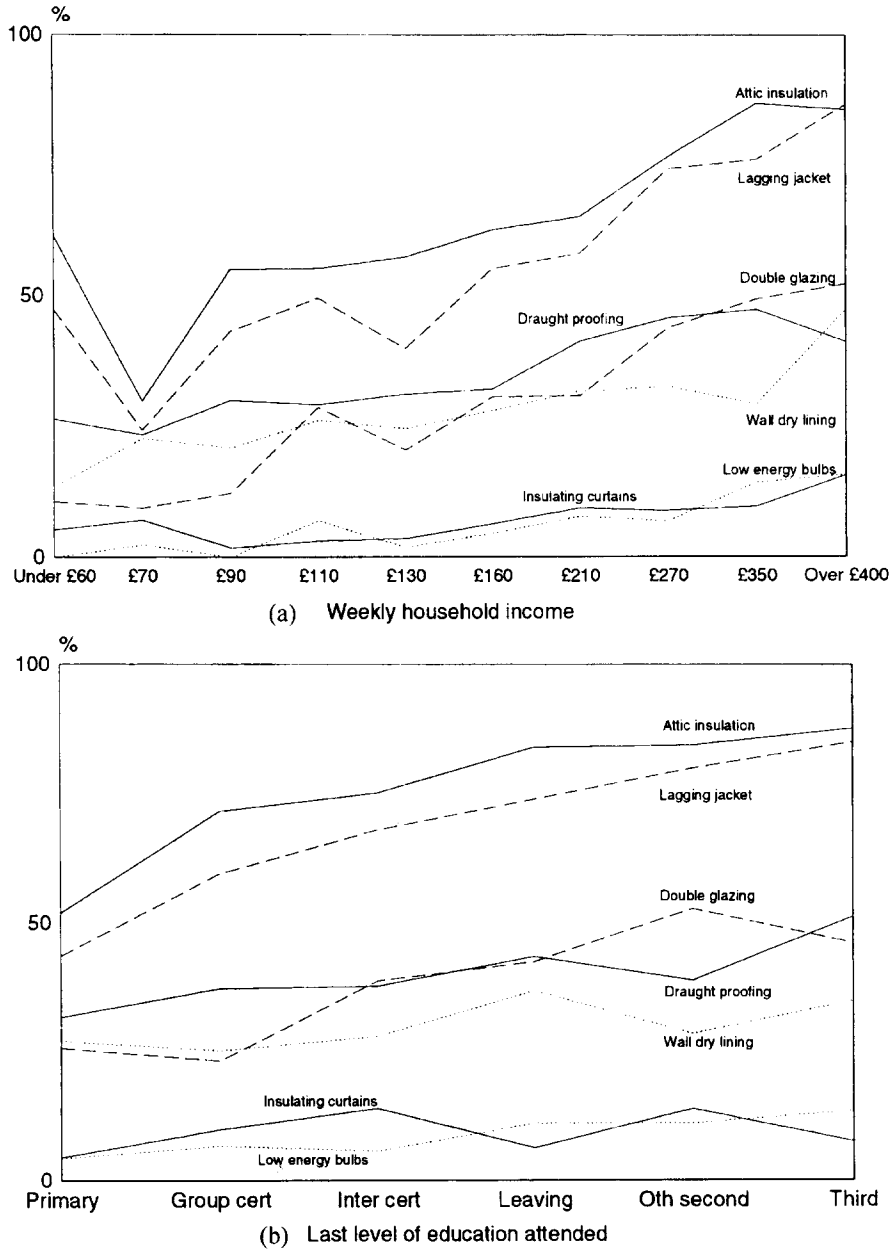

Fig. 1. Percent of households having conservation items (attic insulation applies to houses only) (a) By household income (income at the first quartile, median and third quartile is £114, £178 and £233, respectively). (b) By level of education of the head of household. *Note*: Education labels are in ascending order of level. Primary, primary level; Group cert., group certificate; Inter cert., intermediate certificate; Leaving, leaving certificate; Oth second, other second level (e.g. nursing); Third, third level (university, etc).

useful, on depth of insulation installed for example, but would have been difficult to obtain. It is worth stating that the interviewers were instructed to record 'don't know' when it arose, rather than try to elicit a 'yes' or a 'no', because lack of information was one of the subjects of the investigation.

