Energy Use and Appliance Ownership in Ireland

Eimear Leahy and Seán Lyons
(Economic and Social Research Institute, Dublin, Ireland)

Abstract: This paper examines domestic energy use and appliance ownership in Ireland. Regression analyses on a large micro-dataset reveal how household characteristics can help explain the ownership of energy using appliances. The location of the household, the number of rooms and household income are important factors, as are certain characteristics of the highest earner in the household such as education level and age. We also find evidence that household income, number of persons, accommodation characteristics, region, and age of the highest earner can help explain domestic electricity use, even after taking account of the household's endowment of appliances. The level of demand for domestic heating is also associated with housing tenure and the employment status of the highest earner.

Corresponding Author: Sean.Lyons@esri.ie

Energy Use and Appliance Ownership in Ireland

1. Introduction

The demand for domestic energy is determined by the number of households and certain household characteristics such as the extent to which they employ energy-using appliances and energy-saving features. This paper investigates the determinants of appliance ownership in Ireland. Conditional on appliance ownership, and other household characteristics, we explore the factors which influence energy use in the home, be it derived from electricity or other fuels. In addition, we look at the features of energy use which either enhance or inhibit the amount of useful heat which can be generated in the home.

Since the early 1990s Ireland has experienced rapid economic and demographic change, which in turn has affected domestic energy demand. Between 1990 and 2006 residential energy use increased by over 32 per cent, meaning that household energy demand accounted for almost a quarter of all energy consumed in Ireland in 2006 (O'Leary *et al*., 2008). The demand for energy-using appliances increased substantially as Ireland's economy and population grew. Of the ten appliances studied in this paper the greatest demand increases between 1994 and 2004 were for home computers, dishwashers, tumble dryers, and microwaves. Over the period 1996 to 2006, the average floor space of Irish houses has increased by 170 square feet according to data collected for the permanent tsb / ESRI House Price Index (Duffy, 2009). Larger houses have higher space-heat requirements and higher heat losses due to their proportionally greater surface area (O'Leary *et al*., 2008).

The topic of household energy use has attracted continuing research interest, including several recent contributions. A UK-based study carried out by Druckman and Jackson in 2008 finds that household energy use and associated carbon emissions are strongly, but not exclusively, related to income levels. The type of dwelling, tenure, household composition, location and socio-economic characteristics of the residents are also extremely important. Baker and Rylatt (2008) analysed gas and electricity consumption and identified the most statistically significant indicators to be the number of bedrooms and regular home working.

Appliance ownership in the US was studied by Dale *et al*. (2009). They found that the demand for appliances had increased because the real prices of the appliances included in their study (room and central air conditioners, refrigerators and clothes washers) had decreased over time. The authors attribute this trend to efficiency enhancing technologies, declining price cost margins (mainly because of firm rivalry) and economies of scale associated with higher efficiency appliances.

O'Doherty *et al.* (2008) model the determinants of energy usage and energy-saving features in Ireland. They find that respondents living in newer, detached homes, households with high income levels and home owners are more likely to have a higher number of energy-saving features in their home but they are also more likely to have a higher number of energy-using appliances. Other factors such as the length of time a household has been resident at its current address, respondent age and tenure type were also found to be significant. However, O'Doherty *et al.* (2008) do not have data on actual energy use. This is the main advantage of the current paper.

Another recent paper focusing on household energy demand in Ireland is Scott *et al.* (2008), which uses CSO data on households' energy expenditures, socio-demographic characteristics, main heating appliances and self-reported deprivation to cast light on the extent and determinants of fuel poverty.

In this study we use a large household micro-dataset with which we can estimate models of appliance ownership, electricity use, energy use from other fuels and useful heat in Irish households. We find that similar sets of factors are associated with owning various energy-using appliances; in particular, household disposable income, the number of rooms and the number of people living in the accommodation, tenure and age and education level of the household's chief economic supporter (CES). We also find that while households with higher income levels, accommodation with 8 or more rooms and homes located in urban areas are more likely to own energy intensive devices, they are also more likely to invest in double glazed windows. The opposite is the case for very old accommodation, those in rented accommodation of any description or households where the CES is over 75 years of age. The second part of the paper reveals that many of the factors which affect appliance ownership are also important for the amount of energy used and useful heat generated in the home. The appliances which significantly increase electricity use are deep freezers, tumble dryers, dishwashers, fridge-freezers and vacuum cleaners. We find, however, that the

methods of cooking and space and water heating employed in the home are more important for energy use and useful heat than electrical appliances.

The paper is build-up as follows. Section 2 presents the data and Section 3 the estimated models. Section 4 discusses the results. Section 5 concludes.

2. Data

The main dataset used for this study was the anonymised 2004/05 Household Budget Survey (HBS), which is a survey of a representative sample of all private households in Ireland. Carried out by the Central Statistics Office, the aim of the HBS is to determine current household expenditure patterns. In 2004/05 6,884 households participated in the survey.

The questions asked in the HBS are not sufficient to explain every aspect of household energy usage. Such a study would require more extensive details on efficiency of individual households' appliances and the frequency with which they are used. However, we can model appliance ownership and examine which appliances, heating and cooking methods significantly influence the amount of energy or electricity used in the home. The survey asks about the presence of the following items: washing machine, dishwasher, fridge, deep freezer, fridge-freezer, microwave oven, vacuum cleaner, tumble dryer, video player/recorder, portable television, home computer and CD player. Because CD players, video players/recorders and portable televisions account for only a very small percentage of household electricity/energy use, these appliances are omitted from our analysis.

The first step in this paper is to investigate the determinants of household appliance ownership. Since our dependent variable is discrete (i.e. appliance ownership versus non-ownership), we use a logit estimator. Along with appliance ownership we also examine the factors affecting the presence of double glazed windows. Thus, we can determine if those households which own high energy-using appliances are more or less likely to invest in double glazing. Unfortunately, the data do not allow us to examine any other energy-saving features which may be present in the home.[1]

The second part of the analysis involves estimation of OLS regression models to explain household energy and electricity use conditional on appliance ownership (and a range of other household characteristics). According to O'Leary *et al*. (2008), 49%

---

[1] The HBS includes a question on loft insulation, but it does not seem to have been completed by most households.

of household energy expenditures relate to heating and cooking. We were interested in further investigating this claim, so, we include methods of space heating, water heating and cooking in the analysis. As previously mentioned, we do not know the frequency or intensity with which households use the appliances, cooking or heating methods included in the study, nor do we know when a household has more than one appliance of a given class. It is likely that the amount of energy used by each of the appliance types and cooking and heating methods would vary widely. The partial effects reported in our models therefore refer to the average usage of households that own a given appliance.

