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Fuel poverty in Ireland: an analysis of trends and profiles

Arya Pillai[a,b]*, Miguel Tovar Reaños[a,b] & John Curtis[a,b]

a) Economic and Social Research Institute, Dublin, Ireland
b) Trinity College Dublin, Dublin, Ireland

*Corresponding Author:
Dr Arya Pillai
Economic and Social Research Institute,
Whitaker Square, Sir John Rogerson's Quay,
Dublin, Ireland
Email: arya.pillai@esri.ie

Fuel poverty in Ireland: an analysis of trends and profiles⋆

Arya Pillai[a,b,*], Miguel Tovar Reaños[a,b], John Curtis[a,b]

[a]*Economic and Social Research Institute, Dublin, Ireland*
[b]*Trinity College Dublin, Dublin, Ireland*

Abstract

Fuel poverty in Ireland is a significant issue faced by almost a quarter of the population as per government statistics. In this study, we investigate the trends in fuel poverty in Ireland between 2008 and 2020 using the Irish subset of EU SILC data. We find that the increase in the proportion of households receiving fuel allowance and the decrease in the proportion of poor-quality dwellings have a significant positive impact on the decline in aggregate fuel poverty experienced. We also analyse a sample of low-income households that experience fuel poverty and compare groups that are targeted by official policies with others on key indicators. We find that the existing supports normally target lower-income households who live in energy-inefficient dwellings and are of retirement age. We also find that non-targeted larger urban families who live in rented or mortgaged dwellings experience significant fuel poverty due to difficulty paying bills. We identify some gaps in the current policies that target fuel poverty. We propose that the existing policies in Ireland targeting fuel poverty should be expanded to effectively reduce fuel poverty in Ireland.

Keywords: Fuel poverty, energy-efficient retrofits, policy evaluation
JEL:

1. Introduction

Fuel poverty is an issue faced by a significant proportion of European citizens, with an estimated 8% of households unable to keep their homes warm (European Commission, 2022a,b)[1]. With the recent hikes in energy prices, the situation is likely aggravated. Kyprianou et al. (2019) identify 4 policy measures implemented by the EU Member States to tackle fuel poverty. They are consumer protection through special tariffs, financial interventions through social assistance payments, subsidised schemes for energy-saving and Renewable Energy Sources (RES) technology adoption, and awareness campaigns for improving energy efficiency behaviours. Kyprianou et al. (2019) argue that these policies could be targeting households in income poverty but not necessarily all the households who experience fuel poverty. This concern has received little attention in the existing literature. There is a related strand of literature that questions the efficacy of policy interventions that tackle fuel poverty. Charlier et al. (2019) find that allowances and social energy subsidies have no impact on fuel poverty in France. García Alvarez and Tol (2021) note that bill support subsidies in Spain targeting retirees, unemployed and larger families in Spain have no impact on a household's ability to keep the house warm. Bardazzi et al. (2021) note that subsidies for energy efficiency are often concentrated on homeowners and those who are affluent. Karpinska and Śmiech (2021) find that improvements in policies regarding employment, education and house renovation are suitable only for some clusters of households in fuel poverty whereas for others medical assistance, increase in pensions and free retrofits are more suitable. We add to this emerging literature by identifying low-income households in fuel poverty that could not be targeted by current measures implemented in Ireland to tackle fuel poverty. Our analysis comprises three dimensions:

1. We analyse the evolution of the likelihood of experiencing fuel poverty across the last 13 years for different household types. In addition, we analyse the role of financial support for fuel, called fuel allowances, in the general trend of the likelihood of experiencing fuel poverty.
2. We identify the household types experiencing fuel poverty that are potentially overlooked by current schemes implemented in Ireland to tackle fuel poverty.
3. Finally, we build on Karpinska and Śmiech's (2021) research to analyse how the current policies in Ireland are allocated across different clusters of the vulnerable population.

There is a dearth of literature on the efficacy of policy interventions specifically targeting fuel poverty, while a large number of studies focus on definitions of fuel poverty (García Alvarez and Tol, 2021). Charlier et al. (2019) find that those living in energy-efficient social housing experience a lower incidence of fuel poverty. Hence, they argue that the focus of government policies should be on improving energy efficiency rather than short-term measures such as subsidizing energy bills. Regarding policies to improve energy efficiency, Bardazzi et al. (2021) argue that policies should be designed specifically keeping in mind the regional and spatial inequalities. Pillai et al. (2021) find that the free energy efficiency upgrade scheme in Ireland improved the energy efficiency of some of the most energy-inefficient dwellings in Ireland. Simshauser (2021) studies Queensland's customer hardship policy and notes that targeted policies rarely

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[1]   The estimate is based on the response in an EU survey that they are unable to keep their home adequately warm.

achieve full coverage of vulnerable households. Social welfare schemes are often contingent on enrolment and hence participation rates can be lower. Bednar and Reames (2020) note that US initiatives targeting fuel poverty often fail because of the distributive policies aiming to reach a larger number of households without considering the specific vulnerabilities or outcomes achieved. They argue for the need for a federal definition of fuel poverty and emphasis on improving energy efficiency to improve health and environmental outcomes. Similarly, European Parliament (2016) argues for an EU-wide definition of fuel poverty (which should be refined at the local level) and finding the right combination of policies related to energy efficiency and social support at the local level.

DECC (2020)[2] estimates show that the proportion of people reporting fuel poverty has increased during the recession and after (since 2008). They also find that up to a quarter of Irish households are vulnerable to fuel poverty[3]. Hence, Ireland faces an increased risk of winter mortality, cardiovascular issues, and respiratory diseases due to fuel poverty (DECC, 2020). The main governmental policies to tackle fuel poverty in Ireland are the fuel allowance and free energy efficiency retrofits. Fuel allowance in Ireland currently is means-tested and targets low-income households (DSP, 2022, Citizens Information, 2022a). The fuel allowance scheme is aimed to assist those in social welfare payments with heating costs and it is a fixed amount cash transfer made between the months of September and April. In addition, there is a dwelling energy efficiency improvement programme (Better Energy Warmer Homes scheme, BEWHS) that offers free energy efficiency upgrade retrofits for low-income households (Sustainable Energy Authority of Ireland, 2022)[4]. In this study, we analyse fluctuations in fuel poverty over years for different household types and quantify the role of governmental support to mitigate fuel poverty. We employ the Irish subset of the EU Survey of Income and Living Conditions (SILC) dataset that includes subjective measures of fuel poverty for our analysis. Thomson and Snell (2013) and Watson and Maitre (2015) undertake research for the EU and Ireland respectively to analyse trends in fuel poverty over years in country-specific settings. Based on research conducted in an Irish context, Watson and Maitre (2015) and Tovar Reaños (2021) note that fuel poverty is strongly correlated with basic deprivation (inadequate resources to cover living costs). We add to that literature with analysis employing a more recent, comprehensive, and larger data set. Our analysis undertakes an investigation of trends at an aggregate level along with household-level analysis to understand the factors influencing fuel poverty at both levels. Based on this we can understand the characteristics of fuel poor households in Ireland and the impact, if any, of recent government interventions[5].

It is important to identify the profiles of fuel poor in Ireland to improve upon the targeting of existing governmental policies. Hence, in this study, we use the technique proposed by Anthony (2008) and Karpinska and Śmiech (2021) to identify clusters of households that are experiencing fuel poverty. Studying the segmentation of fuel poor based on similarity can help us to see

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[2]   Department of Environment, Climate and Communications was previously known as Department of Communications, Energy and Natural Resources (DCENR) at the time of publication of cited documents.

[3]   It should be noted that this estimate is based on the expenditure-based approach which is known as the 10% approach and is from a report published in 2015. A household is considered fuel poor if its energy income ratio is greater than 10% as per this method. For a detailed exposition of various definitions of fuel poverty, refer to Charlier and Legendre (2021).

[4]   This scheme is currently known as Free Energy Upgrades Scheme.

