



Working Paper No. 562

May 2017

Financial incentives for residential energy efficiency investments in Ireland: Should the status quo be maintained?

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Abstract: Improving the energy efficiency of residential dwellings is seen by policy-makers as an important tool to help mitigate the impacts of climate change. Many countries, including Ireland, have put in place policies aimed at stimulating energy efficiency renovations in private households. Options to induce further retrofitting activity include the possibility of altering the structure of financial incentives on offer. At the moment, the Better Energy Homes scheme comprises a cash rebate to home owners following the completion of retrofit works. However, alterations to the incentive structure may be more or less preferred by different segments of the population. We analyse these preferences toward different financing structures. We find that the most preferred option of the choice set presented to respondents is the status quo of a post-retrofit cash rebate, followed closely by the alternative of an upfront discount.

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Acknowledgements: This research has been financially supported by the Sustainable Energy Authority of Ireland and the ESRI's Energy Policy Research Centre. The authors thank Seán Lyons and Mel Devine for valuable comments and suggestions on earlier drafts of the paper.

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1. Introduction

The residential sector is the third largest energy consuming sector in the EU, accounting for 24.8% of final consumption (Eurostat, 2016). Space and water heating comprise 67% and 14% of residential energy use, respectively (E.C., 2011). As a result, improving the energy efficiency of residential buildings provides an opportunity for policy to reduce a nation's carbon footprint and for households to save money on their energy bills and improve the comfort of their homes. This is particularly important given the European Union mandate to reduce energy use by 2020 (European Parliament and the Council of the European Union, 2012) and the Paris Agreement's emphasis on the need to reach peak greenhouse gas emissions as soon as possible as a means of helping to achieve the limitation of global warming below 2°C (United Nations, 2015).

Energy efficiency retrofitting is subject to certain market failures, most notably transaction costs and information asymmetries. As such, many governments provide financial incentives for households to engage in energy efficiency retrofitting works. In order to maximise the impact of such subsidies, the structure of incentives must be attractive to home owners. This paper engages with the identification of the most preferred structure of financial incentive to home owners if they were to undertake retrofitting works. Using stated preference data to model individual preferences, this paper is concerned with identifying the variation in preferences for different structures of financial incentive in Ireland and how these preferences vary across the population.

A fully state-financed roll-out of energy efficiency retrofit technologies is unlikely to be feasible due to the economic implications of such an investment. Instead, many governments provide schemes to incentivise retrofitting at the household level. This is an attractive means of driving investments in energy efficiency in residential buildings as households also benefit from such investments, in addition to the state. Examples of these incentives include the UK's recently concluded *Green Deal* financing scheme, France's *crédit d'impôt développement durable* (Sustainable Development Tax Credit) or Germany's *KfW-Effizienzhaus* financing scheme. In Ireland, the *Better Energy Homes* scheme provides approximately 35% of the costs of retrofitting for certain energy efficiency retrofit measures. This is delivered in the form of a cash rebate following the completion of works.

This is supplemented by the *Better Energy Warmer Homes* scheme, which provides the full cost of specific retrofitting works for recipients of specific welfare supports.

The design of incentives for residential energy efficiency retrofitting at the household level raises some concerns surrounding the accessibility of incentives for different groups. Energy efficiency retrofitting results in substantial private gains to the household in the form of lower energy bills, increased comfort and environmental improvements (Aravena et al., 2016; Clinch and Healy, 2001; Gillingham et al., 2009), alongside improved health outcomes (Howden-Chapman et al., 2012; Marí-Dell'Olmo et al., 2016) and increased property values (Brounen and Kok, 2011; Hyland et al., 2013; Fuerst et al., 2015). As such, if general taxation is used to subsidise retrofitting investments, distributional concerns will arise if certain socio-demographic groups are more or less likely to privately accrue these benefits as a result of the introduction of subsidies.