For comparison, we also report results from a model of energy usage that omits appliance ownership variables. We use this to illustrate the risk of misspecification that arises when modelling energy without taking into account the endowment of energy-using appliances.

A list of the variables included in the models and some descriptive statistics on them are set out in Table 1.

[Table 1 about here]

3. Models

Each of the appliance ownership models has a dependent variable representing access to a particular appliance. This is set to a value of one when the appliance (or double glazing) is present in the household, and a value of zero when it is not. The models use a logit estimator to predict whether a given household will own certain electrical appliances based on a number of household characteristics including location (Dublin vs. the rest of the country, urban vs. rural), age and type of accommodation, number of rooms and number of residents. We also include tenure, family composition, quarter in which survey took place, and several characteristics of the household's Chief Economic Supporter (CES):[2] social group, employment status, highest level of education achieved and age. For each categorical explanatory variable there is a reference category, which is, in essence, a baseline against which households with different characteristics may be compared. The results are presented in terms of odds ratios which reflect the odds that a household with a given characteristic will own a

---

[2] The Chief Economic Supporter is the person in the household with the highest gross income.

5

certain appliance, relative to a household in the reference category. An odds ratio of 1 indicates that households with that characteristic are equally likely to own the appliance as those in the reference category. An odds ratio greater than 1 indicates a higher probability of ownership, while a ratio below 1 indicates that the probability of ownership is lower.

For each appliance, we run a logit model including all available variables and then, using the stepwise approach, we estimate a more parsimonious "preferred" model which omits explanatory variables that are not significant. The results of the preferred models are discussed in section 4.

The energy use / useful heat[3] models are OLS regressions analysing those appliances, heating and cooking methods that significantly impact on domestic energy use from electricity and other fuels, after controlling for other household characteristics. Three sets of analyses are carried out in which the dependent variables are 1) total energy use from electricity, 2) total energy use from other fuels and 3) total useful heat from other fuels. Two versions of each OLS model are estimated, the first of which includes all available variables. We then test for joint significance of all variables that appear individually insignificant, generating more parsimonious "preferred" models. For each of the three explanatory variables, the coefficient of determination in the preferred model did not differ significantly from that of the model with all available variables. Because there are a large number of variables in our sample we were conscious of the possible presence of multicollinearity. Having examined the correlations between individual variables, we are satisfied that multicollinearity is not a problem in the data. The results are discussed in the next section.

4. Results

Appliance ownership models

The results of the appliance ownership regressions will be presented first, and they are shown in Table 2 below. Due to the large size of our models, only those variables that are statistically significant will be discussed.

[Table 2 about here]

---

[3] "Useful heat" is a measure that adjusts energy use to take account of the approximate efficiency of heating appliances present in the household. For example, households that use open fires as their main method of winter heating would have a lower efficiency, and thus lower useful heat, than those with central heating.

4.1 Fridge-freezer

Urban dwellers are 24% more likely to own a fridge-freezer than rural dwellers while homes in rural areas more likely to have fridges and/or deep freezers. 3 and 4 roomed homes are less likely than the reference category to have a fridge-freezer, as is accommodation with at least 8 rooms. Instead, homes with more rooms appear more likely to own a fridge and/or deep freezer. Homes built since 1991 have higher odds of owning a fridge-freezer than the reference category, which spans the period 1918-1960. Semi-detached/terraced houses and "other" homes are almost 1.5 and 2.5 times respectively more likely to have fridge-freezers than detached homes. Those living in one-person households have lower odds of fridge-freezer ownership, as do part-time workers and those with no education or primary school education only. Both fridge-freezers and fridges are now considered to be necessary items and either one or both of these are found in 99.64% of homes. As a result, the log of household disposable income was not significant for either of these appliances.

4.2 Refrigerator

While living in the south west, mid west, south east or mid east excluding Dublin decreases the odds of owning a fridge-freezer, it increases the odds of fridge ownership by over 50%, relative to the reference group. A similar trend was observed for accommodation with 3 rooms or at least 8 rooms. Homes built before 1918 are also more likely to own a fridge than a fridge-freezer and people with only a primary education are more likely to buy fridges than fridge-freezers. Conversely, residents of semi-detached/terraced houses and those living in the "other" accommodation category have reduced odds of owning a fridge compared to those living in detached houses.

The only social group with a significant coefficient is the "unskilled and agricultural workers" who are 30% more likely to own fridges than their employers/managers and professional counterparts. The only age group which proved statistically significant for fridge ownership was the 25-34 year old cohort. They are less likely than their seniors in the reference group to buy fridges. Employment status, income, tenure and household composition did not prove to be important indicators of fridge ownership.

4.3 Washing Machine

The odds of owning a washing machine are 83% higher for those in urban areas than those in rural areas. All of the "rooms" variables proved to be significant indicators of ownership. Homes with fewer than 5 rooms have low odds of owning a washing machine but those with 6, and especially, 7 or 8 or more rooms are significantly more likely to have washing machines than the reference category. The odds of ownership are reduced for those living in accommodation which was built before 1918, as is the case for one-person households, retired people and those aged over 75.

"Unskilled and agricultural workers" is the only social group showing a significant effect and is almost 44% less likely to own a washing machine than the corresponding reference group. Also, those with no formal education or primary education only are 84% and 36% respectively less likely to own washing machines than those who have completed the leaving certificate. Those with mortgages are more than 3 times as likely as those who own their homes outright to have a washing machine. As expected, the log of household disposable income is another important variable, indicating that as income rises, the odds of owning a washing machine increase.

4.4 Vacuum Cleaner

As was the case for washing machines, the odds ratio on "urban" is positive and significant. The "rooms" variables also follow a similar pattern to that of the washing machine analysis. However, the effect is not as strong for vacuum cleaners. Those homes built before 1918 are more than one third less likely than the reference group to have invested in vacuum cleaners while those living in accommodation built between 1971 and 1980 or between 1991 and 2000 are about twice as likely as the reference group to own vacuum cleaners. Residents of converted apartments and semi-detached/terraced houses are much more likely to own vacuum cleaners than those living in detached houses.

Those renting, either from local authorities or privately, are significantly less likely to invest in vacuum cleaners than those who own their homes, perhaps because of income constraints or due to their expected length of stay. Interestingly, households with 8 or more people are over 70% less likely to buy vacuum cleaners than two-person households. This variable may be capturing very large families who need to direct their expenditure towards other, more urgently required items. The "family with children" variable reinforces this view, with the probability of owning a vacuum

cleaner being one third lower than that of households without children. Those with no formal education are 83% less likely and those with primary education only are over 65% less likely than the reference group to own vacuum cleaners, most likely because education is closely correlated with income.