Since only about two-thirds of households stated their income levels, the remaining third of households have had their incomes imputed. This was possible owing to a reasonable correspondence of the income of those who responded to this question with their socio-economic characteristics, namely with occupation, education, employment status, the number of people attached to the household and the age of the head of household. (Some of the people with the lowest level of recorded income may be in a temporary situation such as being newly unemployed or in college, which could account for some of the uneven pattern in Fig. 1 (a)).

Fig. 1(a) shows the strong positive relationship of ownership of conservation items with income, particularly for attic insulation, lagging jacket, double glazing and for low energy bulbs. In fact, for all items the correspondence is striking. The story is similar in Fig. 1 (b) for ownership by level of education.

Given the high net present value of these items, the overall levels of ownership are somewhat low, as already stated. Raising ownership to more reasonable levels could be worth over £300 million in net present value terms, according to Scott (1993). By contract with UK levels of over 85% ownership of hot water cylinder insulation and loft insulation, neither exceeded 70% in Ireland. However, Ireland does seem to have witnessed an improvement over the previous seven years. A survey of households in 1985/86 by An Foras Forbatha (1988) indicates, for example, 49% ownership of hot water cylinder insulation, compared with our 59%, and 52% for loft insulation compared with our 66%. Double glazing, which plays a less important role in energy conservation than it does in noise reduction and security of the property, has risen from 10% to our 32%.

In relation to hot water cylinder insulation and loft insulation, we find that a relatively high proportion of pensioners and people in higher age brackets do not have these items. Non-owners have a tendency to have completed primary education only, to be farmers or unskilled, and to have low incomes. They typically live in houses built before 1918, have no central heating, use mainly coal for space-heating in winter and rent from local authorities or own their houses outright. Leaving aside these relative proportions, the largest absolute numbers of households not having these items fall in the middle age groups, are in full time employment and in middle income brackets.

When respondents were asked to tick off their reasons for not having some conservation items, they concentrated on the financial reasons. Some 59% gave 'I have more urgent spending priorities', 50% gave 'It is difficult to find the cash or credit' and 34% gave 'The household financial situation is too insecure'. The transaction costs and information problems did not feature so strongly, with less than 30% giving 'It is difficult to get round to it' and 'I do not want the mess or hassle' and less than 15% giving 'It is hard to find a reliable outfit to do it' or 'It is hard to find the time to find out about it'. These replies, however, need to be

analyzed in conjunction with ownership of specific items, requiring a more focused study, to which we now turn.

4. Logistic regression analysis of ownership of energy saving items

Three energy conservation items will be the subject of our attention. They include attic insulation and hot water cylinder insulation, because they are so worthwhile and because ownership is more likely to be known about. Unlike Brechling and Smith we did not have the benefit of a technical survey of the housing stock, and respondents' stated ownership of cavity wall insulation, for example, might not be accurate. The third item in the analysis is low energy light bulbs. In addition to being worthwhile, these bulbs have the potential to make a useful reduction in the evening peak in electricity demand in winter.

We analyse the roles of the five possible reasons outlined above for not investing in energy conservation, using the combined results of our Consumer Survey and Energy Conservation Survey. The information which forms the explanatory variables is of basically two sorts. One consists of *subjective information*, i.e. information obtained in response to specific questions, like 'Do you think that buying the item saves money in the long run?'. The second consists of *objective information*, like whether the respondent has had third level education. The subjective information has the advantage that it is a record of the household's own views. The obvious drawback is that respondents may simply be justifying their behaviour to the interviewer. Because of these reservations, each regression is performed using first the available subjective type information, and is then repeated using objective or physical type information. Results based on objective information would also be more helpful for targeting policy.

We list in Table 1 the explanatory variables, under subjective and objective data categories, which could be considered to have a bearing on the reasons for owning or not owning the conservation items. The variable names are also given.