Using survey data, we examine whether there exist more or less preferred options to certain demographics of home owners, relative to the status quo. The findings of this analysis provide an insight into and an interpretation of potential distributional and welfare implications of changes to the structure of this financial incentive. We find that, relative to the status quo, the alternatives of a property tax reduction or an upfront discount would be less preferred by respondents of certain characteristics. The alternatives of a tax credit scheme to supplement loan financing and the ability to make repayments on the cost of works via an employer are less favoured by all respondents. The least preferred option is that of no financial incentive to retrofit, although the strength of this distaste varies by characteristics of respondents, most notably across age categories.

The remainder of the paper is outlined as follows. Section 2 provides a discussion of literature in the area. Section 3 describes the data and Section 4 outlines the methodological approach, while Section 5 outlines and discusses the results before Section 6 concludes.

2. Relevant Literature

Previous research in the area is discussed in three sections. Firstly, we discuss research outlining why preferences may vary toward government subsidies in general. This is followed by a discussion of research

on different forms of government incentives for improved energy efficiency. Finally, we discuss literature of particular relevance to energy efficiency retrofitting.

Preferences toward different structures of financial incentive may vary due to issues of distributional equity. For example, low-income households are less likely to be able to avail of subsidised costs for energy efficiency measures. This arises not only from a decreased ability to fund these reduced costs, due to a tighter budget constraint combined with a greater number of competing necessity goods, but also increased liquidity restraints stemming from a restricted access to credit and loans (Camprubí et al., 2016). Similarly, discount rates vary across the income distribution. The decision to invest in energy efficiency retrofit measures can be seen as an inter-temporal consumption decision in which individuals reduce consumption today by investing, in order to increase future consumption of the benefits outlined above. The degree to which households are willing to allocate their consumption over time is dependent on how much they value current over future consumption. However, an inverse relationship between discount rates and income has been found, with those from low income households tending to have higher discount rates than those from higher income households (Hausman, 1979; Train, 1985; Lawrance, 1991). The present value of future energy efficiency benefits is therefore lower for lower-income households. As such, low-income households will be less likely to respond to incentives for energy efficiency renovations. Incentives which involve the delaying of consumption are hence biased in favour of those with higher incomes.

With regard to energy efficiency policies, Markandya et al. (2015) provide a discussion of the types of policy measures which can be used to foster energy efficiency, dividing them into three areas. "Command-and-control" policies mandate minimum levels of energy performance, usually implemented via building codes and standards. "Price instruments" aim to encourage or discourage certain decisions through indirect changes to prices, such as through taxes on or permits for consumption, tax deductions, tax credits, subsidies, rebates or preferable loans for energy saving decisions. "Information instruments" aim to mitigate the market failure of information asymmetry, with examples including smart-metering, energy auditing and energy labelling. This paper is concerned with price instruments and the impact of a change from the current cash rebate scheme to promote retrofitting in Ireland to other price instru-

ments. The literature on price instruments promoting desirable activities cover issues such as tax credits and subsidies. For example, Borenstein and Davis (2016) follow Crandall-Hollick and Sherlock (2012) and Neveu and Sherlock (2016) by investigating the distributional impacts of 'clean energy' tax credits in the US for activities such as weatherising homes, installing solar panels and buying hybrid or electric vehicles. Borenstein and Davis (2016) found issues regarding distributional equity, with the bottom three income quintiles receiving just 10% of all credits and the top quintile receiving about 60% of all credits. West (2004) finds that direct subsidies on new cars would be regressive, while accelerated vehicle retirement programs would be progressive. Distant et al. (2016) examine the distributional impact of a renewable energy subsidy in Italy, concluding that the subsidy acted as a tax on the middle-class, with welfare losses occurring in the second, third and fourth income quintiles