A household whose CES is aged between 15-24 or 25-34 has lower odds of owning a vacuum cleaner than the corresponding 35-44 year old reference category. Households where the CES is aged 45 or older have higher odds of owning a vacuum cleaner but not significantly so. This could reflect different preferences or income constraints on behalf of younger consumers. Again, the log of disposable income is significant and positively affects vacuum cleaner ownership.

4.5 Microwave

Living in an urban area or accommodation with 6 or more rooms increases the odds of microwave ownership relative to the corresponding reference groups. Houses with fewer rooms have lower odds of microwave ownership. Accommodation built before 1918 is over 43% less likely to have a microwave than that built between 1918 and 1960. Conversely, homes built more recently than those in the reference group have higher odds of microwave ownership but only one category is significant; 1971-1980. Residents of semi-detached/terraced houses and mortgage holders are both 32% more likely to have microwaves than those in the relevant reference groups.

The probability of having a microwave in a one-person household is 37% lower than that of two-person households. However, the odds are also low for large households and significantly so for those households with 8 or more people. The only social group of significance is "own account workers and farmers" whose odds of microwave ownership are over 30% lower than that of the reference group. For those households whose CES has only a primary education, the probability of owning a microwave is low relative to those who have completed the leaving certificate. As previously stated, this could be because low levels of education are linked to low levels of income. In contrast to this, however, are households whose CES has a primary or higher degree. Here, the odds of ownership are also lower than they are for those in the leaving certificate category.

"Own account workers and farmers" is the only social group with a significant coefficient, but for members of this group, the probability of microwave ownership is reduced by over 30%. The results suggest that microwaves are much more popular

among households whose CES is younger than that of the reference category. A CES aged between 15 and 24 is almost 60% more likely to own a microwave than the reference group while for those in the 25-34 group, the probability is 36% higher. The odds ratio for the log of household disposable income is as expected. As income increases, so too does the probability of ownership, however, the effect is weaker than it is for some of the bigger, more expensive, electrical appliances.

4.6 Tumble Dryer

Living in Dublin reduces the odds of having a tumble dryer by almost 46%, relative to the reference group. However, when we take the entire country into account, the odds of owning a washing machine are 25% higher in urban areas than in rural areas. Homes with 6 or 7 rooms are significantly more likely to own a tumble dryer than the reference category while homes with at least 8 rooms are over twice as likely. Respondents living in accommodation with 3 or 4 rooms have significant but lower odds of owning a tumble dryer than those from 5 roomed homes. The probability of owing a tumble dryer for those living in accommodation built post 2000 is 57% higher than the reference group.

Residents of bedsitters are over 3.7 times more likely to own a tumble dryer than those in a detached house, probably because they have no garden in which to line dry their clothes. A similar but weaker trend was observed for those living in converted apartments or apartment blocks. Those in rented accommodation of any description are less likely than home owners to own a tumble dryer. As previously stated, tenants may be less likely to invest in appliances because they cannot afford to or because they believe that their stay is short-term in nature.

The odds of ownership in a one-person household are low, however, as the number of people in a household increases, so too does the probability of ownership. Having children in a family increases the likelihood that a tumble dryer will be present in the household by 32%. A household whose CES has a primary education only are less likely to own tumble dryers than the reference group, probably because of income constraints. Interestingly, those in the primary degree category are also less likely to be owners of tumble dryers. Households where the CES is 75 or over are more than a third less likely than the reference category to own tumble dryers. This may be because over 75s are likely to live in one- or two-person households where the demand for a tumble dryer tends to be low. It could also be due to income constraints.

The 25-34 year old group was also seen to have reduced odds of tumble dryer ownership relative to the reference group. As expected, the log of household disposable income was highly significant and positive.

4.7 Dishwasher

Those living in urban areas are 30% more likely than their rural counterparts to own a dishwasher while the odds of ownership are also high for those located in the south west, south east, mid west or mid east excluding Dublin. The results for the room variables echo those of appliances already discussed. For homes with at least 8 rooms, however, the effect is stronger in this case than it is for any other appliance. Homes built in the 1960s, 1980s, 1990s and especially those built since 2000 are all more likely to have dishwashers than those in the reference category.

Those living in semi-detached/terraced houses are 24% less likely to own a dishwasher than residents of detached houses. This could be due to space or income constraints. As was the case for other appliances, those in rented accommodation, one-person or single parent households have a significantly lower probability of owning a dishwasher than their corresponding reference categories. Five- and six-person households are 50% and 60% respectively more likely to own dishwashers than two-person households.

The demand for dishwashers is also higher among families with children. All social groups have lower odds of owning a dishwasher than the employers, managers and professionals group, although, not all are significant. The primary education variable again reduces the odds of ownership because it is closely correlated with earnings. Households whose CES is aged between 25 and 34 or over 75 are significantly less likely than the reference group to own a dishwasher but the 55-64 year olds are 27% more likely to invest in one. The income effect is stronger for dishwashers than it is for any other appliance.

4.8 Deep Freezer

A deep freezer is convenient for those who wish to store a lot of food, either because they have large families or because access to fresh food on a regular basis is difficult. Our location variables indicate that deep freezers are significantly more likely to be found outside of Dublin and in rural areas. Houses with 6, 7, 8 or more rooms are

more likely to own a deep freezer than the reference category, probably because the number of rooms and number of people are correlated.

Deep freezers were at their most fashionable in the 1970s so, it is not surprising that houses built between 1971 and 1980 are significantly more likely to have them than the reference category. Semi-detached/terraced houses have lower odds of owning a deep freezer than detached houses. Again, a lack of extra space could be one of the reasons for this. Both mortgage holders and tenants are less likely than outright owners to possess a deep freezer. This may be because of income constraints on behalf of these groups or the declining size of families. As the number of people living in a household increases, so too does the probability of ownership, however, families with children have reduced odds of owning a deep freezer.

The age effects on dishwasher ownership are almost identical to those of tumble dryers. Households whose CES is aged 75 or over are unlikely to be owners of deep freezers, probably because most over 75s live in households with few people so the need for a deep freezer would be limited. As expected, income is an important predictor of deep freezer ownership but the effect is weaker than that of all appliances discussed thus far. Nevertheless, a household whose CES is unemployed is 40% less likely to have a deep freezer than one whose CES is in employment.

4.9. Home Computer

Home computers are more likely to be found in urban areas than rural areas but the effect is weaker here than it is for any other appliance. 4 roomed homes or homes built before 1918 are less likely than their corresponding reference groups to have computers. Homes built more recently than 1960 are more likely to have computers but only the 1971-1980 category is significant. Residents of rented accommodation, either private or local authority, are less likely to own computers than those who own their homes outright. As expected, one-person households had lower odds of owning a home computer than the reference category. However, three-, four-, five-, six and seven-person households all had a significantly higher chance of owning a computer.