[5]   Due to limitations in data, we do not attempt to study the causal impact of policy interventions, but rather study the overall effect of such interventions on the trends.

who the current policies are targeting. In addition, we can frame policies that target various groups specifically and ensure that no vulnerable groups are left behind. Karpinska and Śmiech (2021) employed clustering techniques for studying the profile of fuel poor in Poland using SILC data. They find that the fuel poor in Poland are typically middle-aged single parents who are unemployed or elderly women living in urban flats. Karpinska and Śmiech (2021) is the only study that uses cluster analysis to identify clusters of fuel poor. However, their main objective is not to identify households that could be excluded from existing programs as in our study. We compare the clusters identified by the cluster analysis to the profile of households targeted by existing government policies. Based on this, we make recommendations for improving existing schemes targeting fuel poverty.

Our analysis shows that fuel poverty in Ireland is correlated with income poverty, however, it is a broader deprivation faced by households who have a higher expenditure on energy bills relative to their income. This paper contributes to the literature on context-specific studies on fuel poverty by identifying the characteristics of fuel poor in Ireland and the extent to which they are supported by existing policies. We identify two distinct clusters among fuel poor in Ireland. The poorer cluster is targeted by existing supports. However, our findings show that certain households have high fuel expenditures relative to their income and they can be vulnerable to fuel poverty as well. Such households may be excluded from support due to the conditionality of schemes around economic status, tenure, age of their dwelling, etc. As mentioned earlier, it is important to target specific clusters based on the distinct type of fuel poverty experienced by them to effectively reduce fuel poverty. These supports can include tax incentives for retrofits, energy-efficiency related obligations, improved targeting based on energy audits and fuel poverty definitions, low-cost loans for deep retrofits, etc. along with improved social welfare systems for those in extreme income poverty. The coming sections will detail the data and methods used in the analysis. This is followed by results and discussion sections. The last section includes concluding remarks and the limitations of the study.

2. Data and methods

2.1. Data

Indicators	Survey question/ Definition
dep_warm_hsehh	Was the household deprived of their ability to keep home adequately warm?
dep_cold_hh	Did the household go without heating during the last 12 months through a lack of money?
hs021	Were there any arrears on utility bills (in the past 12 months)?
Fuel poverty	Any of the above three indicators' answer was 'Yes'

Table 1: Definition of fuel poverty indicators employed in the study

We employ Irish Survey on Income and Living Conditions (SILC) data from the years 2008 to 2020 for our analysis (CSO, 2008-2020). SILC is a broad-ranging household survey, which includes key deprivation and poverty indicators that are often employed in fuel poverty literature (for example in Karpinska and Śmiech (2021) and Watson and Maitre (2015)). We combined the yearly datasets of the Research Micro Files (RMF) to create a pooled cross-sectional dataset that spans from 2008 to 2020. Our sample contains 54,809 observations across the 13 years (48,168 unique households). Table 2 and 3 provides summary statistics for the indicators used in this analysis. The summary tables display the mean and standard deviation estimated using

Table 2: Summary statistics for household characteristics used in the study. The sample size is 54,809 observations.

| Indicators	Mean (SD) Full sample	Mean (SD) Below median income
Disposable income (€)	45,746.04 (37,378.62)	21,266.27 (8,305.59)
Equivalised income (€)	23,97.31 (18366.79)	15,183.55 (6455.60)
Annual bills (€)	4,238.61 (3,920.11)	3,156.74 (1,918.62)
Bills as % of income	15.55 (121.53)	24.62 (183.70)
Equivalised bills(€)	2,424.60 (2,157.29)	2,357.95 (1,603.15)
Equalised allowance	7,898.78 (10,234.92)	9,366.40 (6,699.83)
Poverty at 60% median income (Yes)	0.14 (0.35)	0.31 (0.46)
Fuel allowance	0.18 (0.38)	0.35 (0.48)
BEWHS eligible	0.21 (0.40)	0.3 (0.46)
Other allowances	0.18 (0.39)	0.21 (0.41)
All unemployed (Yes)	0.24 (0.43)	0.44 (0.50)
Disability dummy (Yes)	0.11 (0.31)	0.13 (0.34)
Equ. household size	1.93 (0.77)	1.49 (0.57)
Female head	0.41 (0.49)	0.49 (0.5)
Dark home	0.06 (0.23)	0.07 (0.25)
Poor home condition	0.13 (0.34)	0.16 (0.37)
Fuel poverty dummy	0.17 (0.37)	0.25 (0.43)
Cold home	0.10 (0.30)	0.16 (0.37)
Home not warm	0.06 (0.24)	0.09 (0.29)
Arrears	0.10 (0.30)	0.15 (0.35)
Household type: All adults	0.36 (0.48)	0.29 (0.45)
Couple with children	0.25 (0.43)	0.12 (0.33)
Lone adult	0.23 (0.42)	0.45 (0.50)
Single parent	0.07 (0.25)	0.12 (0.32)
Other	0.10 (0.29)	0.03 (0.16)
Age of head: 18-34	0.14 (0.35)	0.12 (0.33)
35-44	0.20 (0.40)	0.14 (0.35)
45-64	0.42 (0.49)	0.37 (0.48)
65+	0.24 (0.43)	0.36 (0.48)
Education:None	0.01 (0.08)	0.01 (0.10)
Primary	0.19 (0.39)	0.31 (0.46)
Secondary	0.33 (0.47)	0.35 (0.48)
Diploma	0.07 (0.26)	0.06 (0.24)
Vocational	0.17 (0.38)	0.15 (0.36)
Tertiary	0.23 (0.42)	0.13 (0.33)
Job type: Manager/Professional	0.38 (0.49)	0.24 (0.42)
Skilled	0.49 (0.5)	0.58 (0.49)
Unskilled	0.13 (0.34)	0.19 (0.39)
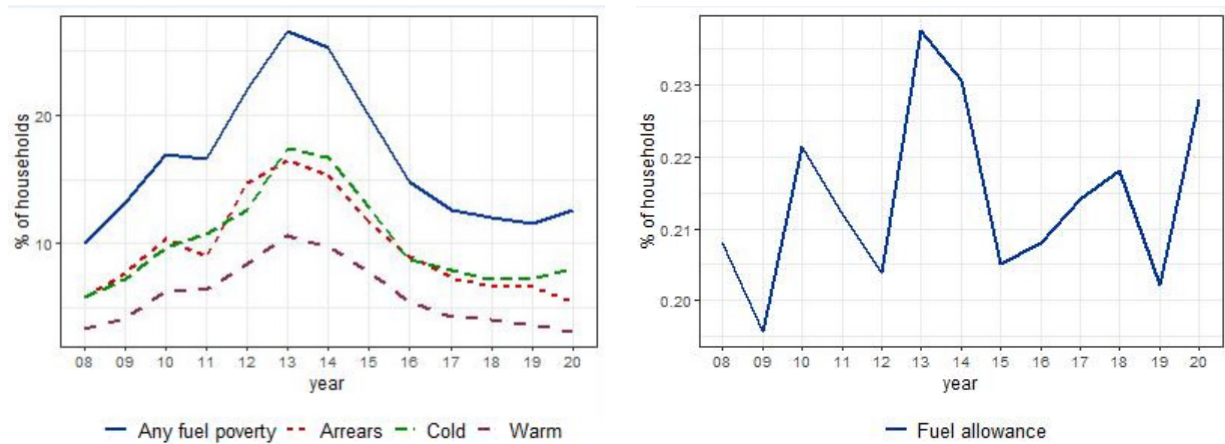
Figure 1: Percentage of fuel poor and households receiving welfare payment related to fuel poverty reported over years.

Table 3: Summary statistics for dwelling characteristics used in the study. The sample size is 54,809 observations.