Looking specifically at policies regarding energy efficiency retrofitting, the issue of the accessibility of financial incentives to retrofit across sub-groups of the population is investigated by Camprubí et al. (2016), who take a theoretical approach to examine, ex-ante, the impact of policies. Camprubí et al. (2016) identify inequalities across socio-demographics in that greater barriers to retrofitting are faced by low-income groups, renters and the elderly, inequalities that may be exacerbated by public policies which do not provide free and/or targeted services to the most affected groups. Neuhoﬀ et al. (2012) examine the up-take of various types of incentives in Germany, Italy, the Netherlands and the United States but do not examine whether any of these subsidies might be more or less preferred by households. Collins and Curtis (2017b) briefly discuss distributional impacts of tweaks to the Irish cash rebate system to improve per household optimization of energy efficiency improvements under the Better Energy Homes scheme. Collins and Curtis (2017b) speculate that a focus on retrofit measures providing greater value for money to the grant provider might lead to a prioritisation of rural homes, relative to urban homes. This is because insulating cavity walls, which are more prevalent in rural areas, provides greater value for money than insulating solid walls, which are more prevalent in urban areas.

We add to the literature on preferences towards incentives to retrofitting across the population of Ireland by investigating how changes to the structure of incentives may not be equally preferred across sub-groups

of the population. This complements the literature examining the distributional impacts of different incentive structures.

3. Data

To explore preferences for certain forms of subsidies, we analyse stated preference data provided by the Sustainable Energy Authority of Ireland from a pooled cross-sectional survey of home owners in Ireland. The survey was undertaken in December 2014 and December 2016. In both instances, a face-to-face survey was conducted in respondents' own homes, using a computer-aided personal interviewing approach. The 2014 and 2016 surveys were conducted on samples of 659 and 650 respondents, respectively, representative of region and socio-economic status, consisting only of owners of houses (i.e. no owners of apartments or renters were included) who were the primary or joint decision-maker responsible for energy usage and energy improvement related decisions. Responses were collected as part of a wider survey on retrofitting. Some respondents were precluded from analysis for not providing full information to certain questions, leaving a sample of 645 from each survey, leading to a total sample of 1,290 respondents.

The primary interest of this analysis concerns stated preferences toward the structure of financial incentives. Respondents were verbally provided with the following question and set of response choices, with surveyors asking respondents for their first, second and third preferences:

Different incentive options may be considered to encourage investment in energy efficiency measures. For example if you undertook to complete an attic insulation or other measure you might receive a financial incentive in one of the following forms. Which of these would you prefer?

1. Reduced property tax based on a better energy efficiency rating
2. Tax credits for each year of the loan term
3. Cash back once the work is complete
4. Ability to pay through your employer via your salary/wages (along the lines of the bike to work scheme where you save on the purchase price with tax relief)

5. A discount on the cost of work upfront
6. None

Table 1: Descriptive Statistics

	Obs.	Prop.
Reduced property tax based on a better energy efficiency rating	145	0.11
Tax credits for each year of the loan term	93	0.07
Cash back once the work is complete	482	0.37
Ability to pay through your employer via your salary/wages	65	0.05
A discount on the cost of work upfront	437	0.34
None	68	0.05
<i>Gender</i>		
Male	615	0.48
Female	675	0.52
<i>Age</i>		
18 - 35	229	0.18
36 - 45	320	0.25
46 - 55	271	0.21
56 - 65	232	0.18
65+	238	0.18
<i>Location</i>		
Urban	771	0.60
Rural	519	0.40
<i>Social Class</i>		
AB	190	0.15
C	755	0.59
DEF	345	0.27
<i>Ownership</i>		
Own outright	493	0.38
Own with mortgage	797	0.62
<i>Property Type</i>		
Detached	559	0.43
Semi-detached	527	0.41
Terraced	204	0.16
<i>Availed of current grant in the past</i>		
No	1,091	0.85
Yes	199	0.15
Total Observations	1,290	

The stated first preference of respondents towards structures of financial incentives provides the variable of interest for our analysis, as will be discussed in Section 4. The order of preferences for each survey and the pooled sample are presented in Figure 1. The total number of preferences varies as some respondents did not express a second and/or third preference. As can be seen, a similar pattern in preferences can be seen in both surveys, with the order of the popularity of preferences remaining the same. Cash back once the work is complete is expressed most often as the most preferred form of financial incentive. This is followed closely by an upfront discount on the cost of work. This is perhaps surprising as, although both options are quite similar, the former requires a larger degree of liquidity in order to first cover total costs, relative to the liquidity required to cover a partial cost.