The "non manual" and "manual skilled/semi skilled" social groups were both significantly more likely than the reference group to own a home computer. This may be because they do not have access to a computer at work, unlike the reference group. It was not surprising to discover that students are almost 2.5 times as likely as the reference group to own computers. This is most likely because of homework and

study requirements. Own account workers and farmers were 28% less likely to have a home computer than the reference group. As expected, households whose CES is unemployed are significantly less likely to have a computer in the home than the reference group while households where the CES is retired are 1.6 times more likely to have a computer. This is plausible as retired people cannot access a computer through place of work.

The primary education variable is again significant and reduces the probability of computer ownership relative to that of the reference group. Interestingly, those households whose CES has a primary degree or higher degree are 16% and 40% respectively less likely to have a computer in the home than those with a leaving certificate education. Perhaps the more highly educated have access to computers through other channels and therefore do not need to privately invest in one.

Households in which the CES is younger than that of the reference category are less likely to have a computer at home. However, as age increases, so too does the probability of ownership but only to a certain point. For those in the 65-74 and 75+ groups, the odds of computer ownership decrease again. This is an interesting result in light of what was observed for the retired members of our sample. As expected, the log of household disposable income plays an important role in predicting home computer ownership. However, its effect is weaker than it is for any other appliance included in the analysis.

4.10 Double Glazing

Over 77% of the sample reported having double glazing somewhere in their home. We include this variable in an attempt to establish whether those respondents who report owning energy intensive appliances have invested in any energy efficiency measure. We would like to investigate other energy-saving features such as the presence of a lagging jacket or attic insulation, but, unfortunately, these data do not allow for this.

The odds of having double glazing are higher for those living in areas outside of Dublin, relative to the reference group. However, when the whole country is taken into account, urban dwellers are 25% more likely to invest in double glazing than their rural counterparts. It is more probable that double glazing will be present in accommodation with 6 or more rooms, compared to the reference category. The more recently built the home, the higher the chance of double glazing being present. In fact,

those homes built since 2000 are over nine and a half times more likely to have double glazing than homes built between 1918 and 1960.

Local authority housing and rented accommodation is less likely to have double glazing, as would be expected. It is often the case that owners do not invest in energy-saving measures unless they are living in the residence themselves. Families with children are more inclined to invest in double glazing while the opposite was the case for single parents, although this was not significant. Other significant but negative predictors of investing in double glazing were own account workers and farmers and those aged 75 or over. The log of household disposable income is highly significant. As income increases, so too does the probability of having double glazing.

Energy use models

Conditional on what appliances may exist in a household, and controlling for other household characteristics, we now explore the factors which help determine domestic electricity use, energy use and useful heat. The results of the preferred OLS regressions are presented in Table 3.[4] The standard errors in each case are robust to heteroscedasticity.

[Table 3 about here]

The dependent variable in the first regression, "energyelec", is the estimated energy use from electricity measured in kilowatt hours. "Energyoth" measures the estimated energy use from fuels other than electricity. These fuels are coal, anthracite, gas, turf, heat oil, paraffin, liquefied petroleum gas (LPG) and wood. (We will refer to these henceforth as other fuels). This variable is also measured in kilowatt hours. The final regression looks at the amount of useful heat derived from fuels other than electricity. We also ran a regression which estimated the amount of useful heat that can be obtained from electricity. The results were identical to those derived for "energyelec". The pattern of results was somewhat similar for all three regressions. There was a positive Dublin effect on each of the explanatory variables. Also, as the number of people living in the household or the number of rooms in the accommodation

---

[4] A joint zero restriction on insignificant coefficients was not rejected. Energyelec: $F_{(43, 6785)} = 1.12$ [0.2687], Energyoth: $F_{(50, 6785)} = 1.15$ [0.2204], Heatoth: $F_{(48, 6785)} = 0.94$ [0.5957]

increases, more electricity and energy from other fuels are used. The amount of useful heat generated also increases.

The year in which the accommodation was built presented some interesting findings. Homes built before 1918 are seen to use 5.34 kWh more electricity. This may be because these homes are poorly insulated, more difficult to heat and generally more inefficient. Central heating may be absent, so that occupiers use electrical heating and power showers. Those built between 1961 and 1970, however, use less electricity. This was also the case for accommodation built after 2000, which makes sense as newer homes are more likely to be better insulated and to own more efficient appliances. Homes built between 1981 and 1990 and between 1991 and 2000 negatively effect "energyoth". The effect on useful heat is also negative, but less pronounced.

Concerning accommodation types, converted apartments are seen to use less electricity than other types of accommodation while apartment blocks have a similar effect on fuels other than electricity. This can be explained by the fact that apartments generally have a smaller floor space than other types of houses and, thus, are easier to heat. Semi-detached/terraced houses were seen to use less of all energy types but the effect was not as strong as that of apartments.

Interestingly, those in local authority housing appear to use more energy from other fuels and the coefficient on useful heat is also positive for this group. In complete contrast to this is the behaviour of those renting privately or living in rent free accommodation.

Single parent households use 9.11 more kWh of electricity than other households while homes in which the CES is retired are slightly lower users of electricity. Their use of other fuels, however, is significantly higher. Where the CES is a student, has no formal education or a third level sub degree education, the effect on other fuel use and useful heat is positive. As the age of the CES increases, electricity use decreases but the age effect is not important for other fuels or useful heat. The income variable was found to be positive and significant, even when controlling for appliance ownership. As the log of household disposable income increases by one unit, electricity use increases by 3.67 kWh, energy use from other fuels increases by 12.7 kWh and the amount of useful heat rises by 8.5 kWh. With increases in income, people can afford to invest in bigger and more powerful appliances; and they may use these more often. However, they are also better able to insulate their homes and to invest in greener

appliances which may explain the positive coefficient in the model on useful heat. As was the case with the logit regressions, the quarter in which respondents were interviewed sometimes proved significant. Yet, there is no discernible reason for why this is so.

With regard to electrical appliances, households with either a fridge-freezer or vacuum cleaner are seen to use between 5 and 6 kWh more electricity than households that do not have such appliances. The effect of having a tumble dryer, dishwasher or deep freezer is even stronger, at over 9 kWh extra electricity. These appliances do not have any significant effect on energy derived from other fuels. However, owning a dishwasher does have a significant, positive effect on useful heat. Microwaves or home computers did not show up as being significant in any of the models, probably because these appliances are not energy intensive. Fridges and washing machines, although they are energy intensive appliances, did not prove significant in any of the regressions. While the presence of double glazing does not significantly affect electricity use, its effect on energy from other fuels and useful heat is negative.