Indicators	Mean (SD) Full sample	Mean (SD) Below median income
Dwelling age: Before 1940	0.002 (0.04)	0.003 (0.05)
1941-70	0.06 (0.24)	0.10 (0.29)
1971-1985	0.15 (0.36)	0.17 (0.37)
1986-2000	0.26 (0.44)	0.23 (0.42)
After 2000	0.52 (0.50)	0.51 (0.50)
Dwelling type: Detached house	0.39 (0.49)	0.37 (0.48)
Apartment	0.07 (0.26)	0.09 (0.28)
Semi detached house	0.54 (0.50)	0.54 (0.50)
Other	0.002 (0.05)	0.004 (0.06)
Home own: Owner	0.51 (0.5)	0.53 (0.50)
Mortgage	0.22 (0.41)	0.10 (0.31)
Tenant	0.12 (0.32)	0.12 (0.32)
Free	0.02 (0.13)	0.02 (0.14)
Reduced rate tenant	0.14 (0.35)	0.22 (0.42)
Rural dummy	0.35 (0.48)	0.40 (0.50)
Number of rooms	5.60 (1.62)	5.05 (1.47)
Central heating	0.64 (0.48)	0.68 (0.47)
NUTS3 Region: Border	0.09 (0.29)	0.11 (0.31)
Dublin	0.29 (0.45)	0.22 (0.42)
Mid-East	0.13 (0.34)	0.11 (0.32)
Mid-West	0.10 (0.30)	0.11 (0.31)
Midlands	0.06 (0.24)	0.07 (0.26)
South-East	0.10 (0.29)	0.11 (0.32)
South-West	0.15 (0.35)	0.15 (0.36)
West	0.10 (0.29)	0.11 (0.31)

the probability weights provided in the survey. We employ the subjective indicators available in SILC for measuring fuel poverty as the main variables of interest (similar application can be found in Watson and Maitre (2015), Karpinska and Śmiech (2021)). Two of these indicators are concerned with the comfort in the dwelling (mainly warmth) and one is concerned with arrears in utility bills, with exact definitions reported in Table 1. These indicators help us focus on two of the most commonly cited reasons for fuel poverty in literature, i.e. inability to pay bills and energy inefficient dwellings. The arrears indicator may capture some of the variation arising from fluctuations in fuel prices as well. We develop a composite indicator for fuel poverty based on these variables, where if the respondent answered 'yes' to any of those questions they are considered fuel poor.

The characteristics of the main decision-maker included in this study are age, gender, highest education level attained, and job type (refer to table 2 for the summary). The household-level characteristics included are household type, household size, employment status of all members, disability status of all members, tenure status, disposable income, equivalised income, poverty status, annual bills paid, bills proportional to income, equivalised bills, and equivalised allowances received. The equivalised income, bills, and allowances are calculated by dividing the original values by the equivalised household size. The bills indicator includes expenses related to electricity, gas, refuse, property tax, broadband, etc. The dwelling characteristics included in the study are the number of rooms, dwelling age (year of construction), dwelling type (whether the dwelling is detached or an apartment), NUTS3 region (administrative regions in Ireland) where the dwelling is located, and rural or urban status (refer to table 3 for the summary). We also include indicators for the presence of central heating and poor condition of the dwelling such as the presence of darkness, dampness, and leaks as a proxy for additional energy efficiency characteristics of the dwelling in our analysis. For this project, we were granted access to additional data for identifying fuel allowance recipients and other retrofit grant eligible allowance recipients from the Central Statistics Office database to further enrich our analysis (CSO, 2008-2020). Due to data protection regulations, we couldn't obtain data on which specific eligible allowance (other than fuel allowance) a household receives. Recipients of allowances, other than the fuel allowance, such as working family payment, one-parent family payment, job seekers allowance, carers allowance, disability benefit, and domiciliary care allowance can be eligible for the retrofit grant known as the Better Energy Warmer Homes Scheme (BEWHS) (Sustainable Energy Authority of Ireland, 2022). For this study, homeowners that receive either fuel allowances or other means-tested benefits are considered candidates for the BEWHS grants. The dummy variable named BEWHS eligible takes the value 1 if the household is eligible for the BEWHS grant.

Tovar Reaños (2021) notes that fuel poverty affects a larger proportion of households than just the income poor and hence the criteria to assess the vulnerability should be wider. European Parliament (2016) notes that there is a need for broader definitions of fuel poverty, however, this should be further refined at local levels. To take this into account, we calculate median disposable income for each year and take a sub-sample of below-median income households for our cluster analysis. This will help us to focus on households where meaningful fuel poverty exists and also exclude outliers with high income and disproportionately large energy bills. A majority of the fuel poor in our data belong to the below-median income sub-sample (around 65-70% on average over the years in the full sample). Panel 1 in figure 1 shows the trends in fuel poverty as reported in the survey over years as a proportion of the yearly sample size. Fuel poverty rise during the crisis years reaches a peak and decreases after 2013 in Ireland. The proportion of fuel poor in the full sample is 17% and the proportion is 25% in the lower-income sample. Panel 2 in figure 1 shows

the proportion of households receiving fuel allowance in Ireland. The proportion of households receiving fuel allowance over years is fluctuating between 19% and 28%. 35% of below-median disposable income households in the sample receive fuel allowance and 21% receive allowances other than fuel allowance, which are included in the eligibility criteria for energy efficiency grants in Ireland (refer to table 2)[6].

15.9% of below-median disposable income households live in dwellings with poorer conditions which include leaks, dampness, etc and 6.6% live in dwellings with darkness (refer to table 2). In our data below-median income households are typically older, female-headed, lower-educated households employed in skilled or unskilled professions (refer to tables 2 and 3). A larger proportion of them are individuals who live alone or are single parents compared to the full sample. There is a significant proportion of fully unemployed households in that sample. The majority of the below-median income households live in subsidised renting or own dwellings. They are more rural and the majority live in counties other than Dublin. They pay a higher proportion of bills to income and live in smaller dwellings compared to the overall sample.

2.2. Methodology

The main objective is to study the profile of fuel poor in Ireland by employing cluster analysis and comparing their characteristics to the households targeted by existing policies. This will help us understand whether any vulnerable groups are excluded from current supports and how well the existing supports are targeted. We also undertake an analysis to understand the factors influencing fuel poverty in Ireland. We analyse at aggregate and household levels to understand the trends in fuel poverty over years.

2.2.1. Factors influencing fuel poverty in Ireland

To understand the factors influencing fuel poverty in Ireland at the household level, we employ a logistic regression model. In this method, we model fuel poverty at the household level to study the characteristics of fuel-poor households in Ireland.

$$Pr(Fuel\ poverty = 1|Z_i) = f(\beta_0 + \beta_1 Z_i + u_i) \tag{1}$$

We employ various household characteristics such as age, gender, education, job type of the main decision-maker, household disposable income, proportion of bills compared to income, household size, the dummy for disability, household type, and homeownership. We include the dummies for fuel allowance recipients and retrofit grant (BEWHS) eligibility as well in the model. The dwelling characteristics included in the regression include rural or urban status, whether central heating is installed, year of construction of the dwelling, dummy for dark home, the dummy for poor dwelling condition, and dwelling type. We also include region and year dummies in the regression. The results of this analysis are given in table 4 and figure 2.

It is important to understand the impact of government interventions such as fuel allowance on fuel poverty in order to improve policies targeting fuel poverty. There are studies that find bill subsidies do not reduce fuel poverty (Charlier et al., 2019, García Alvarez and Tol, 2021). However, since such studies do not consider endogeneity between the outcome and the treatment variables, the results cannot be conclusive. The solution to this problem is not trivial because

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[6]   Some households who are fuel allowance recipients might also receive other allowances included in the eligibility criteria for retrofit grants.

it requires having a convincing instrument that is not available in most living condition surveys. We cannot undertake such an analysis at the household level in this study due to data limitations in our dataset as well (refer to Lance et al. (2014), White and Raitzer (2017) for detailed notes on dealing with endogeneity in impact evaluation studies). However, we are interested in analysing the decline in trends in fuel poverty to understand factors influencing the decline in trend in recent years. We undertake the analysis at an aggregate level to understand the relationship between the proportion of households receiving support and trends in fuel poverty in Ireland between 2008 and 2020. While we cannot make causal claims on the impact of interventions based on this, the analysis is nevertheless helpful in understanding the overall trends. We employ linear regression on indicators aggregated at the region-year level to study the trends. The aggregation is undertaken on data collapsed at the region, rural or urban status, income quartiles, and year of survey indicators. We model fuel poverty as

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \epsilon \tag{2}$$

The Y_{it} in this case is the mean (rate) of chosen fuel poverty indicator across observations for the year-region concerned. The X_{it} employed included in this study are the proportion of fuel allowance recipients, the proportion of BEWHS grant eligible[7], the average of log disposable income, the average of equivalised bills, the proportion of dwellings with poor conditions, proportion with central heating, rural dummy, region dummy, and year dummy. The results of this analysis are given in table 5.