The main difference between the data set here and that available to Brechling and Smith lies in the amount of detail relating to the household versus the dwelling. Information, such as the perimeter and area, was not available to us, but more information was available on items such as education levels attained and opinions of the household. As the list below of explanatory variables shows, under the heading Information, it was reckoned that the level of education would be an objective proxy for the respondent's general knowledge and ability to use advice on energy conservation. Under the heading Savings potential, a detached house may require more money spent on heating and therefore offers more potential for saving than a terraced house, for example. The household's income will influence its access to credit and, by extension, so will the occupation of the head of household. The variables URBAN and the year in which the house was originally built are included under Transactions costs. Their inclusion here may be somewhat tenuous, though it might be argued that there is greater ease of access to the

Table 1

Subjective data	Objective data
Information	
SMNO—'Don't think that the item saves money in the long run'	Level of education of head of household:
SMDK—'Don't know enough about the item'	PRIMARY level
	GROUP certificate
	INTERmediate certificate
RFINDTIM—'Hard to find the time to find out about it'	INTERmediate certificate
RROUTFIT—'Hard to find a reliable outfit to do it'	LEAVING certificate
	OTSEC—other secondary
	THIRD level
Appropriability	
	Tenure of accommodation:
	OWN—owned outright
	LAPUR—local authority purchase
	MORTG—owned with a mortgage
	RENTLA—rented from local authority
	RENTPR—rented from landlord
Savings potential	
RBILLSML—'My energy bill is quite small anyway'	CH—have central heating
	Accommodation type:
	DET—detached house
	APART—apartment or flat
	SEMI—semi-detached house
	TER—terraced house
Access to credit	
RCCREDIT—'It is difficult to find the cash or credit'	YALL—household income.
RSPPRIOR—'I have more urgent spending priorities'	(Mortgage already included in tenure above)
	(Employment status is proxied by education in most cases)
Transactions costs	
RGTROUND—'Difficult to get round to it'	URBAN
	Year that the accommodation was built:
RHASSLE—'Do not want the mess or hassle'	B18—before 1918
	B19.45—between 1919 and 1945
	B46.60—between 1946 and 1960
	B61.73—between 1961 and 1973
	B74.81—between 1974 and 1981
	B1982—built after 1982

[a] Prefix R = reason. In Tables 2–6 we use the additional prefix AI = attic insulation, LJ = lagging jacket to insulate hot water cylinder, and LEB = low energy light bulb.

Table 2
Model of ownership of attic insulation, using *subjective* explanatory variables

	Regression coefficient	*t*-value
Information:		
AISMDK	−0.95681	−6.08386
AISMNO	−1.07070	−4.11960
Appropriability:		
LAPUR	0.48997	2.80631
MORTG	0.66689	5.41031
RENTLA	0.40480	2.38502
RENTPR	−0.60746	−2.75741
Savings potential:		
CH	0.74963	7.63410
SEMI	−0.21168	−1.69030
TER	−0.62421	−5.23666
Access to credit:		
RCCREDIT	−0.16465	−1.75023
Transaction costs:		
RGTROUND	−0.23073	−2.30974
Intercept:	5.20733	42.21196
−2 Log-likelihood	774.534	df832
'Pseudo' R^2	0.375	

		Predicted		Percent correct
Observed		0	1	
0.00	0	157	118	57.09%
1.00	1	61	508	89.28%
			Overall	78.79%

Note that respondents were removed from regression data if they failed to answer any question relating to any one of the dichotomous variables, including those relating to the reference case. The 'pseudo' R^2 measure is that quoted by Brechling and Smith (1992, 1994), their value being 0.156, and is sometimes referred to as the McFadden R^2.

purchase of items in an urban environment and that older houses may be less amenable to retrofitting.

The dependent variable, ownership of the conservation item, is a binary variable and as in the UK study, logistic regression was selected. The explanatory variables are also binary variables, except for household income which is only incorporated in the logistic regression described in Appendix B. The results of the logistic regressions are given below for attic insulation, hot water cylinder insulation and

low energy light bulbs. Each of these three items has slightly different characteristics. Attic insulation is more like an investment item, requiring sizeable upfront expenditure. A hot water cylinder lagging jacket is an investment item which could in the majority of cases be bought out of disposable cash held for current household spending. Low energy light bulbs are less known about but would have a 'new technology' image which could appeal to some households. Results for each energy saving item will be given in turn.