As expected, gas and LPG cookers negatively affect electricity use, while electric space and water heating methods increase it. Electrical space and water heating methods have the opposite effect on other fuels. The coefficient on "no space heating methods" is highly significant and appears somewhat inflated in each of the regressions. However, this finding is probably not robust, since this group consists of only one respondent. Finally, it is worth noting that using renewable sources of energy to heat water increases both electricity and other types of energy use. It also has a positive effect on useful heat.

Energy use models omitting appliance ownership

We found a high level of statistical and economic significance for many appliance ownership variables in the energy use regressions discussed above. This implies that if one were to model energy use without controlling for the endowment of appliances, for example explaining energy use with reference to income alone, the model would be misspecified and could lead to incorrect inferences.

To illustrate this point, Table 4 below repeats our energy use regressions without the appliance ownership variables. The omission of these variables leads to important changes; in particular, the measured effect of income on the demand for electricity

and useful heat is substantially higher in the misspecified model than in the full model.

5. Conclusions

In this paper we investigated the determinants of domestic ownership of energy-using appliances and double glazing in Ireland by running logit regressions on a large cross-sectional dataset. We also explored the factors affecting the level of energy use (under three definitions).

We included explanatory variables related to household and dwelling characteristics, most of which are statistically significant. The relationships we observe are broadly as expected.

Homes in urban areas are more likely to own energy-using appliances, but they are also more likely to have double glazing installed. Similarly, as the number of rooms in the accommodation increases, so too does the likelihood that the household will have energy-using appliances and double glazing. The opposite is the case for homes built before 1918 or for residents of either local authority or privately rented accommodation.

One-person households are less likely to own appliances, but they do not have a significantly different endowment of double glazing. The number of residents significantly affects the ownership of tumble dryers, dishwashers, deep freezers and home computers. Having children in the household positively affects the likelihood of having a tumble dryer, dishwasher and double glazing but reduces the probability of vacuum cleaner, deep freezer and home computer ownership.

Regarding the ownership of home computers, the age of the household's CES plays a very important role. Households in which the CES is middle-aged are more likely to own computers while those whose CES is under 34 or over 65 are a lot less likely to have one. Where the CES is 75 years old or over, the probability of owning most appliances is relatively low.

The social group and employment status of the CES is only significant in some instances. Similarly, the type of accommodation is only important on some occasions and no clear pattern exists as to its relationship with appliance demand. As expected, disposable income is very important and, as income increases, so too does appliance ownership and the uses of these appliances; while double glazing is also more prevalent among richer people, this does not offset the increased energy use.

Similar patterns were observed for the determinants of household electricity and energy use. Five out of the ten energy-using appliances included in our analysis proved to be statistically significant in the energy use regressions. Cooking methods also played an important role. Not surprisingly, however, the methods employed for space and water heating in a household proved to be far more important in determining domestic electricity and energy use than other household characteristics. The results for the amount of useful heat generated in the home follow the same pattern as those for the amount of energy used.

Since 1993, the housing stock in Ireland has increased by over a third (Department of the Environment, Heritage and Local Government, 2009), and while these homes should be more energy efficient than their older counterparts, the presence of more houses increases aggregate energy demand. Also over this period, the average size of houses in square footage has increased, meaning more energy is required to heat the average home. Similarly, the demand for energy-using appliances has increased and, as a result, so has domestic electricity and energy use.

While various household characteristics and ownership of energy-using appliances are important factors in determining domestic energy demand, our findings underline the importance of having efficient cooking and, especially, space and water heating methods in the home.

Our results provide a useful indication of how household characteristics affect ownership of energy-using appliances and, conditional upon such ownership, the amount of energy used by households. However, our analysis is limited by some shortcomings in the available data. We do not know the intensity or frequency with which appliances, heating or cooking methods are employed. Energy ratings for appliances, cookers or heating systems were not available for the sample period either.

References

Baker, KJ and RM Rylatt (2008): Improving the prediction of UK domestic energy-demand using annual consumption-data; Applied Energy 85, 475–482

Dale L, C Antinori, M McNeil, JE McMahon, KS Fujita, (2009): Retrospective evaluation of appliance price trends; Energy Policy 37, 597-605

Department of the Environment, Heritage and Local Government (2009): Housing Statistics;
http://www.environ.ie/en/Publications/StatisticsandRegularPublications/HousingStatistics/

Druckman, A and T Jackson (2008): Household Energy consumption in UK; Energy Policy 36, 3177–3192

Duffy, D (2009): verbal communication

O'Leary F, M Howley and B O'Gallachóir (2008): Energy in the Residential Sector; Sustainable Energy Ireland; Cork

O'Doherty, J, S Lyons and RSJ Tol (2008): Energy-using appliances and energy-saving features: Determinants of ownership in Ireland; Applied Energy 85 (7), 650-662

Scott, S, S Lyons, C Keane, D McCarthy and RSJ Tol (2008): Fuel Poverty in Ireland: Extent, Affected Groups and Policy Issues; ESRI Working Paper 262

Tables and Figures

Table 1 Descriptive Statistics for variables used in regressions (dependent variables are in italics)

Variable	Mean	Std. Dev.
energyelec (Estimated energy use from electricity)	8351.8%	6248.1%
energyoth (Estimated energy use from other fuels)	42275.4%	38930.1%
heatoth (Estimated useful heat from other fuels)	24868.2%	22419.9%
Location of household		
Border, Midland and West (REF)		
South West, South East, Mid West, Mid East excluding Dublin	40.1%	49.0%
Dublin	30.4%	46.0%
Rural (REF)		
Urban	69.8%	45.9%
Number of rooms in accommodation		
I roomed house	0.2%	4.9%
2 roomed house	0.4%	6.2%
3 roomed house	3.4%	18.0%
4 roomed house	9.5%	29.3%
5 roomed house (REF)		
6 roomed house	27.9%	44.8%
7 roomed house	17.8%	38.2%
8 or more rooms in house	10.8%	31.1%
Period in which accommodation was built		
House built pre 1918	12.7%	33.3%
House built between 1918 and 1960 (REF)		
House built between 1961 and 1970	8.4%	27.8%
House built between 1971 and 1980	18.5%	38.8%
House built between 1981 and 1990	16.6%	37.2%
House built between 1991 and 2000	17.4%	37.9%
Post 2000	5.9%	23.6%
Type of accommodation		
Bedsitter	0.2%	4.3%
Converted apartment	1.0%	9.7%
Apartment block big or small	1.7%	12.8%
Detached house (REF)		
Semi-detached house	48.6%	50.0%
Other	0.5%	7.3%
Tenure		
Owned outright (REF)		
Rented from local authority	7.2%	25.8%
Rented privately or rent free	11.0%	31.3%
Mortgage holder	33.1%	47.1%
Household composition		
1 person household	26.2%	44.0%
2 person household (REF)		
3 person household	16.7%	37.3%
4 person household	16.4%	37.0%
5 person household	9.5%	29.3%
6 person household	3.5%	18.5%
7 person household	1.0%	9.8%
8 or more people per household	0.4%	5.9%
Family composition		
No children in household (REF)		
Family with children	18.8%	39.1%
Two parent household (REF)		
Single parent	1.7%	12.8%