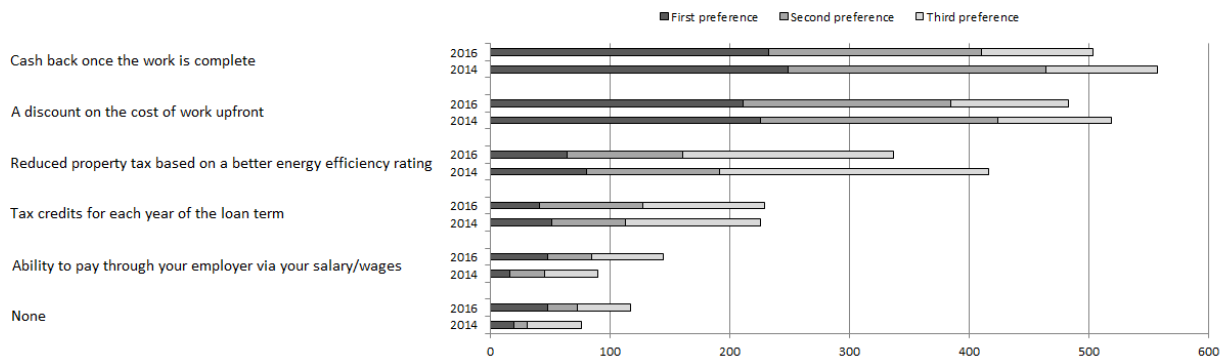


Figure 1: Ranking of preferences for suggested incentive structures

Reduced property tax is seen to be third-most popular choice, although the popularity of this option appears to have declined quite strongly between 2014 and 2016. Tax credits for each year of a loan term are the next most-preferred option and, finally, the ability to make repayments through an employer is the least popular choice. The popularity of the option to make repayments via an employer has increased, however, from 2014 to 2016. Overall, while the order of popularity of each choice has remained the same, there has been a noticeable reduction in the popularity of the first three options, i.e. cash back after works, an upfront discount and reduced property tax, while the popularity of repayments through an employer has risen.

Other information collected about respondents includes socio-demographic characteristics, property type, ownership, location and whether they have availed of a grant for retrofitting in the past. Socio-demographic information comprises gender, age category and social class. As discussed in Section 2, preferences may vary due to variation in impacts of policies across these characteristics. Social class is categorised according to the Central Statistics Office socio-economic groupings, where ‘A’ comprises “Employers and managers”, ‘B’ is described as “Higher professional” and ‘C’ as “Lower professional”. ‘D’ is described as “Non-manual”, ‘E’ as “Manual skilled” and ‘F’ as “semi-skilled” and in this case also includes Farmers. Property type is divided into three types of houses, these being detached houses, semi-detached houses and terraced houses, while location is divided between urban and rural dwellings. These characteristics may affect preferences as property values may affect preferences for incentives related to property tax. Ownership is categorised as those who

own their homes with a mortgage and those who own their homes outright and may affect preferences due to the ability and/or appetite to take on credit. Descriptive statistics for the pooled dataset are presented in Table 1.

4. Econometric Approach

This research concerns the identification of home owners’ preferences toward different structures of financial incentive to retrofit. We use a multiple regression to gain an understanding of how these preferences vary across characteristics of the population. We design a discrete choice model in which the dependent variable represents the probability that a home owner possesses a stated first preference for a specific structure of financial support. Since our dependent variable represents an unordered choice that can be one of the six options discussed in Section 3, we use a multinomial logit model. A number of papers follow a similar approach to modelling issues surrounding space heating (Braun, 2010; Couture et al., 2012; Michelsen and Madlener, 2012).