2.2.2. Fuel poverty and socio-economic characteristics of fuel poor vs targeted groups

We study the factors influencing fuel poverty in Ireland based on the methodology followed in section 2.2.1. We expect that the fuel poor in our dataset can be clustered into groups based on their diverse characteristics. Such application of clustering can be found in the literature on poverty and fuel poverty research as well (see Anthony (2008), Karpinska and Śmiech (2021)). Understanding the profiles of fuel poor will help policymakers to tailor policies more effectively. It will also help us understand which groups are vulnerable to fuel poverty but remain excluded from the support, if any. Various clustering techniques are applicable in this case to partition the data based on observed characteristics (Waggoner, 2021). We construct the profile of fuel poor in Ireland based on various household and dwelling characteristics employing k-means clustering. k-means clustering classifies objects into groups, where objects within each cluster are similar (Kassambara and Mundt, 2017, Kaufman and Rousseeuw, 2009). In centroid-based clustering methods, such as k-means clustering, each object is assigned to a cluster based on its distance to the centroid. The centroid of each cluster is a central location, which represents the center of the cluster. Following Karpinska and Śmiech (2021), we replicate the analysis using the Partitioning Around Medoids (PAM) method as well. The results obtained from the k-means and PAM methods are similar. k-means clustering is more commonly employed in similar literature (see Anthony (2008)). We employ the Factoextra library in R for clustering (Kassambara and Mundt, 2017, Karpinska and Śmiech, 2021, Lê et al., 2008). The distance metric used to calculate the dissimilarities between the observations is the Euclidean distance in our case (see Kaufman

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[7]   While we have data on the actual fuel allowance recipients, we do not have such data on BEWHS recipients. Hence, we identify the households who are eligible for the scheme and calculate their proportions in the sample to study how it relates to trends in fuel poverty.

and Rousseeuw (2009) for details). To obtain the optimal number of clusters, we calculate the average silhouette width at the different number of clusters employing the k-means method (Charrad et al., 2014). The cluster silhouette is a measure of the similarity of the observations within a cluster and has values ranging from -1 to 1. A higher silhouette width indicates that the objects are well matched within the cluster. We include only the below-median income households in this analysis as explained in the data section. We include characteristics of the decision-maker, household, and dwelling in the analysis to identify the clusters. The summary of key characteristics of the clusters identified is reported. This is shown in tables 7 and 8.

There are concerns that fuel price fluctuations along with policy measures such as carbon taxing can have distributional impacts on vulnerable subsections of the population and can push them towards fuel poverty or income poverty (Tovar Reaños, 2021). To prevent such adverse impacts the Government of Ireland has introduced financial support for vulnerable subsections in Ireland (DPER, 2022). The two main supports available for lower-income households in Ireland are the fuel allowance (Citizens Information, 2022a, DSP, 2022) and the energy efficiency upgrade retrofit grant known as the BEWHS (Sustainable Energy Authority of Ireland, 2022). The fuel allowance is generally provided to vulnerable groups such as households with older individuals (state pension recipients), disabled residents, single parents, low-income farmers, unemployed residents, etc provided they pass a means test (and already receive one of the eligible social welfare payment related to their specific vulnerability). It is also provided to low-income families with children and individuals who provide care to family members who are unwell. The BEWHS grant is provided for homeowner households who already receive fuel allowance or those who receive one of the allowances which makes them eligible for the fuel allowance. There are also increases in social welfare allowance amounts announced by the Government of Ireland (GOI) for families with children, older individuals who are living alone, and existing fuel allowance recipients as support for carbon taxes (DPER, 2022)[8]. We define targeted groups as those who receive fuel allowance or those who are eligible for BEWHS[9]. We compare the characteristics of the clusters identified with the targeted households in our sample to identify gaps in policies. For that purpose, we compare key characteristics of targeted households with non-targeted households to understand the extent of fuel poverty and related issues faced by such households. We test the difference in means between the targeted group and others on key characteristics. We also study the coefficient of variation for both groups when it comes to key characteristics. The Coefficient of Variation (CV) is used in the literature as a measure of the heterogeneity within the group. It is a relative measure and hence can be used for comparison when it comes to dispersion of data points around the mean in different groups. A larger estimate indicates that the heterogeneity within that group is higher.

$$CV = \sigma_i/\mu_i \tag{3}$$

where μ_i is the sample mean and σ_i is the sample standard deviation (see a similar application in Tovar Reaños and Lynch (2022) and Cronin et al. (2019)). The results of this analysis are given in table 6.

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[8] The carbon tax supports are provided as increases in existing allowance/ benefit amounts for the listed groups.
[9] Other than the those who receive child benefits (which is universal), the groups which meet the eligibility criteria for carbon tax supports is the same as fuel allowance and BEWHS.

3. Results

3.1. Factors affecting fuel poverty in Ireland

Table 4: Logistic regression results for determinants of fuel poverty (full sample)

	(1) FP(OR)	(2) FP(OR)
Fuel allowance (Yes)	1.57***	
	(0.08)	
BEWHS eligible dummy (Yes)		2.38***
		(0.12)
Bills proportional	1.00**	1.00**
	(0.00)	(0.00)
Age Cat (ref cat: 18-34)		
35-44	0.98	1.01
	(0.06)	(0.06)
45-64	0.94	0.98
	(0.06)	(0.06)
65+	0.38***	0.42***
	(0.03)	(0.04)
Household size	1.07	0.99
	(0.06)	(0.05)
Gender:Female	1.25***	1.22***
	(0.05)	(0.05)
All unemployed (Yes)	1.79***	1.75***
	(0.08)	(0.08)
Education (ref cat: Tertiary)		
None	2.64***	2.44***
	(0.43)	(0.39)
Primary	1.72***	1.62***
	(0.13)	(0.12)
Secondary	1.47***	1.42***
	(0.09)	(0.09)
Diploma	1.32***	1.32***
	(0.10)	(0.10)
vocational	1.56***	1.52***
	(0.10)	(0.10)
Disability (Yes)	1.23***	1.30***
	(0.07)	(0.07)
Household type (ref cat: Couple with children)		
All adults	0.76***	0.73***
	(0.05)	(0.04)
Lone adult	1.09	1.06
	(0.10)	(0.10)
Single parent	1.90***	1.85***
	(0.15)	(0.15)
other	1.17*	1.13
	(0.10)	(0.09)
Job type (ref: Manager/professional)		
Skilled	1.43***	1.36***
	(0.07)	(0.06)
Unskilled	1.53***	1.43***
	(0.09)	(0.09)
Home ownership (ref: tenant)		
Mortgage	0.75***	0.53***
	(0.05)	(0.04)
Owner	0.52***	0.36***
	(0.04)	(0.03)
Reduced rate tenant	1.08	1.21***
	(0.07)	(0.07)
Free	0.90	0.89
	(0.11)	(0.11)
Rural dummy (Yes)	0.99	0.98
	(0.04)	(0.04)
Rooms	0.95***	0.97**
	(0.01)	(0.01)
Central heating (Yes)	0.93*	0.92**
	(0.04)	(0.04)
Construction cat (ref: After 2000)		
Before 1940	0.30***	0.29***
	(0.13)	(0.13)
1941-70	0.70***	0.66***
	(0.07)	(0.06)
1971-1985	0.82***	0.81***
	(0.06)	(0.06)
1986-2000	0.95	0.94
	(0.05)	(0.05)
Dark home (yes)	1.71***	1.69***
	(0.11)	(0.11)
Home poor condition (Yes)	2.88***	2.82***
	(0.13)	(0.12)
Dwelling type (ref: Apartment)		
Detached house	1.18*	1.21**
	(0.11)	(0.11)
Semi detached house	1.24***	1.26***
	(0.09)	(0.10)
Other	0.80	0.78
	(0.27)	(0.27)
Observations	54,809	54,809
Year dummy	Yes	Yes
Region dummy	Yes	Yes
AIC	1.500e+07	1.480e+07
BIC	1.500e+07	1.480e+07
ll	-7.496e+06	-7.424e+06