The logistic regression model was run with SPSS (1990), Release 4.1/4.0. The regression coefficients represent the effects of variables by comparison with a reference household, which was chosen such that it has the most frequent characteristic within each information subset. In general terms, the reference household is as follows:

- it believes that the conservation item saves money in the long run;
- the head of household completed primary level education;
- owns its house outright;
- does not have central heating;
- lives in a detached house;
- its occupation does not equal farmer (in regressions in which the only occupation listed is farmer). (Its occupation is Other Manual Worker in regressions which include the other occupations).
- does not state that it is difficult to find the cash or credit or difficult to get round to it;
- its accommodation was originally built before 1918;
- lives in the country.

4.1. Attic insulation

The results for attic insulation, using subjective and then only objective explanatory variables, are shown in Tables 2 and 3, respectively. The overall results are good with the proportion of households correctly predicted at nearly 80%. (A household is predicted as having the item when the estimated probability is greater then 0.5 in the SPSS routine used.) Nearly 90% of those owning attic insulation are correctly predicted while less than 60% of non-owners are correctly predicted. Of the cases that are inconsistent with the model, the group of interest consists of those 40% or so of non-owners who are incorrectly predicted as having the item. In so far as the model could be claimed to be able to identify market failure (some care having been taken above to include all the relevant variables) and if the data collected accurately reflected those variables, then these cases are the potential non-optimisers, mentioned at the end of Section 2. Cases predicted as non-owners where the households are in fact owners, on the other hand, are less likely to be potential non-optimisers. This is because the items are very worthwhile, with minor exceptions such as where low levels of heat are desired. Even in rented accommodation, it would generally pay to negotiate with the landlord to have the item installed. Overall prediction, particularly of ownership, is slightly better in the case

Table 3
Model of ownership of attic insulation, using *objective* explanatory variables

	Regression coefficient	*t*-value
Information:		
GROUP	−0.02205	−0.14098
INTER	0.19320	1.47978
LEAVING	0.37426	2.53768
OTSEC	0.05387	0.19578
THIRD	0.37761	2.30526
Appropriability:		
LAPUR	0.04542	0.27582
MORTG	0.35462	2.70101
RENTLA	−0.10772	−0.59877
RENTPR	−0.70217	−3.07210
Savings potential:		
CH	0.62067	6.48113
SEMI	−0.20946	−1.56871
TER	−0.39420	−3.12803
Access to credit:		
FARMER	−0.33696	−2.54719
Transactions costs:		
B19.45	0.30301	2.22597
B46.60	0.27066	1.95323
B61.73	0.46283	3.59819
B74.81	0.89478	5.27163
B82	0.97368	4.50092
Intercept:	4.61642	34.37385
−2 Log-likelihood	841.618	df 869
'Pseudo' R^2	0.351	

		Predicted		Percent correct
Observed		0	1	
0.00	0	179	122	59.47%
1.00	1	80	507	86.37%
			Overall	77.25%

of the model using subjective data, as expected, though not markedly better. This is reassuring in the event that access to objective data is somehow restricted.

All the regression coefficients have the correct signs and are generally quite precise. In Table 2 the strong performance of statements 'Don't know enough

about it' (AISMDK) and 'Don't think it saves money' (AISMNO) is as expected. The positive coefficient for RENTLA indicates that large numbers of local authority rented dwellings in fact have attic insulation, because it has been mandatory since 1975. Insulation in private rented accommodation, RENTPR, is clearly wanting, however, showing the significance of appropriability. The importance of central heating, which we suggest indicates energy savings potential, is well demonstrated. Transaction costs and, marginally, access to credit, appear to be significant.

In Table 3 ownership is again well explained in terms of information, appropriability, savings potential, possibly access to credit in so far as farmers might feel that they do not have access (alternatively they may simply prefer an outdoor atmosphere), and transactions costs, the latter having a somewhat tenuous proxy in the variable giving the year that the accommodation was built. Having a mortgage is a very important positive factor in ownership of attic insulation. Recalling that the reference household owns its house outright, there is more than just appropriability explained by the variable MORTGAGE. It would also indicate access to credit and that the sunk transactions costs of already having obtained a mortgage would reduce the transactions costs of obtaining extra finance.

Fig. 2 shows the distribution of predicted probabilities for the observed households, for the model using objective explanatory variables. The greater certainty with which the model predicts the cases that do have attic insulation is consistent with Brechling and Smith's (1992) finding. However, compared with their results, as well as having higher 'Pseudo' R^2, these show improved prediction of those without attic insulation. The addition here of such explanatory variables as education level attained and occupation is an advantage and probably accounts for the improved fit.