The multinomial logit model estimates the probability that a respondent will choose one of the alternative incentive structures as their first preference, relative to the base outcome of the status quo. The multinomial logit model assumes that errors are independently and identically distributed according to the type I extreme value distribution, commonly referred to as the Gumbel distribution. A multinomial probit model was also considered but this did not cause any significant changes to the estimates of the model. In the case of the multinomial logit, the probability that home owner i chooses option j ($j=1,2,\dots,J$) is speci-

fied as follows:

$$P(IS_j) = P_{i,j} = \frac{\exp(\beta_j x_i)}{1 + \sum_{k=1}^J \exp(\beta_k x_i)} \quad (1)$$

where IS_j represents incentive structure j and $P_{i,j}$ the choice probability. The vector x_i represents the characteristics of respondent i discussed in section 3, while β represents the vector of estimated coefficients. To interpret the results of the analysis, relative risk ratios are calculated. Relative risk ratios are calculated as the exponent of the coefficient and represent the relative probability of an outcome, relative to the base outcome, corresponding to a unit change in the predictor, holding all else constant.

In a multinomial logit model the ratio of two probabilities, for example $(P_{i,j=1}/P_{i,j=2})$, is assumed not to depend on any alternatives other than $j = 1$ and $j = 2$, irrespective of the other alternatives available. As such, the model assumes what is termed independence from irrelevant alternatives (IIA). McFadden (1973) advises that multinomial logit models “should be limited to situations where the alternatives can plausibly be assumed to be distinct and weighed independently in the eyes of each decision maker”. For our empirical application it is not unreasonable to assume that households possess a clear distinction in preferences between potential structures of financial incentives for retrofitting measures.

Variations in preferences may be caused by various theoretical mechanisms and/or combinations thereof. The random utility framework provides a commonly used theoretical approach in the energy efficiency literature, with examples including Grösche and Vance (2009), Michelsen and Madlener (2012) and Collins and Curtis (2017a). In this framework, home owners make decisions to invest in certain energy efficiency renovations based on a number of factors. Households decide to invest on the condition that they believe it is the optimal time to retrofit, i.e. when net present value is maximised at the time of investment. Expectations regarding the optimal time to retrofit are based on current and future expectations surrounding the characteristics of their home, capital costs, the cost of energy consumption, energy savings accrued from renovating, other non-monetary benefits and costs, such as search costs, comfort and health gains, etc. and the regulatory environment. This regulatory environment includes the level and structure of grant aid and building regulations, which could impact on the costs of retrofitting and the supply of contractors. Home owners will choose to invest if, among

other things, the structure of financial incentive is not expected to be amended to a more preferable structure for the individual.

Prospect theory might also provide a potential explanation for variations in preferences. In particular, prospect theory might hypothesise a preference toward a cash rebate over structures which seek to reduce expenditures, such as reduced property tax, upfront discount or tax credit system. While the net outcome might be the same in each case, the net perceived benefit may be greatest in the case of a cash rebate. Consumers are found to value gains and losses differently. While some consumers may treat each option as a net outcome (Johnson and Thaler, 1985), others may treat them as segregated gains and losses, both of which provide decreasing marginal changes to utility but with losses providing greater marginal changes to utility than equivalent gains (Kahneman and Tversky, 1984). If the utility accrued from a rebate of the cash grant exceeds the dis-utility accruing from the additional payment of the value of the cash rebate then a cash rebate system can be seen as more preferable.

5. Results and Discussion

Estimated results are presented in Table 2. The model presented here provides an insight into how preferences toward the structure of financial incentives to retrofitting vary by socio-demographic characteristics. We cannot say for certain that changes will lead to lesser or higher uptake of retrofitting incentives as we do not know the strength of preferences, how well the stated preferences of respondents reflect their true preferences or how each structure could impact on individuals’ investment decisions.