Robust seeform in parentheses
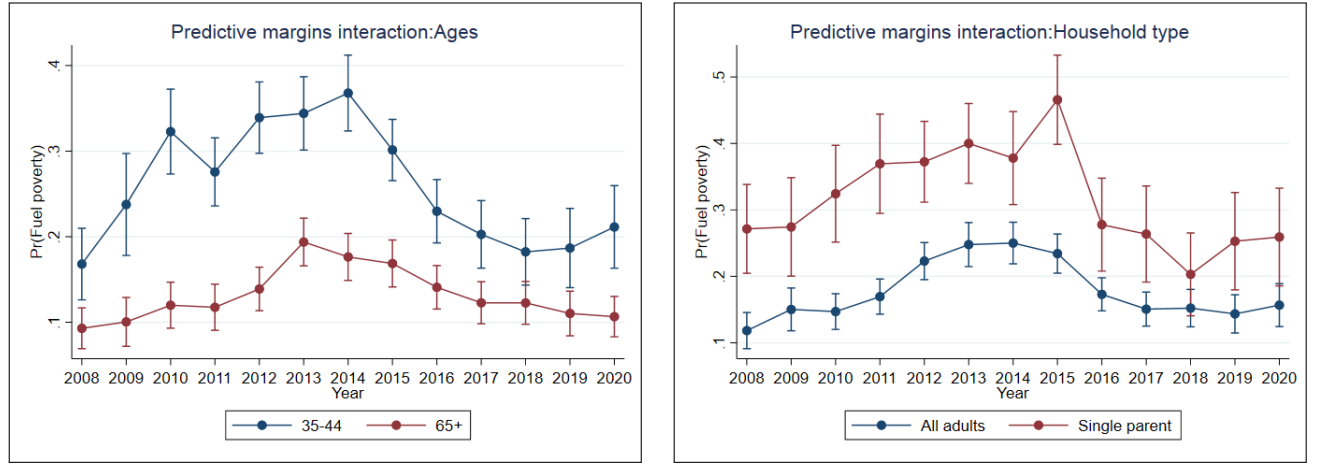*** p<0.01, ** p<0.05, * p<0.1

Figure 2: Predictive margins of selected indicators and their probability of being fuel poor in the below-median income sample

Table 5: Results for regression involving aggregated variables (full sample results reported)

	(1)	(2)
	Fuel Poverty	Fuel poverty
Fuel allowance (mean)	-0.06**	
	(0.03)	
BEWHS eligible (mean)		-0.08***
		(0.03)
Disposable income (log)	-0.14***	-0.15***
	(0.01)	(0.01)
Bills equivalised	-0.00	-0.00
	(0.00)	(0.00)
Rural (Yes)	-0.05***	-0.04***
	(0.01)	(0.01)
Home condition poor (mean)	0.20***	0.18***
	(0.04)	(0.04)
Central heating	-0.00	-0.00
	(0.03)	(0.03)
Constant	1.56***	1.57***
	(0.10)	(0.10)
Observations	824	824
R-squared	0.63	0.64
Year dummies	Yes	Yes
Region dummies	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results of the logistic regression for understanding general factors that drive fuel poverty in the full sample are shown in table 4. The results suggest that households where the main decision-maker is female, with lower educational attainment, or all members are unemployed have a higher probability of being fuel poor. When it comes to the type of occupation, both skilled and unskilled workers have a higher probability of being fuel poor compared to professionals or managers. Tenants and reduced rate tenants have a higher probability of fuel poverty compared to homeowner households. Households living in dwellings with poor conditions such as leaks, mould, or darkness have a higher probability of being fuel poor. When it comes to dwelling type, semi-detached and detached dwellings have a higher probability of being fuel poor compared to apartments. Fuel allowance recipients and BEWHS grant eligible households have a higher probability of being fuel poor (refer to table 4). The eligibility criteria for the supports related to fuel poverty normally comprise households that are in income and fuel poverty, and thus the model is just capturing this fact. We do not claim any causal impact of targeted supports on fuel poverty based on this analysis. We observe that households living in newer dwellings have a higher probability of being fuel poor. However, it should be noted that there can be significant measurement error in the construction year variable since the SILC defines this variable as 'year of contract or purchase or installation'. This means that the dwelling categorized as new might be older dwellings purchased after the 2000s.

Figure 2 shows predictive margins concerning the probability of being fuel poor for selected indicators for the below-median income sample. Younger households have a higher probability of being fuel poor (panel 1 of figure 2). In recent years the probability of being fuel poor for younger households is increasing after showing a declining trend till 2018. When it comes to household composition, single parents have the highest probability of being fuel poor and all adult households (without a child in the household) have the lowest probability of being fuel poor (refer to panel 2 of figure 2). While single parents show a higher probability of experiencing fuel poverty, the overall trend in recent years shows a decline in marginal probabilities (however 2019 and 2020 show a slight increase).

We further investigate the role of fuel allowances in the general trend of fuel poverty. We collapsed the data by year of survey, NUTS 3 areas, rural status, and income quartiles. The results of this regression are shown in table 5. Model 1 shows the impact of the proportion of fuel allowance recipients on fuel poverty trends and model 2 shows the impact of the proportion of BEWHS eligible. An increase in the proportion of fuel allowance recipients and BEWHS eligible households over years is associated with the decrease in reported fuel poverty. This association is statistically significant. Further, we find that an increase in disposable income is significantly associated with the decline in fuel poverty. As per this analysis, the average difference in the proportion of fuel poor between urban and rural areas is 0.05 and 0.04 in models 1 and 2 respectively, and these coefficients are statistically significant. Border counties experience higher rates of fuel poverty compared to others. Fuel poverty experienced is positively correlated with the proportion of households with poor home conditions. Hence, when the proportion of households with poor home conditions decreases the fuel poverty reported also decreases and vice versa.

3.2. Comparing targeted groups with others on key indicators related to fuel poverty

Certain vulnerable groups are targeted by the Irish government for support related to fuel poverty, which includes the fuel allowance and BEWHS grants. These groups are low-income households with older members, disabled members, single parents, those who are unemployed

or are low-income farmers, etc. (Citizens Information, 2022a,b). It is also provided to low-income families with children and also those who care for family members who are unwell. If they are also homeowners they can apply for the free energy retrofits. We analyse the difference in means between the targeted group, defined as the households who receive fuel allowance or are eligible for free retrofits, and others when it comes to key indicators related to fuel poverty. Table 6 displays the means and Coefficient of Variation (CV), which is used as a measure of the heterogeneity experienced within the group, for the targeted group and others. The difference in means for selected indicators is shown in table 6.