Appendix B shows a further logistic regression which includes (partially imputed) income as an explanatory variable. It too is a significant variable, indicating again perhaps that access to credit is an important determinant of ownership. Owing to the strong correspondence of income with education level and to the fact that income was imputed using the education level, the latter variable was omitted

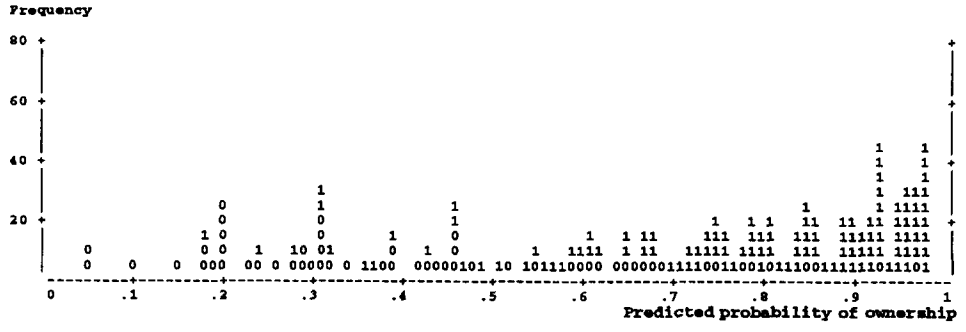

Fig. 2. Observations and model's predicted probabilities of having attic insulation. Each symbol represents five observed cases. 0 = 5 cases without attic insulation, 1 = 5 cases with attic insulation.

whenever income was included in the regression specification. The results are similar when income or when education is included, and this applies also when we look at hot water cylinder insulation and low energy light bulbs. Therefore further results of regressions incorporating partially imputed income will not be shown.

4.2. Hot water cylinder insulation

Tables 4 and 5 show that results overall are slightly less good for hot water cylinder insulation than for attic insulation, though many of the results are similar. Just over 70% of households are correctly predicted with, again, relatively better prediction for those having the conservation item. Some 35–45% of non-owners were incorrectly predicted as owning the conservation item, and could be viewed again as potential non-optimisers. In contrast to the results for attic insulation and

Table 4
Model of ownership of hot water cylinder insulation, using *subjective* explanatory variables

	Regression coefficient	*t*-value
Information:		
LJSMDK	−0.96813	−6.04389
LJSMNO	−1.04685	−5.56371
Appropriability:		
MORTG	0.38099	4.09303
RENTLA	−0.26130	−1.84049
RENTPR	−0.23189	−1.48112
Savings potential:		
CH	0.48235	5.49026
Access to credit:		
RCCREDIT	−0.07152	−0.87772
Transactions costs;		
RGTROUND	−0.21624	−2.50892
Intercept:	5.04520	53.34421
−2 Log-likelihood	990.561	df 880
'Pseudo' R^2	0.209	

		Predicted		Percent correct
Observed		0	1	
0.00	0	194	163	54.34%
1.00	1	91	441	82.89%
			Overall	71.43%

Table 5
Model of ownership of hot water cylinder insulation, using *objective* explanatory variables

	Regression coefficient	*t*-value
Information:		
GROUP	0.16381	1.19996
INTER	0.39192	3.34733
LEAVING	0.28122	2.16043
OTSEC	0.32689	1.38499
THIRD	0.27186	1.48399
Appropriability:		
LAPUR	−0.13884	−0.92023
MORTG	0.16487	1.54412
RENTLA	−0.35051	−2.30609
RENTPR	−0.55392	−3.53122
Savings potential:		
CH	0.35088	3.96860
Access to credit:		
SELFEMP	0.30071	1.99559
FARMER	−0.01357	−0.10668
PROF	0.52150	2.72547
NONMAN	0.15249	1.10014
SKILL	0.20706	1.88773
Transactions costs:		
B19.45	0.13959	1.10777
B46.60	−0.00395	−0.03020
B61.73	0.40128	3.43379
B74.81	0.33805	2.57085
B82	−0.04228	−0.28651
URBAN	0.56693	6.21356
Intercept:	4.28815	34.83491
−2 Log-likelihood	1111.522	df 1009
'Pseudo' R^2	0.253	

