Social Situation Monitor

Energy Prices, Energy Policies and Energy Poverty: Exploring the Connection

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Executive Summary

In this research note we examine the impact of energy prices and policies on energy poverty in European countries from 2007-2017. To undertake this analysis, we combine three pan-European datasets: the EU Survey of Income and Living Conditions (EU-SILC), the MURE database of energy policies, and energy price data from Eurostat. The data is analysed using a fixed-effects panel econometric framework, which accounts for unobserved country and time specific factors, for example annual temperatures, national income and broader economic factors, which could confound our results.

We examine four measures of self-reported energy poverty. Results show that a one percent increase in electricity prices is associated with a 2.3 percent increase in households with arrears on their utility bills (though not statistically significant), a 6.3 percent reduction in households able to adequately warm their homes, a 3.4 percent increase in households struggling to make ends meet and a 4.3 percent increase in the households with leaky or damp homes. The signs on our control variables, income, dwelling size and share of owned properties are all intuitive and in line with expectations.

We find that both the count of policies implemented in a country and the policy intensity, as measured by the expected quantitative impact of the policy has a statistically significant impact on energy poverty. More specifically 1 percent increase in the number of policies in place is associated with a 1.4 percent increase in households in arrears and a 1.2 percent increase in the households struggling to make ends meet. Policies also impact the share of households with the ability to warm their home and the share reporting a leaky or damp home but these results are not statistically significant. While not all statistically significant, the striking feature about our results is that policies appear to be adversely associated with all measures of energy poverty.

To further understand these results we create a variable to capture policy intensity and disaggregate by the type of policy, financial and fiscal, information and energy performance standards. Different policy categories have different impacts but broadly speaking energy performance standards have the strongest adverse association with self-reported measures of energy poverty. We also disaggregate by policies targeting heating, electricity and all fuel consumption, and results seem to generally support our overall findings.

When we examine the varying impact of policies with underlying changes in prices, we find that in particular, energy policies are negatively associated with measures of energy poverty for areas with sufficiently high electricity prices. The results are consistent in terms of direction, for both renters and owner-occupiers, but do change in magnitude. Similarly, we find that the results are broadly consistent across income groups in terms of direction, but do change in magnitude.

When we examine the impact of the share of policies targeted at low income households, we find that this potentially mediates the impact of policies and may reduce some of the adverse associations we observe. These results are not statistically significant though. In other cases the adverse impact appears more pronounced and satisfy statistical significance.

We acknowledge that these results may appear counter-intuitive and certainly there are limitations with this analysis. In particular, analysis at an aggregate country-level may mask important variation within individual countries. The use of self-reported measures, while allowing a comparison across countries does not allow for an objective assessment of energy poverty. We cannot say that we present evidence of a causal relationship between increased energy policies and an increase in energy poverty. We remain silent on the role of social policies which may also alleviate energy poverty.

Despite these limitations, the models are well estimated and include country and time fixed effects to control for a range of unobserved factors that may confound results. The coefficients on our control variables are broadly as one would expect. And the direction of our results is consistent across four measures of energy poverty and to different sample disaggregations. Further analysis is beyond the scope of this report, but we would argue is warranted on the basis of our results.

1. Introduction

Energy poverty is an increasingly important issue among European households and consequently the focus of multiple policy initiatives from the European Commission and individual member states. Efforts to improve the physical quality of dwellings have thus far included energy performance standards and certificates, subsidies and other forms of financing, tax incentives and information provision. The European Commission's Communication and roadmap on the European Green Deal (EC, 2019a) sets out key objectives of decoupling economic growth from resource use, ensuring that there are no net emissions of greenhouses gas by 2050, and also ensuring that no person or place is left behind, illustrates the commitment of policymakers to achieving these objectives. Two of the primary actions of the European Green Deal will be ensuring that buildings are more energy efficient and decarbonising the energy sector. Delivering on these important policies comes at a cost to society that must be distributed in as equitable a manner as possible. This distributional question is important both from a moral perspective and from a policy acceptability perspective.

To further illustrate this point, Figures 1 and 2 present electricity and gas costs for European countries in 2017, along with the share of costs related to taxes and levies. While there is significant variation across country, taxies and levies account for a significant proportion of total costs (EC, 2019b).