The targeted group has a smaller mean of equivalent income and smaller CV than the non-targeted group. The non-targeted group has a larger equivalent income, however, the CV is also larger for this group which indicates that there is a larger within inequality regarding the distribution of income for that group (refer to table 6). The targeted group has lower levels of average bills paid annually, however, this is very close to the average of the non-targeted group. This implies that despite the statistically significant difference, similar to the non-targeted group they spend high amounts on bills. The bills indicator includes any expense other than the mortgage paid by the household as per the SILC definition, which includes electricity, gas, refuse, property tax, broadband, etc. The proportion of bills to income is higher for the non-targeted group and they have a higher CV for this indicator, which shows that the burden of high bills is present for the non-targeted group as well. It should also be noted that the proportion of bills to income for both groups in the below-median income sample is over 20% (making a significant proportion of households in both categories fuel poor by the 10% definition of fuel poverty). This proportion could be even higher considering the increase in energy prices due to the pandemic and the conflict in Ukraine.

The targeted group is more likely to have poor dwelling conditions (e.g. darkness and leakage in the dwelling) and experience fuel poverty based on subjective indicators. However, the non-target group has a larger CV for poor dwelling conditions and fuel poverty indicating a high degree of inequality in that group when it comes to those two characteristics. It should be noted that the non-targeted group also experience a high proportion of fuel poverty, even though it is lower than the targeted group (20% as per table 6). Regarding the year of construction, we find that the targeted group is more likely to live in old dwellings. The targeted group is also more likely to be eligible for retrofits that are fully covered by the government based on the eligibility criteria. However, based on table 6 some households in the non-targeted groups could be living in older dwellings with low-income levels while not being eligible for free retrofits (28% of them live in dwellings constructed before 1985). Detached and semi-detached houses are more exposed to the extremes in outside temperatures and the targeted groups are more likely to live in such dwellings.

While a larger proportion of the targeted group is income-poor households, they typically own their dwellings (around 73%). However, some of these vulnerable households may not be able to participate in the free retrofit schemes due to not owning their dwellings (around 5%). In the same line, the non-targeted group who own their dwellings (around 65%) and have low-income levels may not be able to afford the partially subsidized retrofit schemes (their relatively higher household incomes might result in them failing the means test and make them ineligible for free retrofits). To summarise, the targeted households are typically poorer with lower equivalized incomes. They have lower bills and proportion of bills compared to non-targeted households (partially owing to smaller dwelling sizes). They experience higher rates of fuel poverty and

Table 6: Difference in means and Coefficient of variation for selected characteristics of the targeted groups (sample of below-median income households)

	Mean (not targeted)	Mean (targeted)	CV (not targeted)	CV(targeted)	t value (significance)
Equivalised income (€)	16,352.82	13,937.31	0.45	0.31	33.28 (***)
Poverty at 60% median income	0.25	0.29	1.74	1.58	-5.15 (***)
Equivalised bills	2,492.87	2,358.83	0.71	0.52	7.27 (***)
Bills proportional to income	30.10	21.27	8.92	2.33	3.88 (***)
Home condition poor	0.14	0.18	2.47	2.15	-8.24 (***)
Fuel poverty	0.20	0.25	2.01	1.72	-10.22 (***)
All unemployed	0.39	0.60	1.27	0.82	-35.43 (***)
Household size	1.44	1.40	0.38	0.37	5.29 (***)
Rural	0.40	0.46	1.23	1.08	-10.79 (***)
Rooms	5.20	5.00	0.30	0.28	11.26 (***)
Years 1941-70	0.10	0.16	2.97	2.24	-13.13 (***)
Years 1971-1985	0.18	0.20	2.12	2.02	-2.81 (***)
Years 1986-2000	0.23	0.24	1.84	1.77	-2.80 (***)
After 2000	0.48	0.40	1.03	1.23	14.19 (***)
Owner	0.56	0.65	0.88	0.74	-13.94 (***)
Mortgage	0.09	0.08	3.14	3.36	3.19 (***)
Tenant	0.14	0.05	2.46	4.48	27.13 (***)
Reduced rate tenant	0.18	0.21	2.15	1.94	-6.76 (***)
Free	0.03	0.02	6.20	8.19	6.30 (***)
Apartment	0.10	0.04	3.07	4.64	-16.76 (***)
Detached house	0.39	0.41	1.24	1.21	-2.19 (**)
Semi detached house	0.51	0.55	0.99	0.91	-6.14 (***)
Age 18-34	0.12	0.05	2.72	4.27	-19.98 (***)
Age 35-44	0.14	0.09	2.49	3.12	11.68 (***)
Age 45-64	0.364	0.292	1.323	1.556	12.434 (***)
Age 65+	0.38	0.56	1.28	0.88	-30.49 (***)

live in poor quality older dwellings. They are typically unemployed, older, and live in smaller households. They typically live in detached or semi-detached which they own in rural areas.

3.3. Profile of fuel poor in Ireland

In this section, we provide the results from the cluster analysis undertaken by k-means clustering. This method involves the segmentation of households below-median income who experience fuel poverty based on within-cluster homogeneity (Anthony, 2008)[10]. The optimal number of clusters estimated by calculating the average silhouette width (quality of the match within a cluster) for different cluster numbers is shown in panel 1 of figure 3. The number of clusters with the highest average silhouette width should be considered optimal and in this case, it is 2. The silhouette plot for each of the chosen clusters is shown in panel 2 of figure 3. This shows that cluster 2 is larger and both clusters are well matched. We can see that the model with two clusters has the maximum average silhouette width (panel 1 in 3) and hence this is optimal in our case (Charrad et al., 2014). We use only the households that are fuel poor and below-median income for this analysis. Out of the two clusters identified, cluster 1 has 2,732 observations, and cluster 2 has 3,218 observations. Table 8 provides the estimated mean and Coefficient of Variation (CV) for some of the analysed variables for the two identified clusters. Table 7 provides a summary of cluster characteristics based on their relative proportions in the data.
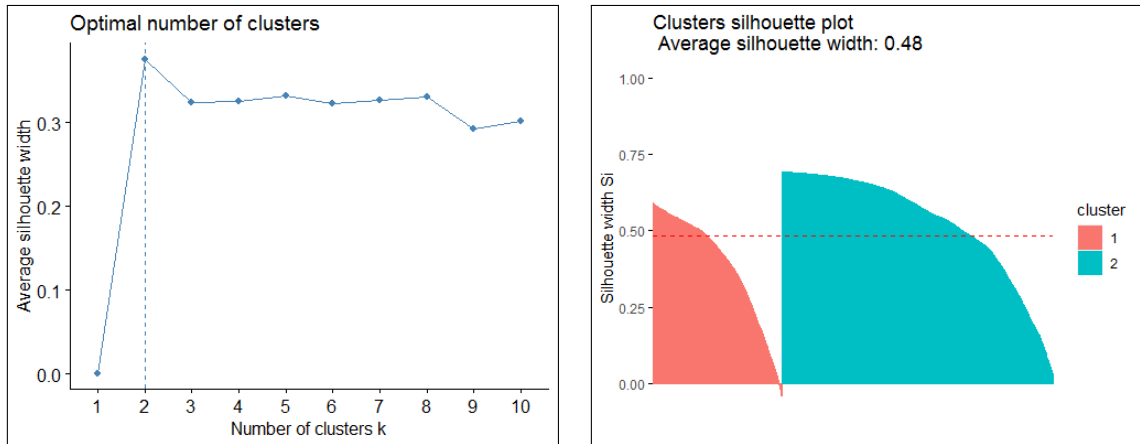

Figure 3: Optimal number of clusters and cluster silhouette for the profiles of fuel poor. Only below-median income households are considered.

Table 8 shows that cluster two is more likely to have a cold home and less likely to have arrears. This group is also more likely to be in income poverty. The quality of dwelling in cluster 2 is worse compared to cluster 1, however, the difference between them is not as high as the difference between targeted and non-targeted groups. Cluster 2 is more likely to live in older, owned dwellings compared to cluster 1. A significant proportion of them also lives in social housing. Cluster 1 is more likely to have dependent children and have a young head of household with some degree of skills for work and higher education. Cluster 2 typically receives fuel allowance and cluster 1 typically receives other allowances that are included in the eligibility criteria for retrofit grants. Based on location we can classify cluster 1 as lower-income households

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[10] The results obtained were replicated in the analysis conducted using the full sample as well.

in urban areas and cluster 2 as the rural poor. Cluster 2 households are also more likely to be fully unemployed households. Table 7 provides the summary of the characteristics of each cluster based on the analysis.