		Predicted		Percent correct
Observed		0	1	
0.00	0	265	154	63.25%
1.00	1	125	487	79.58%
			Overall	72.94%

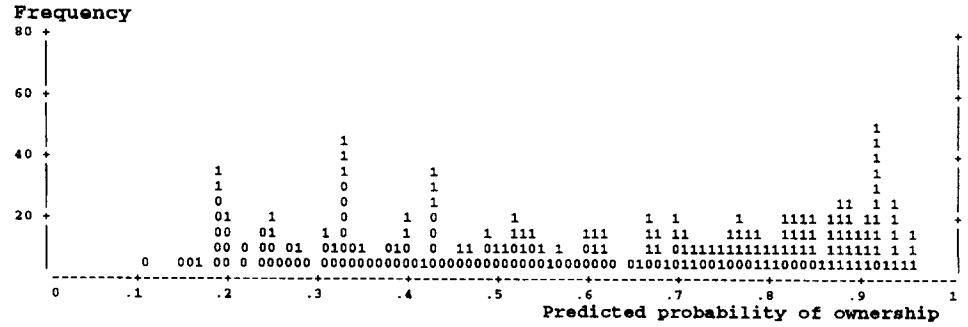

Fig. 3. Observations and model's predicted probabilities of having hot water cylinder insulation. Each symbol represents five observed cases. 0 = 5 cases without hot water cylinder insulation, 1 = 5 cases with hot water cylinder insulation.

as expected, RCCREDIT (access to credit) is not significant, since hot water cylinder lagging jackets cost something in the region of £10 only. Savings potential is again important with central heating owners having an added likelihood of ownership of this conservation item. Table 5 indicates that in addition to RENTPR, or private rented dwellings, RENTLA, or local authority rented dwellings, are also wanting and significantly so. The prominent showing of PROF, i.e. professional occupation, as a proxy for access to credit is probably also an indication of a household with better information.

The model's predicted probabilities of ownership of hot water cylinder insulation and the observations of ownership are shown in Fig. 3. By contrast with the results for attic insulation, there is a heavier concentration of predicted probabilities close to 0.5. There are also more owners who are predicted not to be owners.

4.3. Low energy light bulbs

The logistic regression for low energy light bulbs is shown in Table 6. Attempts to model ownerhsip of this item were least satisfactory, probably owing to the low take up of this item at the time of the survey. Although in fact 93% of households were correctly predicted, no houses owning the item were correctly predicted as such; in fact, no households at all were predicted as owning the item. The spurious explanatory power of the regression relies heavily on the subjective explanatory variable: 'low energy bulbs do not save money in the long run'. Use of objective explanatory variables only was even less satisfactory. Brechling and Smith did not analyse ownership of hot water cylinder insulation or low energy light bulbs; however, our findings for the latter bear a similarity to theirs for wall insulation where their model also predicted virtually no owners. Like low energy bulbs, wall insulation is installed in a low proportion of eligible dwellings. The results do, however, reaffirm our findings, namely that information, savings potential, and access to cash or credit have a role to play. Transactions costs and appropriability

Table 6
Model of ownership of low energy bulbs, using *subjective* explanatory variables

	Regression coefficient	*t*-value
Information:		
LEBSMDK	−0.34061	−2.22995
LEBSMNO	−1.12135	−2.20130
Savings potential:		
APART	−0.74502	−1.42704
TER	−0.42530	−2.57089
Access to credit:		
FARMER	−0.25577	−0.98453
PROF	0.32103	2.20082
RSPRIOR	−0.26829	−2.09706
Transactions costs:		
URBAN	0.34143	2.32026
Intercept:	3.87627	27.75929
−2 Log-likelihood	481.407	df 1053
'Psuedo' R^2	0.094	

		Predicted		Percent correct
Observed		0	1	
0.00	0	990	0	100.00%
1.00	1	72	0	0.00%
			Overall	39.22%

are obviously less of an issue where installing light bulbs is concerned, though we still find that urban dwellers, who might have easier access to outlets selling these items, have a higher tendency to ownership.

It can be seen from Fig. 4 that non-ownership is predicted with some certainty; however, unfortunately some of the owners are also predicted to be non-owners with a similarly high level of certainty.