Variable	Mean	Std. Dev.
Social group of Chief Economic Supporter (CES)		
Employers and Managers, Higher Professional, Lower Professional (REF)		
Non Manual	14.8%	35.5%
Manual skilled and Semi-skilled	18.6%	38.9%
Unskilled and Agricultural workers	6.7%	25.1%
Own account workers and farmers	10.2%	30.2%
All others gainfully occupied and unknown	16.7%	37.3%
Employment status of CES		
Full time Employee (REF)		
Part time Employee	7.7%	26.7%
Unemployed	2.3%	15.1%
Retired	15.7%	36.4%
Student	1.7%	12.8%
Other	13.7%	34.4%
Education level of CES		
No formal education	0.4%	6.0%
Primary education	21.0%	40.7%
Junior Cert/O level	21.1%	40.8%
Leaving Cert/A level (REF)		
Sub degree	11.5%	32.0%
Primary degree	11.3%	31.7%
Higher degree	7.6%	26.5%
Missing education observations	1.7%	12.9%
Age of CES		
0-14	0.0%	1.3%
15-24	4.8%	21.3%
25-34	15.0%	35.7%
35-44 (REF)		
45-54	20.2%	40.2%
55-64	15.6%	36.3%
65-74	13.2%	33.8%
75+	9.4%	29.2%
Income		
Log of household disposable income	645.2%	79.9%
Period in which interview took place		
Q3 2004	11.0%	31.3%
Q1 2005	23.5%	42.4%
Q2 2005 (REF)		
Q3 2005	21.1%	40.8%
Q4 2005	19.9%	40.0%
Electrical Appliances		
Washing Machine	95.3%	21.2%
Dishwasher	50.1%	50.0%
Fridge	43.4%	49.6%
Deep freezer	35.4%	47.8%
Vacuum Cleaner	95.5%	20.7%
Tumble Dryer	61.7%	48.6%
Home computer	34.3%	47.5%
Double Glazing	76.0%	42.7%
Fridge-freezer	63.4%	48.2%
Microwave	86.0%	34.8%

Variable	Mean	Std. Dev.
Cooking Methods		
Electric cooker (REF)		
Gas or LPG cooker	27.2%	44.5%
Solid fuel cooker	3.1%	17.4%
Oil fired cooker	1.6%	12.4%
Combined methods or other cooking methods	2.6%	15.8%
Heating Methods		
No central heating (REF)		
Central heating	93.8%	24.1%
Space heating by central heating (REF)		
Space heating by open fire	2.6%	16.0%
Space heating by solid fuel heater or cooker	1.4%	11.9%
Electric heaters and appliances	2.5%	15.7%
Space heating by piped gas	0.2%	4.1%
Space heating by LPG paraffin or other	0.3%	5.1%
No space heating methods	0.0%	1.3%
Water heating by central heating (REF)		
Water heating by solid fuel (fire/cooker/stove)	16.2%	36.9%
Water heating by electric means, e.g. immersion	10.2%	30.3%
Water heating by gas boiler	6.6%	24.9%
Water heating by renewable energy	0.0%	1.0%
Water heating by other methods or no water heating	1.5%	12.0%

Table 2 Logit regression results for determinants of appliance ownership (results are presented as odds ratios)

	Fridge-Freezer	Fridge	Washing Machine	Vacuum Cleaner	Microwave	Tumble Dryer	Dishwasher	Deep Freezer	Home Computer	Double Glazing
Location of household										
Border, Midland and West (REF)										
South West, South East, Mid West, Mid East excluding Dublin	0.691***	1.53***					1.23***	1.6***		1.35***
Dublin	0.779***	1.17**				0.542***				
Rural (REF)										
Urban	1.24***	0.789***	1.83***	1.52**	1.31***	1.25***	1.31***	0.762***	1.13**	1.25***
Number of rooms in accommodation										
1			0.17***							
2			0.151***	0.283**						
3	0.374***	2.34***	0.172***	0.258***	0.318***	0.43***	0.343***			
4	0.817**		0.594***	0.562***	0.659***	0.739***	0.439***		0.722***	
5 (REF)										
6			1.77**	1.81***	1.39***	1.24***	1.48***	1.4***		1.44***
7			4.02***	2.74***	1.89***	1.72***	2.77***	1.64***		1.86***
8 or more	0.721***	1.59***	3.37**	2.73***	1.95***	2.11***	4.01***	2.48***		1.86***
Period in which accommodation was built										
Pre 1918	0.865*	1.26***	0.512***	0.646***	0.566***				0.787***	0.656***
Between 1918 and 1960 (REF)										
Between 1961 and 1970							1.27**			1.35***
Between 1971 and 1980		1.14**		2.09***	1.27**			1.2***	1.15**	
Between 1981 and 1990							1.3***			
Between 1991 and 2000	1.17**			1.93***			1.46***			3.58***
Post 2000	1.33**					1.57***	2.86***			9.55***
Type of accommodation										
Bedsitter						3.67**				
Converted apartment				2.53**		1.93**				
Apartment block						2.3***				
Detached house (REF)										
Semi-detached/terraced	1.48***	0.686***		1.79***	1.32***		0.76***	0.672***		
Other	2.45**	0.394**								0.0941***

	Fridge-Freezer	Fridge	Washing Machine	Vacuum Cleaner	Microwave	Tumble Dryer	Dishwasher	Deep Freezer	Home Computer	Double Glazing
Tenure										
Owned outright (REF)										
Rented from local authority				0.443***		0.684***	0.411***	0.669***	0.618***	0.484***
Rented privately or rent free				0.598**		0.484***	0.394***	0.535***	0.733***	0.494***
Mortgage holder	1.17***		3.08***		1.32***		1.45***	0.822***		
Household composition										
1 person household	0.782***		0.26***		0.625***	0.659***	0.543***	0.567***	0.633***	
2 person household (REF)										
3 person household						1.29***		1.47***	1.58***	0.842**
4 person household						1.46***		1.48***	1.61***	
5 person household						1.87***	1.49***	1.61***	1.9***	
6 person household						1.98***	1.6***	2.28***	1.81***	
7 person household						3.14**			3.51***	
8 or more people per household				0.271**	0.396**					
Family composition										
No children in household (REF)										
Family with children				0.64**		1.32***	1.24**	0.847**	0.797***	1.44***
Two parent household (REF)										
Single parent							0.564***			
Social group of Chief Economic Supporter (CES)										
Employers and Managers, Higher Professional or Lower Professional (REF)										
Non Manual							0.809**		1.31***	
Manual skilled/Semi-skilled							0.764***		1.21**	
Unskilled and Agricultural workers		1.3***	0.564**	0.46***			0.624***			
Own account workers and farmers					0.671***				0.729***	0.657***
All others gainfully occupied and unknown										
Employment status of CES										
Full time Employee (REF)										
Part time Employee	0.828**									