Figure 1 : European household electricity prices in 2017. Source DG ENER

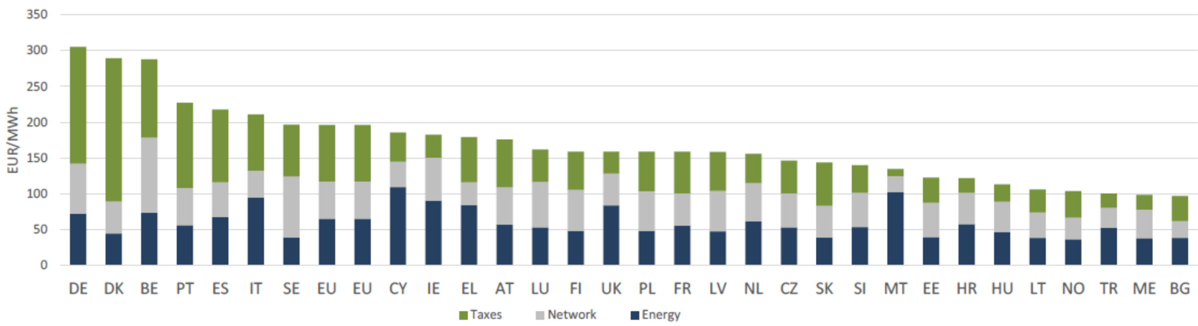
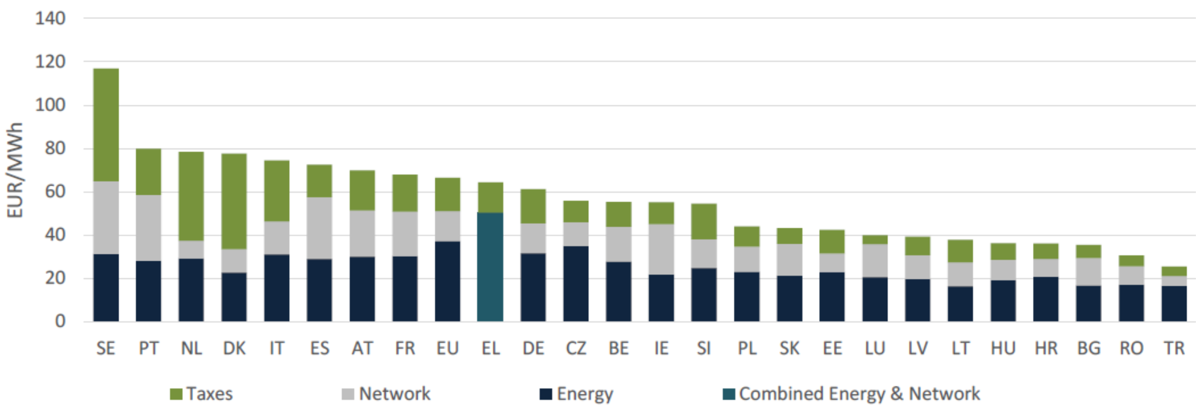


Figure 2 : European household gas prices in 2017. Source DG ENER



Previous research has shown that as policy costs from energy efficiency measures and renewable energy rise, imperfect targeting of low-income households can result in those least able to afford it being loaded with a disproportionate amount of the costs (Chawla and Pollitt, 2013; Neuhoff et al., 2013). Compounding this issue is heterogeneity in the financial savings from installing energy efficiency measures mean savings can be lower for low income households (McCoy and Kotsch, 2020). These households tend to be further from their optimum level of energy service usage and may be taking back some of the potential savings as increased thermal comfort (Aydin et al., 2017).

As the transition towards low-carbon economies within the region is expected to bring upward pressure on energy prices, at least in the medium term, which can also impact European households' access to affordable housing and to energy services.[1] An important question is thus raised about the net impact of these opposing forces. Studying the connection between these factors is relevant for European governance and policy strategy at different levels, primarily due to their immense social, economic, environmental and health implications (Papada and Kaliampakos, 2018).

This research paper bridges the gap between quantitative aggregate analyses of energy demand and comparative analyses of energy poverty.[2] By undertaking this analysis, we can shed new light on the evolution of energy poverty over time and across country. In particular, we can estimate the impact of various types of energy policy and changing energy prices on self-reported energy poverty in European countries.