Finally, some predicted probabilities, calculated from the results of the logistic regression for attic insulation in Table 3, are shown in Table 7 for three sorts of household. Ownership of attic insulation in the State overall is about 66%. Household 1 is a fairly typical household and it can be seen, for example, that renting from a private landlord or being a farmer would reduce considerably the probability of having attic insulation. Household 2, having third level education, a mortgage and central heating, the characteristics associated with high ownership, is unlikely to be much affected if the head were a farmer. Household 3, with low

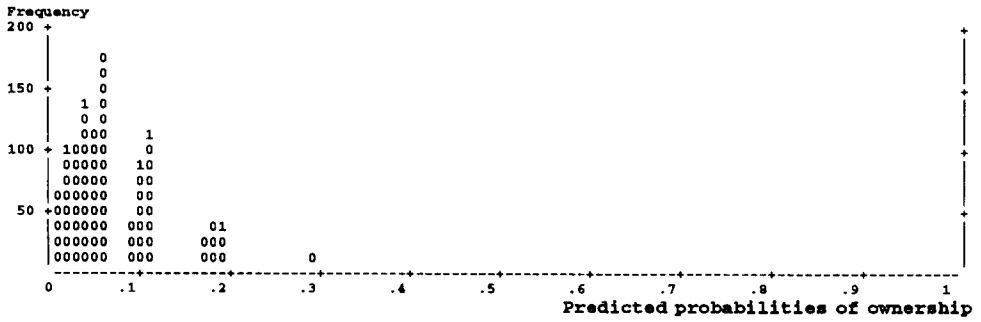

Fig. 4. Observations and model's predicted probabilities of having low energy bulbs. Each symbol represents 12.5 observed cases. 0 = 12.5 cases without low energy light bulbs; 1 = 12.5 cases with low energy light bulbs.

education, owning the accommodation outright and having no central heating, increases the probability of ownership markedly if it has central heating.

A final word about behaviour is in order. We were able to isolate the subset of model-inconsistent households which were predicted to be owners but were in fact non-owners, and we argued that they might be non-optimisers. It is worth inquiring whether they have any pattern of characteristics, compared with the sample as a whole. Focusing on those that do not own attic insulation, they in fact have only minor identifying characteristics. They would tend to come from households with more residents, having completed their education at a lower level and fewer would be in full-time employment or have a mortgage, more would own the home outright, and more would be farmers and rural inhabitants. Perhaps the most striking difference is that they tend to rely relatively more on coal and anthracite as their main space heating fuel in winter. Model-inconsistent non-owners of hot water cylinder insulation tend to reflect the overall population even more closely, except that there are relatively more farmers and less managerial or professional persons, more rural households and less with high levels of education, and there are relatively more consumers of peat as the main method of space heating.

5. Summary and conclusions

There appear to be significant and important reasons for the low take up of worthwhile energy saving items in Ireland, particularly of attic insulation and hot water cylinder insulation. As found by Brechling and Smith for the United Kingdom, straightforward market failures prevail. These market failures, which were found to be significant in explaining ownership or otherwise, include incorrect or absence of information about the energy conservation item, inability to appropriate the benefits of the investment, lack of access to credit or level of income (in contrast to the UK study) and, to some extent, transactions costs. The small size of the potential for savings in energy consumption, though not a market failure,

Table 7
Predicted probabilities of having attic insulation

Type of household	Predicted probability of having attic insulation (%)
Household 1:	
Leaving certificate	
• Accommodation owned outright	
• No central heating	
• Lives in semi-detached house	
• Head is not a farmer	
• House built between 1946 and 1960	52.6
Household 1, but renting from local authority	47.2
Household 1, but renting from a private landlord	21.4
Household 1, but head of household is a farmer	36.1
Household 2:	
Third level education	
• Has a mortgage	
• Has central heating	
• Lives in detached house	
• Head is not a farmer	
• House built after 1982	97.9
Household 2, but living in a terraced house	95.7
Household 2, but head is a farmer	96.1
Household 3:	
Primary level education	
• Accommodation owned outright	
• No central heating	
• Head is not a farmer	
• House build before 1918	31.7
Household 3, but with leaving certificate	50.4
Household 3, but renting from a private landlord	18.8
Household 3, but has central heating	61.1

was also significant. The behaviour of the majority of non-owners (roughly 60%) is explained in this manner. The behaviour of the remaining 40% of non-owners, who were predicted to be owners, are possibly non-optimisers. They tended to have completed lower levels of education and to be rural. It was reassuring to find that the use of subjective and of objective explanatory variables gave somewhat similar indications as to the importance of the five main reasons for not having the items. Ownership of low energy bulbs was not satisfactorily modelled, though the results do give pointers as to the importance of perceptions about whether the bulbs save money in the long run.