	Fridge-Freezer	Fridge	Washing Machine	Vacuum Cleaner	Microwave	Tumble Dryer	Dishwasher	Deep Freezer	Home Computer	Double Glazing
Unemployed								0.592**	0.538***	
Retired			0.661**						1.62***	
Student										
Other				0.601***					0.675***	
Education level of CES										
No formal education	0.304**		0.162***	0.169***	0.368**					
Primary education	0.718***	1.27***	0.637***	0.344***	0.79**	0.761***	0.619***		0.548***	
Junior Cert/O level										
Leaving Cert/A level (REF)										
Sub degree										
Primary degree					0.586***	0.732***			0.846*	
Higher degree					0.455***				0.601***	
Missing education observations										
Age of CES										
0-14										
15-24				0.255***	1.59**				0.686***	
25-34		0.824***		0.423***	1.36**	0.839**	0.779***	0.841**	0.821**	
35-44 (REF)										
45-54									1.4***	
55-64							1.27***			
65-74									0.614***	
75+			0.638***		0.525***	0.637***	0.479***	0.698***	0.228***	0.652***
Income										
Log of household disposable income			1.63***	1.62***	1.26***	1.45***	1.83***	1.12**	1.05	1.38***
Period in which interview took place										
Q3 2004	0.836**	1.22**								
Q1 2005					0.808**			0.84***		
Q2 2005 (REF)										
Q3 2005										
Q4 2005										1.18**

Table 3 OLS regression results for determinants of electricity use, energy use and useful heat

	Energyelec		Energyoth		Heatoth	
	Coef.	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**
Location of household						
Border, Midland and West (REF)						
South West, South East, Mid West, Mid East excluding Dublin			-51.8***	11.2	-17***	5.94
Dublin	5.47***	1.86	26.4*	14.2	45.8***	8.51
Rural (REF)						
Urban					16***	5.91
Number of rooms in accommodation						
1	-30.7***	8.38	-189***	29.9	-104***	19.8
2	-18.7**	8.39	-145***	47	-74.3***	23
3			-130***	20.8	-72***	12
4						
5 (REF)						
6	4.93***	1.75				
7	7.24***	2.01			22.3***	6.82
8 or more	13.7***	2.47	50.6***	15.7	45.3***	9.42
Period in which accommodation was built						
Pre 1918	5.34**	2.27				
Between 1918 and 1960 (REF)						
Between 1961 and 1970	-4.85**	1.92				
Between 1971 and 1980						
Between 1981 and 1990			-32.5***	11.9	-19.7***	6.79
Between 1991 and 2000			-25.1**	11.8	-16.6**	6.95
Post 2000	-7.11***	2.59				
Type of accommodation						
Bedsitter						
Converted apartment	-10.1**	5.04				
Apartment block big or small			-101***	24.3	-46.6***	15.7

26

	Energyelec		Energyoth		Heatoth	
	Coef.	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**
Detached house (REF)						
Semi-detached house	-5.61***	1.61	-31.5***	10.4		
Other						
Tenure						
Owned outright (REF)						
Rented from local authority			67.1***	20.5	38***	11.6
Rented privately or rent free			-71.7***	15.1	-28.8***	9.69
Mortgage holder					10.9*	6.36
Household composition						
1 person household	-14.5***	1.72	-90.3***	13.4	-47.3***	7.1
2 person household (REF)						
3 person household	11.9***	2.04	35.8***	14	15.8**	7.47
4 person household	21.2***	2.53	22.8*	12.9		
5 person household	33.9***	3	64.9***	22	25***	9.5
6 person household	35.5***	3.8	93.8***	29.8	45.3***	16.5
7 person household	49.1***	5.8				
8 or more people per household	59.3***	12.7				
Family composition						
No children in household (REF)						
Family with children						
Two parent household (REF)						
Single parent	9.11**	4.42				
Social group of Chief Economic Supporter (CES)						
Employers and Managers, Higher Professional, Lower Professional (REF)						
Non Manual						
Manual skilled/Semi-skilled			-36***	10.6	-21.1***	5.79
Unskilled and Agricultural workers						
Own account workers and farmers						
All others gainfully occupied and unknown						

	Energyelec		Energyoth		Heatoth	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Employment status of CES						
Full time Employee (REF)						
Part time Employee						
Unemployed						
Retired	-2.99	2.07	31.1**	14.8	21.7***	8.17
Student			175***	41.1	98.4**	49.1
Other						
Education level of CES						
No formal education						
Primary education			38.2***	14.8	17.1**	7.14
Junior Cert/O level						
Leaving Cert/A level (REF)						
Sub degree			17.9	13.1	14.5*	7.72
Primary degree						
Higher degree					12	11.4
Missing education observations	-1.83	5.79	-275***	33.8	-151***	46.9
Age of CES						
0-14	2.46	4.41				
15-24						
25-34						
35-44 (REF)						
45-54	7.42***	2.07				
55-64	8.49***	2.4				
65-74	-12.7***	2.59				
75+	-17.2***	2.86				
Income						
Log of household disposable income	3.67***	1.29	12.7	7.92	8.49*	4.61

	Energyelec		Energyoth		Heatoth	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Period in which interview took place						
Q4 2004	-4.57**	2.04			-23**	9.69
Q1 2005	5.64***	2.07	58.7***	13.4	26.8***	7.91
Q2 2005 (REF)						
Q3 2005	-9.1***	1.98	-106***	11.6	-61.7***	6.95
Q4 2005	-12.3***	1.65	-63***	13.3	-57.3***	7.64
Electrical appliances						
Fridge-freezer	5.91***	1.67				
Fridge						
Washing Machine						
Vacuum Cleaner	5.43*	3.14				
Microwave						
Tumble Dryer	9.27***	1.52				
Dishwasher	9.25***	1.7			17.2***	5.94
Deep freezer	9.92***	1.83				
Home computer						
Energy saving measures						
Double Glazing			-35.1***	12.7	-14**	6.74
Cooking method						
Electric cooker (REF)						
Gas or LPG cooker	-10.1***	1.45	54.3***	11.1	38.7***	6.08
Solid fuel cooker	-15.1***	2.79				
Oil fired cooker						
Combined methods or other cooking methods	-10.2***	3.43				
Heating methods						
No central heating (REF)						
Central heating						
Space heating by central heating (REF)						
Space heating by open fire	5.65	4.33			-105***	17.8
Space heating by Solid fuel heater or cooker						