In Section 2 we briefly highlight the main literature we draw from, and how our approach can contribute new insights; Section 3 describes the three primary datasets used; Section 4 the econometric methodology; Section 5 the results and Section 6 concludes.

2. Related Literature

2.1 Energy Poverty

Energy poverty occurs when a household is unable to secure an adequate level of energy services in their home. This occurrence can be temporary and episodic, and it can be spatially dynamic. The inability to secure adequate energy services is considered a complex combination of low income, high energy costs and energy inefficient housing. As a concept, energy poverty has proven thorny to define and consequently difficult to measure accurately, and to compare over time or across country. Combined with the lack of consensus on how to measure it, limited availability of comparable data and statistical indicators have made it challenging to determine the appropriate policy response to address energy poverty.

Thompson et al (2017.a) provide a useful overview of approaches to measuring energy poverty. They describe three general approaches, resulting in three methods of measurement:

1. Expenditure approach: considers the ratio of household income to energy expenditure
2. Direct measurement: directly measures internal temperatures
3. Consensus approach: based on self-reported assessment of indoor housing conditions

The **expenditure approach** is probably the most widely used measure. For example, in 1991 the UK established a 10 percent threshold of income as an absolute measure of

[1] While there is considerable uncertainty in any long-term prediction, European Commission scenario modelling suggests that costs of electricity prices are expected to rise until 2030 and then remain broadly stable afterwards (EC, 2016).

[2] By "quantitative analyses of energy demand" we mean country-level statistical or econometric analysis of the determinants of energy demand. Section 2.2 provides more detail.

energy poverty. Under this measure a household is considered to be energy poor if they spend 10 percent of their income on energy. This measure is quantifiable, and arguably objective. However, the threshold level is arbitrary, and much uncertainty can exist in the calculation of energy costs and income. The **direct measurement approach** typically seeks to measure internal temperatures in the home. Clearly, this provides an objective view, however uncertainties exist in which temperature thresholds to use and as a comparative measure it has limited value given the practical difficulties in large-scale measurement of internal temperatures. For this reason, there have been limited studies, with a few notable exceptions being Healy (2004), Oreszczyn et al (2006) and Kolokotsa and Santamouris (2015).

The **consensual approach** is the most appropriate for comparative analysis, given that no standardised and objectively measured microdata exists at the European level on housing conditions and fuel expenditure. For that reason, the EU Survey of Income and Living Conditions (EU-SILC) questionnaire information on housing and material deprivation provide the means for a comparative analysis. Thompson and Snell (2013) perform such an analysis using EU-SILC 2012 data. They use a range of outcome variables such as arrears on utility bills, inability to heat the home, living in a leaky or damp house, variables relating to dwelling size and the ability to make ends meet. The authors find a high level of fuel poverty in southern and eastern states. Some of the same authors use the European Quality of life Survey, again from 2012, to undertake a comparative analysis of the relationship between energy poverty, health and well-being for all European countries Thompson et al (2017.b).

2.2 Quantitative aggregate energy demand analysis

The other key literature we draw from seeks to understand, at an aggregate country-level, the determinants of energy demand. Typically, this line of research takes a more quantitative approach using tools from applied econometrics such as stochastic frontier methods and panel data analysis.

The stochastic frontier method has been widely used by Filippini et al (2014), Filippini and Hunt (2015), Saussay et al (2012), amongst others. This method essentially uses a production function approach to examine how efficiently different entities convert inputs into outputs. The relevant application in our case is the range of papers examining energy demand frontier functions which seek to model energy consumption as a function of national income, energy prices and population size (Filippini and Hunt, 2011; Evans et al., 2013). Additional explanatory variables incorporated into this framework have included policy indicators derived from the MURE database. The basic idea is to estimate at an aggregate level the impact of energy efficiency policies in reducing consumption. For example, using this methodology Filippini et al (2014) find that financial incentives and energy performance standards have played a more important role in energy efficiency improvements than informative measures.