As the econometric model is comprised solely of categorical independent variables, the estimated constants reflect the preferences of those in our reference categories. In this case, the reference category is comprised of males in the ‘18-35’ age category, those living in detached houses in urban areas who own their house outright, those in the ‘AB’ social class and who have not availed of a grant for retrofitting works in the past. The reference category does not possess a statistically significant preference toward either the reduced property tax or upfront discount alternatives, relative to the status quo. The remaining three alternatives are, however, much less preferred by the reference category. The option of no incentive is found to be the least likely option to be chosen, with a relative risk

Table 2: Homeowners' likelihood of possessing a preference for incentive structures other than the status quo, reported using relative risk ratios

	Base category = Status quo ("Cash back once work is complete")				
	"Reduced property tax based on a better energy efficiency rating"	"Tax credits for each year of the loan term"	"Ability to pay through your employer via your salary/wages"	"A discount on the cost of work upfront"	"None"
Constant	0.603 (0.240)	0.218*** (0.109)	0.165*** (0.0957)	1.072 (0.318)	0.0442*** (0.0377)
<i>Gender (ref = Male)</i>					
Female	0.574*** (0.112)	0.867 (0.198)	0.665 (0.180)	1.064 (0.144)	1.069 (0.292)
<i>Age (ref = 18 - 35)</i>					
36 - 45	1.120 (0.347)	1.359 (0.443)	2.170** (0.839)	0.950 (0.196)	1.327 (0.866)
46 - 55	0.971 (0.319)	1.059 (0.378)	1.384 (0.597)	0.958 (0.206)	2.123 (1.352)
56 - 65	1.217 (0.413)	0.839 (0.337)	0.491 (0.298)	1.147 (0.277)	3.650** (2.321)
65+	1.047 (0.383)	0.206*** (0.121)	0.212* (0.184)	0.996 (0.253)	8.556*** (5.580)
<i>Location (ref = Urban)</i>					
Rural	0.682* (0.141)	0.952 (0.242)	0.914 (0.270)	0.873 (0.126)	0.542** (0.164)
<i>Social Class (ref = AB)</i>					
C	0.826 (0.224)	1.281 (0.442)	0.970 (0.356)	0.769 (0.150)	1.624 (0.861)
DEF	0.824 (0.259)	0.894 (0.389)	0.442 (0.247)	1.067 (0.242)	2.250 (1.273)
<i>Ownership (ref = Own outright)</i>					
Own with a mortgage	0.979 (0.220)	0.790 (0.209)	0.835 (0.289)	1.136 (0.187)	1.239 (0.397)
<i>Property Type (ref = Detached house)</i>					
Semi-detached	0.705 (0.152)	1.149 (0.307)	1.636 (0.530)	1.071 (0.163)	0.617 (0.187)
Terraced	0.449** (0.142)	0.961 (0.336)	1.132 (0.489)	0.767 (0.151)	0.389** (0.175)
<i>Availed of grant in the past (ref = No)</i>					
Yes	1.431 (0.333)	1.111 (0.340)	0.646 (0.277)	0.574*** (0.112)	0.320** (0.156)

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Relative risk ratios are calculated as the exponents of the estimated coefficients of the multinomial logit model.

ratio of 0.0442, meaning that the reference category are over twenty times less likely to choose this option than the status quo. The options of a tax credit for each year of a loan term and the ability to make repayments on costs via an employer were also found to be less preferred to the status quo, reporting estimated relative risk ratios of 0.218 and 0.165, respectively.