	Energyelec		Energyoth		Heatoth	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Electric heaters and appliances	36.2***	5.62	-205***	20.5	-135***	11
Space heating by piped gas			-111**	49.3		
Space heating by LPG paraffin or other						
No space heating methods	12.8**	5.71	1350***	30	602***	15.8
Water heating by central heating (REF)						
Water heating by solid fuel (fire/cooker/stove)			53.1***	14.8	23.4***	7.46
Water heating by electric means, e.g. immersion	10.9***	2.83	-74.3***	16.7	-49.5***	9.43
Water heating by gas boiler			77***	20.3	73.6***	13.5
Water heating by renewable energy	21.6***	4.86	311***	36.4	210***	19.7
Water heating by other methods or no water heating	-12.3***	3.76				

Table 4: OLS regression results for determinants of electricity use, energy use and useful heat, with appliance ownership omitted

	Energyelec		Energyoth		Heatoth	
	Coef.	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**
Location of household						
Border, Midland and West (REF)						
South West, South East, Mid West, Mid East excluding Dublin			-57.9***	11.3	-20.6***	5.86
Dublin	3.78**	1.88	36***	13.9	57.8***	8.13
Rural (REF)						
Urban	2.95*	1.72			16.5***	5.99
Number of rooms in accommodation						
1	-21.7***	5.83	-161**	74.8	-77.8	53.2
2			-226***	44.4	-133***	23.7
3			-142***	22.8	-89.9***	13.5
4					-19.7**	9.4
5 (REF)						
6	6.53***	1.75				
7	11.1***	2.04			24***	6.85
8 or more	17.9***	2.52	53.8***	15.8	50.4***	9.57
Period in which accommodation was built						
Pre 1918	5.96***	2.3				
Between 1918 and 1960 (REF)						
Between 1961 and 1970						
Between 1971 and 1980	4.9***	1.84	-18.4	14.7	-11.5	7.28
Between 1981 and 1990			-50.8***	13.1	-27.6***	7.42
Between 1991 and 2000			-48.1***	13.6	-22.1***	7.56
Post 2000			-40.7**	19.5		
Type of accommodation						
Bedsitter			-152*	78.3	-103*	55.4
Converted apartment					-81.7***	17.4
Apartment block big or small			-163***	26.4		

	Energyelec		Energyoth		Heatoth	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Detached house (REF)						
Semi-detached house	-6.71***	1.71	-35.4***	10.4		
Other						
Tenure						
Owned outright (REF)						
Rented from local authority			82.8***	21.5	32.9***	11.7
Rented privately or rent free			-82.4***	15.9	-44.3***	10.1
Mortgage holder			19.6*	11.8	16.3**	6.49
Household composition						
1 person household	-17.1***	1.73	-94.1***	13.4	-52.6***	7.37
2 person household (REF)						
3 person household	13.6***	2.08	43.5***	14.3	17.4**	7.65
4 person household	22.7***	2.62	28.5**	13.4		
5 person household	36.7***	3.09	72.4***	22.7	27.2***	9.57
6 person household	39.3***	3.81	96.2***	30.5	43.9***	16.6
7 person household	49.2***	5.92	81.9*	41.9		
8 or more people per household	59.5***	12.5				
Family composition						
No children in household (REF)						
Family with children						
Two parent household (REF)						
Single parent						
Social group of Chief Economic Supporter (CES)						
Employers and Managers, Higher Professional, Lower Professional (REF)						
Non Manual						
Manual skilled/Semi-skilled			-34.8***	11	-20.2***	5.99
Unskilled and Agricultural workers						

	Energyelec		Energyoth		Heatoth	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Own account workers and farmers						
All others gainfully occupied and unknown						
Employment status of CES						
Full time Employee (REF)						
Part time Employee						
Unemployed						
Retired			28.3*	15.3	17.3**	8.39
Student			141***	38.1	76.3**	36.2
Other						
Education level of CES						
No formal education						
Primary education	-6.25***	1.89	54.7***	15.9	25.3***	8.07
Junior Cert/O level			13.7	11.9	12.2*	6.93
Leaving Cert/A level (REF)						
Sub degree			18	13.6	14.8*	8.14
Primary degree						
Higher degree					15.1	12
Missing education observations	-1.51	6.2	-248***	30.6	-137***	32.9
Age of CES						
0-14						
15-24						
25-34						
35-44 (REF)						
45-54	8.13***	2.12				
55-64	9.02***	2.51				
65-74	-14***	2.35				
75+	-19.9***	2.71				
Income						
Log of household disposable income	5.51***	1.32	8.32	8.31	11.3**	4.61

	Energyelec		Energyoth		Heatoth	
	Coef.	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**	**Coef.**	**Robust Std. Err.**
Period in which interview took place						
Q4 2004	-4.82**	2.07			-23.5**	9.74
Q1 2005	5.8***	2.13	56.4***	13.6	24.3***	8.1
Q2 2005 (REF)						
Q3 2005	-8.56***	2.03	-106***	11.7	-62.4***	7.14
Q4 2005	-10.3***	1.68	-67.8***	13.4	-64.2***	7.78

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2009		
	276	Discounting for Climate Change *David Anthoff, Richard S.J. Tol* and Gary W. Yohe
	275	Projecting the Future Numbers of Migrant Workers in the Health and Social Care Sectors in Ireland *Alan Barrett* and Anna Rust
	274	Economic Costs of Extratropical Storms under Climate Change: An application of FUND Daiju Narita, *Richard S.J. Tol*, David Anthoff
	273	The Macro-Economic Impact of Changing the Rate of Corporation Tax *Thomas Conefrey* and *John D. Fitz Gerald*
	272	The Games We Used to Play An Application of Survival Analysis to the Sporting Life-course *Pete Lunn*
2008		
	271	Exploring the Economic Geography of Ireland *Edgar Morgenroth*
	270	Benchmarking, Social Partnership and Higher Remuneration: Wage Settling Institutions and the Public-Private Sector Wage Gap in Ireland *Elish Kelly, Seamus McGuinness, Philip O'Connell*
	269	A Dynamic Analysis of Household Car Ownership in Ireland *Anne Nolan*
	268	The Determinants of Mode of Transport to Work in the Greater Dublin Area *Nicola Commins* and *Anne Nolan*
	267	Resonances from *Economic Development* for Current Economic Policymaking *Frances Ruane*
	266	The Impact of Wage Bargaining Regime on Firm-Level Competitiveness and Wage Inequality: The Case of Ireland *Seamus McGuinness, Elish Kelly* and *Philip O'Connell*