A complementary method is to estimate the impact of policies and other factors on energy demand using panel data analysis. Several authors have used this approach, including Ó Broin et al. (2015) and Bertoldi & Mosconi (2020). Ó Broin et al. find that regulatory policies, such as energy performance standards, have a greater impact than financial incentives or informative policies. While in a recently published paper, Bertoldi & Mosconi (2020) implement a dynamic panel estimation and find that for the household sector it takes about three measures and some time to reduce energy consumption by about one percent.

2.3 Contribution of this research paper

Our contribution is to combine both of the above approaches in a novel application that allows us to generate new insights into energy poverty in Europe, and the impact of policies and prices in alleviating it. As mentioned above, limited comparative analysis examining energy poverty has been undertaken in European countries. The analysis that has been undertaken has typically been static, for an individual year and descriptive, although Thompson and Snell (2013) did perform a regression analysis on the predictors of household's inability to keep the home adequately warm. The more quantitative approaches have thus far primarily been applied to estimating energy demand and energy efficiency. We feel there is considerable scope to apply these methods to examine energy poverty, in a way that will deliver new policy insights.

3. Data

3.1 Datasets used in this analysis

To conduct the quantitative analysis, we have combined a number of datasets covering EU-member countries. For data involving household income and living conditions, we used (i) the European Union Statistics on Income and Living Conditions (EU-SILC). EU-SILC cross-sectional household-level data are available for conditional access from 2007-2017. EU-SILC data are then combined with; (ii) country-level panel-data on energy efficiency policies and measures from the MURE database; and (iii) energy price data from Eurostat. Below we describe each dataset in detail.

3.1.1 EU-SILC

The primary dataset used in this analysis is the European Survey of Income and Living Conditions (EU-SILC)[3] for the years 2007-2017[4]. This dataset contains cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions at the household level for European Union Member States. In particular we are interested in two key metrics of energy poverty at the individual household level: (i) **HS021**: Arrears on utility bills; and (ii) **HH050**: Ability to keep home adequately warm[5]. These variables enable us to identify self-reported measures of energy poverty and how they vary by sociodemographic characteristics and dwelling type. We combine these variables with information on household income and housing costs[6] to build a comprehensive picture of energy poverty over time for each country. We then aggregate all of our measures enabling us to analyse trends in these factors over time.

3.1.2 MURE

The ODYSSEE-MURE database[7] provides comprehensive country-level data on energy efficiency instruments and measures in the residential sector implemented in EU Member

[3] https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

[4] We have access for the period 2004-2006. Nonetheless, the Eurostat price data has changed in data collection methodology since 2007 (see . https://ec.europa.eu/eurostat/data/database). To eliminate its potential effect on our estimates, we opted to drop observations earlier than 2007.

[5] Two of the primary indicators on energy poverty as defined by the EU Energy Poverty Observatory: https://www.energypoverty.eu/indicators-data

[6] For example: HH070: Total housing cost [Total housing cost (including electricity, water, gas and heating)]

[7] http://www.measures-odyssee-mure.eu/. MURE is coordinated by Fraunhofer-ISI with the technical support of Enerdata, that contains a description, with their impact evaluation whenever available, of

States. This database includes measure defined in the National Energy Efficiency Action Plans (NEEAP) and EU level measures. Measures are categorised into (i) Legislative - mandatory standards and labelling; (ii) Financial – grants/subsidies; (iii) Fiscal – income tax/VAT reductions; (iv) Information provision and; (v) Co-operative measures agreed with energy suppliers and white goods producers. As per Fillippini et. al (2014) we aggregate the above into three categories: (i) financial and fiscal incentives; (ii) information and (iii) energy performance standards. Following this categorisation, we isolate the targeted end-use of the policy and categorise as: (i) space and water heating and cooling; (ii) electricity and lighting and (iii) total final end use. Finally, we identify which policies were targeted specifically at low-income households. We also can identify the start and end year of each policy. Taking all of the above together, this categorisation allows us to create for each country and each year a set of variables which count the number of policies in place, their type, their targeted end-use and their target audience. Table 1 provides an overview of the number of policies by type and country over the entire period for which MURE provides data. In total we observe 489 domestic energy policies. Financial and fiscal policies, and energy performance standards make up a sizeable proportion (about 40% each), while information policies account for approximately 15% of the policies we observe.