Cluster 2 resembles one of the clusters identified by Karpinska and Śmiech (2021) in a study in Poland (refer to table 7). Cluster 2 is targeted by fuel allowance as per our analysis, however, this group lives in energy inefficient housing based on the subjective indicators for home condition and colder dwelling conditions. Cluster 1 faces the issue of arrears even though their reported dwelling conditions are better than cluster 1. Since they are not strictly income poor, they may not be eligible for fuel subsidies based on the current eligibility criteria. To summarise, cluster 2 households are poorer, with lower education and skills, and live in energy inefficient dwellings. They are eligible for grants and subsidies. The cluster 1 households are relatively higher-income households with larger family sizes and dwellings. They may not be eligible for fuel subsidies or free retrofit grants due to the conditionality in government policies when it comes to income and tenure status.

Characteristics based on relative proportions	Cluster 1	Cluster 2
Home condition	Better	Colder/ Poor
Fuel poverty type	Arrears	Cold dwelling
Equivalised bills	Lower	Higher
Bills proportional to income	Lower	Higher
Poverty	Lower	Higher
Equivalised income	Higher	Lower
Unemployment	Lower	Higher
Allowances	Other grant eligible	Fuel allowance
Age	Younger	Older
Education	Higher	Lower
Job type	Skilled	Unskilled
Household type	All adults/ Couple with children /Single parents	Live alone
Dwelling size	Bigger	Smaller
Homeownership	Tenants/ Mortgaged	Fully owned/ social housing
Location	Dublin/ urban	Rural/ Border
Dwelling age	After 2000	Before 2000

Table 7: Typical characteristics of the two identified clusters based on the proportion of fuel poor households in each category

Table 8: Averages and coefficient of variation of clusters in the below-median income sample

varname	Mean (Cluster1)	Mean (Cluster 2)	CV (Cluster 1)	CV (Cluster 2)	t value (significance)
Home condition poor	0.28	0.31	1.61	1.49	-2.61 (***)
Dark home	0.11	0.13	2.81	2.55	-2.38 (**)
Cold home	0.62	0.70	0.78	0.66	-6.1 (***)
Home not warm	0.36	0.43	1.32	1.15	-5.26 (***)
Arrears	0.61	0.54	0.80	0.92	5.37 (***)
Bills prop to income	0.12	0.42	0.68	7.68	-5.25 (***)
Equivalised income (€)	16,022.32	11,071.34	0.33	0.32	41.59 (***)
Equivalised bills (€)	2,046.72	2,392.47	0.78	0.54	-9.13 (***)
Poverty at 60% median	0.20	0.56	1.97	0.89	-30.41 (***)
Fuel allowance	0.34	0.49	1.40	1.03	-11.71 (***)
Other allowances	0.35	0.22	1.35	1.86	11.01 (***)
BEWHS eligible	0.26	0.31	1.68	1.50	-4.03 (***)
All unemployed	0.37	0.59	1.30	0.84	-17.05 (***)
Rural	0.32	0.36	1.45	1.33	-3.09 (***)
Rooms	5.06	4.67	0.26	0.32	10.73 (***)
Years 1941-70	0.05	0.06	4.53	3.96	-2.32 (**)
Years 1971-1985	0.09	0.11	3.14	2.88	-2 (**)
Years 1986-2000	0.18	0.21	2.12	1.93	-2.94 (***)
After 2000	0.68	0.62	0.69	0.79	4.86 (***)
Mortgage	0.16	0.09	2.30	3.12	7.57 (***)
Owner	0.31	0.38	1.49	1.27	-5.78 (***)
Tenant	0.21	0.14	1.91	2.52	7.94 (***)
Reduced rate tenant	0.29	0.37	1.57	1.32	-6.28 (***)
Free	0.03	0.02	6.21	6.66	0.81 (NS)
Couple with children	0.23	0.06	1.84	4.05	18.85 (***)
Lone adult	0.18	0.66	2.10	0.72	-42.63 (***)
Single parent	0.26	0.16	1.71	2.28	8.82 (***)
Age 18-34	0.21	0.13	1.96	2.63	8.2 (***)
Age 35-44	0.25	0.16	1.71	2.27	8.69 (***)
Age 45-64	0.36	0.45	1.34	1.11	-7.13 (***)
Age 65+	0.18	0.26	2.13	1.68	-7.56 (***)
Skilled	0.62	0.56	0.79	0.89	4.28 (***)
Unskilled	0.19	0.24	2.04	1.76	-4.79 (***)
None	0.01	0.02	9.83	7.45	-2.47 (**)
Primary	0.23	0.33	1.83	1.43	-8.4 (***)
Secondary	0.35	0.34	1.35	1.39	1.06 (NS)
Diploma	0.07	0.06	3.58	4	2.13 (**)
Vocational	0.20	0.17	1.99	2.25	3.57 (***)
Tertiary	0.13	0.09	2.57	3.18	5.07 (***)

4. Discussion

Vulnerable groups	Gaps in support
Lower-income couple with children	While carbon tax support is universal, they are eligible for fuel allowance and free retrofits only if they meet any other eligibility criteria and means test.
Single parents	Universal carbon tax support, however eligibility for fuel allowance or free retrofits is subject to passing the means test.
Lone adults	Unless means test and other eligibility criteria (state pension recipients, widow/ widowers, etc.) are met, not eligible for free retrofits or fuel allowance. No carbon tax support for the below 66 age group, if they don't already receive fuel allowance.
Older pensioners	Universal carbon tax support for individuals who live alone. The failed means test will result in not being eligible for fuel allowance or free retrofits.
Low-income tenants	Carbon tax supports and fuel allowance based on meeting other eligibility criteria. Cannot directly apply for retrofit grants (partial grants application can be made by the landlord).
Low-income homeowners	Only dwellings built before 2006 can avail of free retrofits if other eligibility criteria are met. Partial subsidy for those who do not pass the means test or meet other criteria and for dwellings built before 2011.
Unskilled workers	Fuel allowance or free retrofit grant based on the means test and other eligibility criteria being met.

Table 9: **Gaps in social policies targeting households in Ireland vulnerable to fuel poverty as per literature and findings in this study. For details on eligibility for fuel allowances and free retrofit grants, refer to DPER (2022), DSP (2022), and Sustainable Energy Authority of Ireland (2022).**

Our study replicates some of the findings in previous literature such as the probability of fuel poverty being higher in vulnerable groups such as single parents (Tovar Reaños, 2021, Karpinska and Śmiech, 2021), lower-income households (Watson and Maitre, 2015, Tovar Reaños, 2021), rented dwellings (Tovar Reaños, 2021, Aristondo and Onaindia, 2018), etc. Fuel poverty is correlated with other forms of deprivation such as income poverty, unemployment, and regional disparities. We find that those who live in detached dwellings and dwellings with poor conditions such as leakage, mould, etc have a higher probability of being fuel poor. Hence, energy efficiency improvement of dwellings should be prioritized as a policy for combating fuel poverty in Ireland. The government of Ireland has announced a National Retrofit Plan (NRP) with increased funding for retrofit subsidies recently (SEAI, 2022). As per the NRP, there will be a renewed focus on retrofitting dwellings of fuel poor households occupied before 1993 (and with very poor energy

rating) and the overall goal is to lift the Building Energy Rating (BER) to B2[11][12]. The CSO (2022) notes that while most buildings built after 2015 have the most efficient ratings, buildings constructed between 2000 and 2010 have comparatively poor energy ratings (majority below the B2 rating planned as per the Long term Renovation strategy of DECC (2021)). The majority of the fuel poor in our data live in dwellings 'purchased/installed' after 2000. Hence the fact that free energy efficiency retrofits are limited to dwellings built or occupied before 2006 (Sustainable Energy Authority of Ireland, 2022) might leave some of the energy inefficient dwellings owned by fuel poor to be not covered by the scheme (refer to table 9). Simultaneously, only half of the Irish housing stock has completed an energy audit. Hence, it will be better to accelerate the energy rating of dwellings and create eligibility criteria around this, rather than just the age of the dwelling to bring all dwellings to better energy efficiency[13]. Our aggregate regression also shows that the reduction in the proportion of households with poor dwelling conditions is correlated with the decline in the proportion of subjective fuel poverty reported by households (refer to table 5). Energy-efficiency related policies are more effective in the long term compared to social policies targeting high fuel prices (Charlier et al., 2019, European Parliament, 2016), hence they argue that the member states must realign their spending related to energy efficiency accordingly (BPIE, 2014).