The implications for policy are fairly clear. With information being such a prominent factor, it is recommended that the ordinary public be helped to understand the worthwhile nature of these investments. In addition to the payback period, people should be made aware of the net present value or annuity value. The indicated importance of appropriability suggests that rented private accommodation be regulated to install these items, with reimbursement via the rent. Some similar procedure is required for local authority houses; in theory at least, their maintenance costs and the social welfare fuel allowances could fall (Scott, 1996). The finding that savings potential is a significant factor indicates the need to aid low-income households, who may not save much energy after insulation but whose comfort levels might be significantly improved. Access to credit applies here too and the availability of manageable credit facilities for investment in insulation is worthy of consideration, as for example offered by the Electricity Supply Board (whatever one's reservations about an energy supplier promoting energy conservation). Transactions costs are less easily overcome. Of course energy price rises, resulting from the introduction of carbon taxes, for example, would reduce the disincentive effect of these transactions costs and their introduction would have some advantages (see FigzGerald and McCoy, 1992).

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Appendix A: Investment appraisals of energy conservation items

Item	Ireland 1979 IRR %	UK 1984 NPV/K	UK 1990 a good investment	UK 1991		Ireland 1992		Ireland 1993			
				Cost £	Payback years	Cost £	Payback years	Cost £	NPV £	Life years	Payback years
Tank insulation	77–135	16–51	up to 80 mm (from < 50 mm)	5–8	0.5	6–8	0.3	10	322	10	0.3
Attic insulation	13–28 (50 mm) 16–52[a]	1–9 (100 mm)	up to 150 mm (from ≤ 25 mm)	170–280 120–145[a]	3–4	100–150	3	200	566	20	3
Draught proofing	0–32 9–32[a]	0–2.4		110–190 5–40[a]	3–10 1–3[a]	20–150	2	150	218	12 +	4
Insulating curtains						0–100	4				
Cavity wall/block insulation	9–19	1–5	for 80% for all cavity walls	300–400	4–6	500–1500	3–15				
Dry lining of walls	0–5			1500–3000 180–225[a]	20 + 2–4	500–1500	3–15				
Low energy light bulbs[b]			if used fairly continuously			15	1–2	15	30	3.6	1.2
Double glazing	−2 (secondary windows)	−0.7 to −0.2	if replacing window anyway	150–530 120–280[a]	8–10[b,c] 4–10[b]	500–3000	5–50				

Note: It is important to bear in mind the assumptions associated with these measures, used by the sources: Ireland 1979 = Minogue; UK 1984 = Pezzey; UK 1990 = Shorrock and Henderson; UK 1991 = Energy Efficiency Office; Ireland 1992 = O'Rourke; Ireland 1993 = McSharry (using 10% discount rate).

[a] Do-it-yourself.

[b] Per item, McSharry (Ireland 1993) assumes 6 hours use on average per day.

[c] If replacing anyway.

Appendix B: Model of attic insulation, using *objective* explanatory variables and *partially imputed income*

	Regression coefficient	*t*-value
Appropriability:		
LAPUR	0.01624	0.09914
MORTG	0.37287	2.89565
RENTLA	−0.09875	−0.55265
RENTPR	−0.63988	−2.89022
Savings potential:		
CH	0.60644	6.28782
SEMI	−0.19278	−1.45805
TER	−0.41672	−3.33189
Access to credit:		
YALL	0.00108	2.46263
FARMER	−0.37352	−2.85594
Transactions costs:		
B19.45	0.27264	2.02833
B46.60	0.29860	2.16316
B61.73	0.46209	3.62133
B74.81	0.89015	5.30112
B82	1.00387	4.66322
Intercept:	4.51392	29.38399
−2 Log-likelihood	846.652	df 873
'Psuedo' R^2	0.343	

		Predicted		Percent correct
Observed		0	1	
0.00	0	183	118	60.80%
1.00	1	81	506	86.20%
			Overall	77.59%

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