Table 1 : Overview of MURE policies by country

Country	Financial and fiscal	Energy performance standards	Information	Total
Austria	4	2	3	9
Belgium	8	10	4	22
Bulgaria	7	9	2	18
Croatia	6	2	0	8
Cyprus	5	1	1	7
Czech Republic	9	2	1	12
Denmark	1	5	4	10
Estonia	7	3	1	11
Finland	2	10	9	21
France	8	1	6	15
Germany	14	9	4	27
Greece	10	7	2	19
Hungary	5	3	0	8
Ireland	7	14	4	25
Italy	2	13	1	16
Latvia	8	11	3	22
Lithuania	8	6	3	17
Luxembourg	9	8	0	17
Malta	19	2	4	25
Netherlands	12	3	2	17
Norway	8	10	10	28
Poland	3	2	0	5
Portugal	2	7	1	10
Romania	4	12	0	16

all energy efficiency measures implemented at EU or national level. MURE was initially developed by ISINNOVA. A network of 36 partners from 31 countries participate in this initiative. MURE is co-funded by the EC Horizon 2020 programme.

Serbia	2	4	1	7
Slovakia	11	6	1	18
Slovenia	7	15	1	23
Spain	11	20	2	33
Sweden	3	4	1	8
Switzerland	1	0	0	1
United Kingdom	5	6	3	14
Total	**208**	**207**	**74**	**489**
Period covered	1975-2019			

Source: MURE dataset

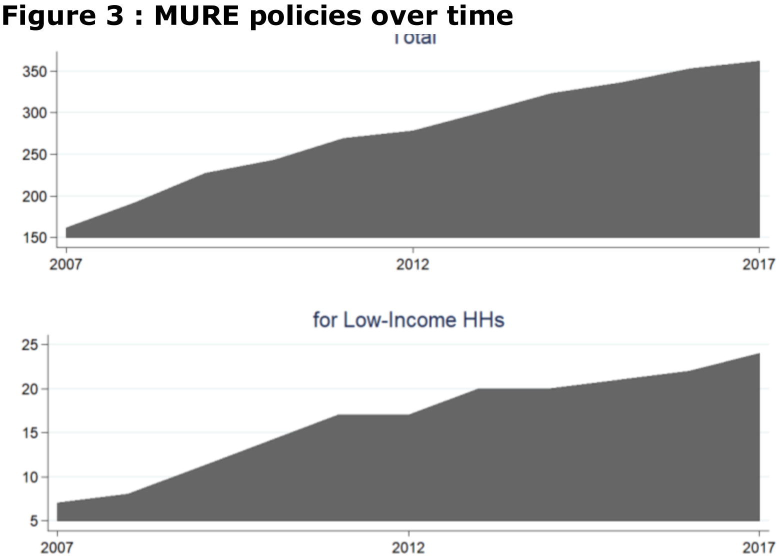
Within the MURE database, policies have a start-year and an end-year. See Table 2 as an example. When we perform our analysis, we consider policy HOU-IRL38 to be in place for each year between 2006-2009. When a policy is described as "Ongoing", for example HOU-UK34, and does not have an end-year we assume that this policy is still in place at 2017, the last year in our dataset.

Table 2: Example of policies from MURE database

Code	Country	End Use	Target	Title	Status	Type	Starting Year	Ending Year
HOU-IRL38	Ireland	space heating	All groups	Low Carbon Homes Scheme	Completed	Financial	2006	2009
HOU-UK34	United Kingdom	space heating	Low income	Home Energy Efficient Programmes (Scotland)	Ongoing	Financial	2013	

We use binary variables to denote when a policy is in place within each country-year. Figure 3 plots the cumulative policy intensity over time for both any type of policy and policies specifically targeted at low income households. The number of policies in place increased substantially over our period of analysis.

Figure 3 : MURE policies over time



Source: MURE. Note: The figures shown includes countries with non-missing observations for the period 2007-2017.