5.1. Socio-demographics

While the results presented in Table 2 show no statistically significant preferences with regard to social class, significant variation is found regarding the age of respondents. Those in the '65+' category are significantly less likely to prefer incentive structures involv-

ing tax credits for each year of a loan term or making repayments through an employer, relative to the '18-35' category. Relative to those aged between 18 and 35, those aged 65 or older report relative risk ratios of 0.206 and 0.212 for the tax credit and repayment through an employer alternatives, respectively. It is not surprising that respondents in the '65+' category are less likely to prefer an incentive structure where repayments on the costs of work are made via an employer. This is because members of this age category are more likely to be out of the workforce due to retirement and therefore unable to avail of the scheme. By contrast we see that those in the '36-45' age category, an age category where one would expect the majority

to be employed in the labour market, are significantly more likely to prefer this incentive scheme, relative to the '18-35' category, reporting an estimated relative risk ratio of 2.17.

Furthermore, the aversion to tax credits is likely due to retirement from the labour market and thus lower incomes. Those in the '65+' category are more likely to be in receipt of a lower income due to retirement and/or reliance on pension income. In this case, the income of these respondents is likely to give rise to lower tax liabilities and, as such, tax credits may be less attractive due to the greater likelihood of potential tax credits exceeding tax liabilities. The results therefore suggest an aversion to incentive schemes which involve tax credits or making repayments through an employer among older age cohorts, which is likely explained by the life cycle of labour market participation and earnings.

While the reference category is found to be very unlikely to express a preference for the option of no incentive to retrofit, those in the '56-65' and '65+' age categories are significantly more likely to choose such an option. Table 2 reports estimated relative risk ratios of 3.65 and 8.556 for respondents in the '56-65' and '65+' age categories, respectively. There exist a couple of possible explanations for this trend in preference toward the no incentive option. Firstly, those in these older age categories will naturally possess shorter future lifespans and thus will possess less time to accrue the benefits of engaging in retrofitting works. Those who are therefore not interested in engaging in retrofit works might prefer state expenditure to be used elsewhere as they would not stand to gain from the availability of such an incentive. This explanation would appear to be justified by the increasing relative risk ratio as one moves from the '56-65' to the '65+' age category. Secondly, older people in Ireland are found to prioritise environmental protection less than younger age groups and that environmental concern is found to decline from the '35-44' age category onward (Motherway et al., 2003). As concern for the environment falls, older people may be less likely to see de-carbonisation of the built environment as an area of priority for policy might therefore be less likely to see the presence of financial incentives as necessary. They might thus believe that there are other areas where state funds could be better spent. As such, older age groups may be more likely to prefer a situation where financial incentives were not on offer to retrofit. It is therefore clear that stated preferences towards the structure of financial incentives

vary considerably across age categories.

5.2. Ownership and history of retrofitting

The results presented in Table 2 show that there is no significant relationship between type of ownership of a property and the likelihood of expressing a preference for any specific incentive structure. However, respondents' history of retrofitting is an important determinant of such a preference. Those who have retrofitted through the scheme in the past are found to be 0.574 times as likely to express a preference for an upfront discount as for a cash rebate, relative to those who have not. People who have retrofitted in the past via the cash rebate scheme are less likely to have liquidity constraints which would prevent them from paying the full cost of works upfront as they have been able to do so in the past.

As discussed in Section 4, prospect theory provides a potential explanation for why the status quo option of a cash rebate may be preferred to an upfront discount. As those who have retrofitted via the scheme in the past have experienced the segregated gain of the rebate, the estimated preference is consistent with prospect theory. Similarly, those who have availed of the grant scheme in the past are even less likely to express a preference for no incentive. As those who have availed of the grant scheme in the past naturally possess more information regarding the benefit of retrofitting it is likely that, as a result, they understand better the benefits of such an incentive and are thus less likely to advocate a no incentive option. We also cannot preclude the possibility that those who have retrofitted in the past may be more likely to suffer from status quo bias, which hypothesises a disproportionate preference for the status quo among individuals (Samuelson and Zeckhauser, 1988).