We find younger individuals, especially those with children and those who live alone have a high probability of experiencing fuel poverty (based on findings in table 4). While carbon tax supports[14] (DPER, 2022) are a welcome development for this subgroup, increased support especially by improving energy efficiency in rental housing stock might be more critical for these households, who do not necessarily own their dwellings (refer to table 9). Measures such as introducing tax incentives for energy efficiency retrofits and energy efficiency obligations can improve energy efficiency in the rental sector specifically (European Parliament, 2016)[15]. For instance, European Parliament (2016) notes that countries like UK and France have already introduced limits on rents and outright bans on renting buildings with very poor energy efficiency standards.

While fuel allowance can only be a palliative measure to combat fuel poverty as noted by Bardazzi et al. (2021), our study shows that it can be an important component to combat fuel poverty at least in the short term considering the proportion of households reporting arrears on bills. European Parliament (2016) notes that the specifics of social policies suitable for each member state should be assessed independently taking into account factors such as nature of tenure in the country, differences in national social security systems, etc. This is especially important in the early stages when the energy efficiency initiatives have not sufficiently penetrated the existing building stock occupied by fuel poor. Our analysis of trends indicates that the lower reported fuel poverty in later years can be attributed at least partially to an increase in the proportion of fuel allowance recipients. It would help to have broader fuel poverty definitions at

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[11]   The BER scale in Ireland goes from A to G, with A rating given to most energy efficient dwellings.

[12]   For details of the new announcements related to NRP refer to DECC (2022).

[13]   The NRP announcement includes plans for targeting lower-income households living in some of the lowest rated dwellings when it comes to energy efficiency (E, F or G) to be prioritized for energy efficiency grants (DECC, 2022).

[14]   As mentioned earlier, carbon tax supports are disbursed as increases in existing social welfare payments.

[15]   The Irish government recently announced plans for regulations in housing including minimum standards in rental units when it comes to energy efficiency (Department of Housing, Local Government and Heritage, 2021).

the EU level, which can be further refined at the local level to effectively monitor and design the right combination of social policies and energy efficiency policies (European Parliament, 2016). Considering the multi-dimensional benefits of energy efficiency improvements, the funding for energy efficiency policies can be enhanced by using infrastructure funds for other sectors such as health and social welfare along with revenues from carbon taxation (European Parliament, 2016).

We undertake cluster analysis to study the profile of fuel poor in Ireland in detail (refer to section 3.3). We identify two profiles of fuel poor in Ireland and one of these reflects those found elsewhere in the literature (Karpinska and Śmiech, 2021). This cluster includes typically older households, that live in older dwellings with poor conditions, mainly in rural areas. They are well-targeted by fuel allowance and other social policies. However, the fact that they own homes in poor condition, highlights the fact that the energy efficiency schemes are the best bet when it comes to reducing fuel poverty experienced by these households. But the lower education and higher unemployment status indicate that these groups may require significant assistance to ensure that they opt into the schemes. Karpinska and Śmiech (2021) note that coordination of unemployment-related policies with the fuel poverty related policies might be more effective for the households with income poverty and unemployment. This is important specifically for unskilled workers who are identified as vulnerable to fuel poverty by our logistic regression analysis as well. Karpinska and Śmiech (2021) also note that considering their older age they may need additional support such as the increase in pensions and medical support to account for their vulnerability due to fuel poverty. We identify a second cluster with higher education and higher incomes compared to the other cluster. These are typically larger households who live in mortgaged or rented urban homes. They are not typically targeted by the means-tested welfare payments or free retrofit schemes. While single parents are targeted by social welfare schemes, our analysis shows that a significant proportion of families with children are also vulnerable to fuel poverty, especially in urban areas. The burden of bills and rent or mortgage payments can be too high for households just above the poverty line. The fuel poverty related policy measures in Ireland are focused on households vulnerable to poverty but not necessarily on all the fuel poor. 7,436 households in our below-median income sample (27,404 households) are in income poverty[16]. Out of the fuel poor studied in our cluster analysis (5950 households), only 34% of households in cluster 1 and 49% of households in cluster 2 are targeted by targeted schemes (in the below-median income sample). Hence creating a broader definition of fuel poverty based on expenditure-based measures and energy efficiency and applying such a measure for targeting households for policies might be more advisable. Since many such households already live in newer dwellings (provided such dwellings have a good energy rating), a bill support measure will be the more appropriate measure for combating fuel poverty in that group. European Parliament (2016) notes that considering their relatively lower incomes (even though they are not below the poverty line) they might be unwilling to take mortgages or loans for renovations to cover the cost of retrofits. For those in this category who are living in dwellings they own, initiatives such as low-cost loans to supplement state grants for deep retrofits might help to improve the adoption rate (European Parliament, 2016).

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[16]   As per the SILC definition, the households in poverty have household income less than 60% of median national income.

Based on table 6, while targeted groups experience higher fuel poverty, the incidence of fuel poverty in the non-targeted group is also considerable. The non-targeted group who are also below-median income households experience a higher proportion of bills to their income, despite their relatively higher household incomes compared to the targeted groups. Hence further expansion of support schemes in line with our findings related to profiles of fuel poor and gaps identified in table 9 might be helpful in effectively tackling fuel poverty in the short and long term. Overall table 9 shows that while the GOI targets many of the extremely vulnerable groups, means testing and some of the regulations related to energy efficiency grants leave some fuel poor without support. Additional supports such as tax incentives, energy efficiency-related obligations, improved targeting based on energy audits and fuel poverty definitions, low-cost loans for retrofits, etc. along with improved social welfare systems for those in extreme income poverty should be considered as mentioned earlier (European Parliament, 2016).

5. Conclusion

In this study, we investigate the evolution of fuel poverty in Ireland and the extent of coverage achieved by targeted policies aiming to tackle fuel poverty. We find that fuel poverty in Ireland has declined in recent years after the increase during the recession and recovery years. The overall decline in fuel poverty can be at least partially attributed to the increase in the proportion of households targeted by support measures. While the targeted supports reach some of the households most vulnerable to fuel poverty, some below-median income households are not receiving any support related to fuel poverty currently as per our analysis. Our cluster analysis reveals those who are well targeted by the support are the income poor, older cohort living in energy-inefficient buildings. There is another group of fuel-poor who have higher incomes while still being below-median income households, with larger families and typically renting or mortgaging their dwellings. This group experiences fuel poverty because of arrears and is not covered by existing supports. We argue that additional support including tax credits (tax incentives), energy-efficiency related obligations, improved targeting based on energy audits and refined official fuel poverty definitions, low-cost loans for retrofit, etc. along with improved social welfare systems should be introduced to support all households in Ireland experiencing fuel poverty.

Our study undertakes a comprehensive analysis of fuel poverty in Ireland in recent years. However due to limitations in data especially when it comes to exact energy expenditure, some of the results can only indicate a correlation. Since we cannot separate fuel bills from the total amount of utility bills, we could not include an objective measure of fuel poverty in this study. Further analysis needs to include the causal impact of fuel allowance on fuel poverty, however, this requires the identification of credible instruments to account for possible endogeneity in the treatment. Future studies which take into account these factors can provide a more complete picture of fuel poverty in Ireland.

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