To parameterise the impact of policies in our regression models we draw from previous research using the MURE database. Within the database policies are assigned a semi-quantitative impact based on quantitative evaluations or expert estimates within each country. The impact of a policy is categorised as: low = less than 0.1%; medium = 0.1%–0.5%; and high = greater than 0.5% savings. The weighted indicator can be interpreted as the percentage decrease in energy consumption expected to be achieved by the policy. Two important previous studies using this weighting scheme are Ó Broin et al. (2015) and Bertoldi & Mosconi (2020). The weightings that each use are summarised in Table 3 below. Both are broadly aligned with the weighting assigned in MURE but use different scaling. The key comparison is in the "Ratios" columns where we can see that the ratio of high-medium-low impact is similar in both cases. For our analysis we adopt the weighting applied by Bertoldi & Mosconi (2020) as this is closer to the mid-points of the MURE distribution.

Table 3 : Policy Intensity weightings applied to MURE database

		Weighting		Ratios	
Semi-quantitative impact	MURE Assessment	O'Broin	Bertoldi	O'Broin	Bertoldi
High	Greater than 0.5%	20	0.7	1	1
Medium	0.1%-0.5%	10	0.3	0.50	0.43
Low	Less than 0.1%	1	0.05	0.05	0.07

Notes: Policy weighting and ratio of semi-quantitative impact as per Ó Broin et al. (2015) and Bertoldi & Mosconi (2020)

3.1.3 Energy price data

Energy price data will come from Eurostat[8]. This dataset provides half-yearly residential gas and electricity prices for European countries. Energy prices from Eurostat are expressed in local currencies at current prices. In order for these prices to be comparable across counties and over time, we first expressed these energy prices into Euros using the historical exchange rates for each country from the OECD. We then deflated these prices using the Harmonized Index of Consumer Prices (HICP) and expressed energy prices in 2015 prices.

Figure 4 plots the maximum (blue lines), average (green) and minimum (red) of gas and electricity prices over time. Note that the minimum and average prices exhibited generally flat trend for both gas and electricity. Interestingly, maximum prices are more volatile, with noticeable divergence between electricity and gas prices starting in 2012.

8 https://ec.europa.eu/eurostat/web/energy/methodology/prices

Figure 4 : Gas and electricity prices over time (2015 Euro)

Source: EU-SILC (number of HHs); Eurostat (semi-annual prices across different customers for each country). All prices are in 2015 Euros.

3.1.4 Selected summary statistics

As described above, we focus on two key outcome variables (i) **Warm**: the share of households with the ability to keep their home adequately warm; and (ii) **Arrears**: the share of households with utility arrears. While these measures are self-reported they are key proxies for energy poverty. While Arrears may comprise other utility bills, energy costs are the most significant component, and this measure is an indication of a household's inability to secure adequate energy services. These variables are combined with our key policy and price explanatory variables. In addition to the policy and price variables we also control for other factors which will influence the ability to heat the home; average disposable income, property size (average no of rooms), and the share of owned properties in a country. Summary statistics are presented in Table 4. The Data Appendix provides further summary statistics on a range of other variables within the datasets used.

Table 4 : Summary statistics for variables in regressions

Variables	N	Mean	SD
Dependent variables			
Share, ability to keep home adequately warm	340	0.886	0.123
Share, HH with utility arrears	340	0.092	0.080
Key explanatory variables			
Number of policies: Total targeted to low income	330	1.112	1.593
Number of policies: Total	330	1.061	1.263
Average gas prices, Euro/kWh	330	2.194	2.051
Average electricity prices, Euro/kWh	330	1.930	1.863
Control variables			
Average disposable income	340	29628	19006
Average number of rooms	337	3.856	0.764
Share, tenure: owner	340	0.760	0.118
No of countries	32		
Period covered	2007-2017		

4. Empirical Strategy

Our analysis will begin with a presentation of stylised facts that will visually illustrate patterns and trends of our outcome, policy and price variables in relation to economic and environmental factors. These trends form part of the conceptual framework underpinning our estimation method. Moreover, the trends and patterns also motivate the empirical questions that the study aims to address. The presentation of stylized facts will be substantiated by an econometric model.