5.3. Location and property type

Rural respondents are significantly less likely than urban respondents to express a preference toward either the reduced property tax or no incentive options over the status quo of a cash rebate. All else equal, rural respondents possess relative risk ratios of choosing the reduced property tax and no incentive options of 0.682 and 0.542, respectively. However, with regard to the alternative incentive structures, the relative risk ratios for rural respondents remain insignificant. Similarly, Table 2 shows that, relative to respondents who are owners of detached houses, those who own terraced houses are significantly less likely to prefer a

reduced property tax or no incentive structure, reporting relative risk ratios of 0.449 and 0.389, respectively. Again, no significant relationship is found with regards to owners of terraced houses for the remaining alternative incentive structures. Finally we see that no significant preferences for an alternative incentive structure are found for owners of semi-detached houses, relative to detached houses.

These findings suggest that owners of terraced houses and rural respondents possess similar preferences. Both are less likely to prefer the option of either a reduced property tax based on a better energy efficiency rating or no financial incentive to retrofit, relative to the status quo. Both owners of terraced houses and rural respondents also possess no statistically significant preferences for the remaining alternatives relative to the status quo. These preferences are likely to operate through the same mechanism. It is likely that respondents who live in rural or terraced homes reside in less valuable properties than those who live in urban houses and/or detached or semi-detached houses. As such, they are likely to possess relatively lower property tax liabilities. Any reduction in property taxes based on a better energy efficiency rating would therefore lead to smaller savings in absolute terms than the reduction in property tax for those with more valuable properties and thus higher property tax liabilities. This incentive scheme could therefore be considered regressive, as those with more valuable properties would accrue greater subsidisation than those with less valuable properties for any energy efficiency works undertaken. For those with less valuable properties, it is therefore not surprising to find a distaste for a reduced property tax incentive structure.

Finally, it is not surprising that both groups also prefer the status quo to the no incentive option as it is generally more preferable to receive grant aid than not, conditional on respondents placing value on a state-sponsored retrofitting incentive.

6. Conclusion and Policy Implications

Improving the energy efficiency of the residential building stock is a stated policy goal in Ireland. As such, policy-makers use various instruments to help stimulate improvements in energy efficiency. In Ireland, the *Better Energy Homes* scheme, a price instrument used to incentivise retrofitting at the household level, currently comprises a cash rebate to home owners following the completion of

retrofitting works. This paper considers whether alterations to this structure might induce greater levels of retrofitting throughout the residential sector. Such alterations may, however, have positive and/or adverse impacts across segments of the population of home owners.

We add to the literature by investigating the preferences of Irish house owners toward different financing structures. We apply a multinomial logit to a pooled representative survey, examining stated preferences towards different incentive structures, relative to the status quo. This is used to identify socio-demographic groups which are more or less likely to prefer alterations to the structure of financial incentives offered by the state to promote residential energy efficiency retrofitting. We find that, relative to the status quo, the alternatives of a reduced property tax based on improved energy efficiency ratings or an upfront discount on the cost of works are less preferred by respondents possessing certain characteristics. The alternatives of a tax credit scheme to supplement loan financing and the ability to make repayments on the cost of works via an employer are less favoured by all respondents. The least preferred option is that of no financial incentive to retrofit, although the strength of this distaste varies by characteristics of respondents, most notable across age categories.

The results of this research provide certain policy implications. The findings suggest that the most preferred option of the choice set presented to respondents is the status quo, which comprises a cash rebate to home owners after the completion of works. This is followed closely by the alternative of an upfront discount, with only those who have engaged in retrofitting works in the past expressing a preference for the status quo over the upfront discount. The option of reduced property tax based on an improved energy efficiency rating would be less preferred by those living in less valuable properties. Similarly, while a tax credit or repayment via an employer system is found to be generally less preferred by the reference group, this distaste is even stronger among older age categories. As a result, the status quo remains the most preferred option of the choice set presented. As such, on the basis of the first preferences expressed by home owners, the findings of this analysis would point to a recommendation not to alter the structure of the financial incentive on offer. The authors acknowledge that other options exist outside of this choice set that may be more preferred but may not have been considered for this survey. As such, the status quo is not

necessarily the 'best' option but is the most preferred alternative within the choice set presented to respondents.

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