In order to combine all three datasets, we will first aggregate the EU-SILC microdata to create a longitudinal (or panel) dataset of energy poverty by country and over time. This aggregated data captures the count and/or proportion of households living in in energy poverty in each country over time. We then link this to our data on policies and prices at the country-year level. Creating this merged dataset enables us to estimate econometric models expressing energy poverty as a function of energy policies, energy prices and their interaction.

$$EPOV_{it} = f(EPOL_{it},\ EPRICE_{it}, \alpha_i, \gamma_t\ )$$

Where *EPOV* denotes energy poverty, *EPOL* energy policy, *EPRICE* energy price in country *i* and year *t*; α_i and γ_t are country and time fixed effects. This functional form will allow us to quantify the association between different types of energy policy, changes in energy prices and their relationship with various dimensions of energy poverty. We use a rich set of country-year fixed effects which will allow us to control for any unobservable confounding factors which may vary by country and year. This would include annual temperatures, national income and broader economic factors.

4.1 Econometric methodology

We will analyse the dependent variable, y_i (i.e. arrears and warm) and assume that observations are independent, where $0 \leq y_i \leq 1$. Our assumption is that, for all i,

$$E(y_i|x_i) = G(\boldsymbol{x_i \beta})$$

where $G(\cdot)$ is a known function satisfying $0 \leq G(z) \leq 1$ for all values of z. This expression ensures that all the values of y are within the interval (0,1). We intend to employ different functional forms of $G(\cdot)$ and test which ones best fit.

Our baseline model is an Ordinary-Least Squares (OLS) linear regression model. In particular, we begin with the linear model

$$E(EPOV|\boldsymbol{x}) = \beta_1 + \beta_2 EPRICE + \beta_3 EPOL_{all} + \beta_4 EPOL_{low} + \beta_5 INC + \beta_6 ROOMS + \beta_6 OWNED$$

where $EPOV$ is as previously defined, $EPOL_{all}$ and $EPOL_{low}$ are the number of energy policies implemented in a given year for a particular country for all and low-income HHs, respectively; $EPRICE$ is the average electricity price; INC and $ROOMs$ is the average equivalised disposable income and number of rooms, respectively; and $OWNED$ is the share of owned housing. This model is estimated using ordinary least squares (OLS). For the inference, we calculated heteroskedasticity-robust standard errors.

While it is unlikely that the dependent variable has no feedback effect on each explanatory variable, it is highly probable that there are several omitted variables that are not accounted for in the model. These factors include different energy mixes and different housing policies across countries to name a few. Moreover, as we shall see in the stylized facts, there seems to be differences in relationship between our key outcome variables and the regressors when country- and year-specific heterogeneity are accounted for in the analysis. Thus, we can expand the model to

$$E(EPOV|\boldsymbol{x}) = \beta_1 + \beta_2 EPRICE + \beta_3 EPOL_{all} + \beta_4 EPOL_{low} + \beta_5 INC + \beta_6 ROOMS + \beta_6 OWNED + \gamma_y + \delta_c$$

where all other variables except γ_y and δ_c are as previously defined. γ_y and δ_c denote year- and country-specific effects which are estimated by including year- and country- dummies in the estimation. This model is also estimated using ordinary least squares (OLS), thus implying that $G(\cdot)$ is a standard normal cumulative density function (cdf).

As reported by Papke and Wooldridge (1996), the linear model does not fit well for fractional responses, as the linear model is likely to miss important nonlinearities and potentially make estimates less efficient. That said, we next use the non-linear model

$$E(EPOV|\boldsymbol{x}) = G(\beta_1 + \beta_2 EPRICE + \beta_3 EPOL_{all} + \beta_4 EPOL_{low} + \beta_5 INC + \beta_6 ROOMS + \beta_6 OWNED)$$

where $G(\cdot)$ is the logistic function. This model is estimated using quasi-maximum likelihood estimation (QMLE) following Papke and Wooldridge (1996).

The current nonlinear model, however, does not allow the same degree of flexibility as the linear model that accounts for year- and country-specific effects and controlling for various omitted variables. We are currently working on refining the analysis to incorporate year- and country-fixed effects into the nonlinear estimation.

4.2 Extensions

Building on our baseline model we will also explore heterogeneity by outcome measure, by policy type, by income group, by policy target group, by tenure type, and by country. In particular we hope to identify and quantify the effectiveness of different policy types in alleviating energy poverty.

5. Results

5.1 Stylized Facts

Before presenting results from a formal analysis we present some stylised facts regarding the relationship between our primary outcome variables and explanatory variables. Figures 5-8 present correlation plots in which the y-axis plots the share of households with the ability to adequately warm their dwellings (Warm), or the share of households in arrears (Arrears), against electricity and gas prices on the x-axis, aggregated for all countries. For each figure we present the correlations net of year- and country-specific effects.

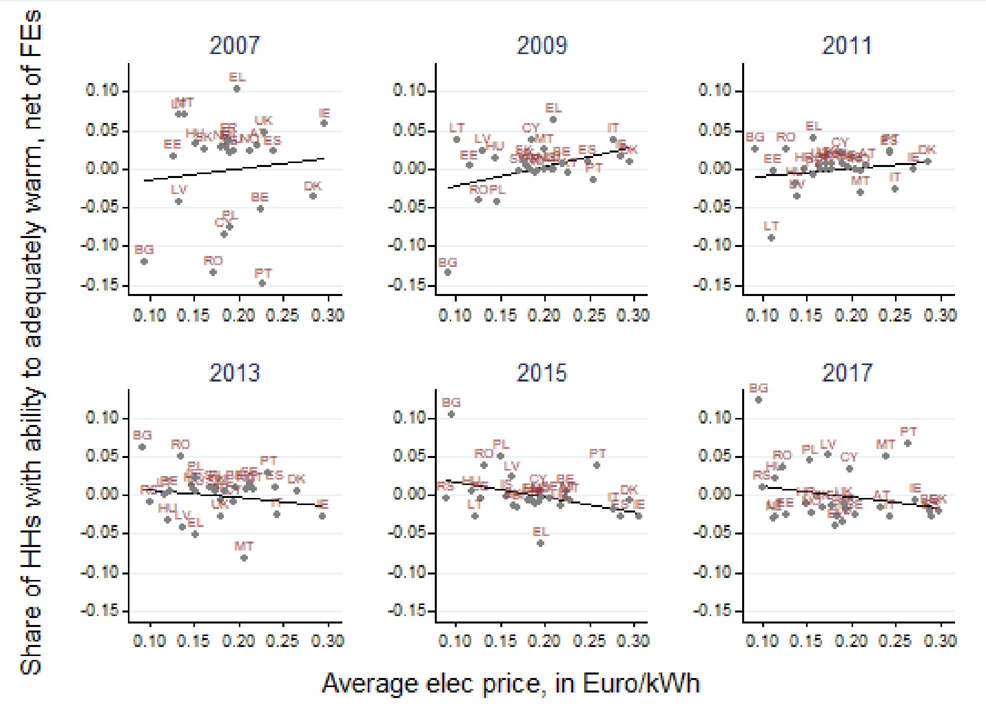
Figures 5 and 6 demonstrate correlation between the share of households who can adequately warm their homes and energy prices (both electricity and gas) is initially positive. That is, in countries with higher energy prices, we observe a higher proportion of households with the ability to heat their homes. This positive association diminishes over time and changes sign between 2011-2013. Figures 7-8 suggest that there is a very weak and unstable relationship between the share of arrears and average energy prices.

Some of these results would appear to be counter-intuitive, however a number of confounding factors may be driving this result. Although energy prices are equivalised for each country using a consumer price index, there is likely some unobserved confounding relationship between higher energy prices and higher income which would partially explain some of our findings. In addition, the arrears variable available to us is a composite of electricity, gas and other utility costs. This aggregation would lead to some measurement error when comparing solely to arrears on electricity or gas bills. Finally, higher prices will also reflect a greater policy intensity, to the extent that policy costs are subsequently loaded onto energy prices. Disentangling this relationship is a core objective of this research and motivates applying more advanced statistical techniques.

Figures 9-10 present times trends in each of these factors for each individual country. Figure 9 presents the share of households with arrears in their utility bills, average gas and electricity prices (in Euro/kWh), and number of energy policies (total and targeted to low-income HHs), by country, 2007-2017. Firstly, it is interesting to note the degree of variation in the share of arrears across country. For many countries we observe a U-shaped pattern in arrears, with a peak around 2012 following the financial crisis. For other countries, such as Germany (DE), the share of households in arrears in declining throughout our sample period. Prices appear to remain relatively stable, while policies are increasing for most countries over time.

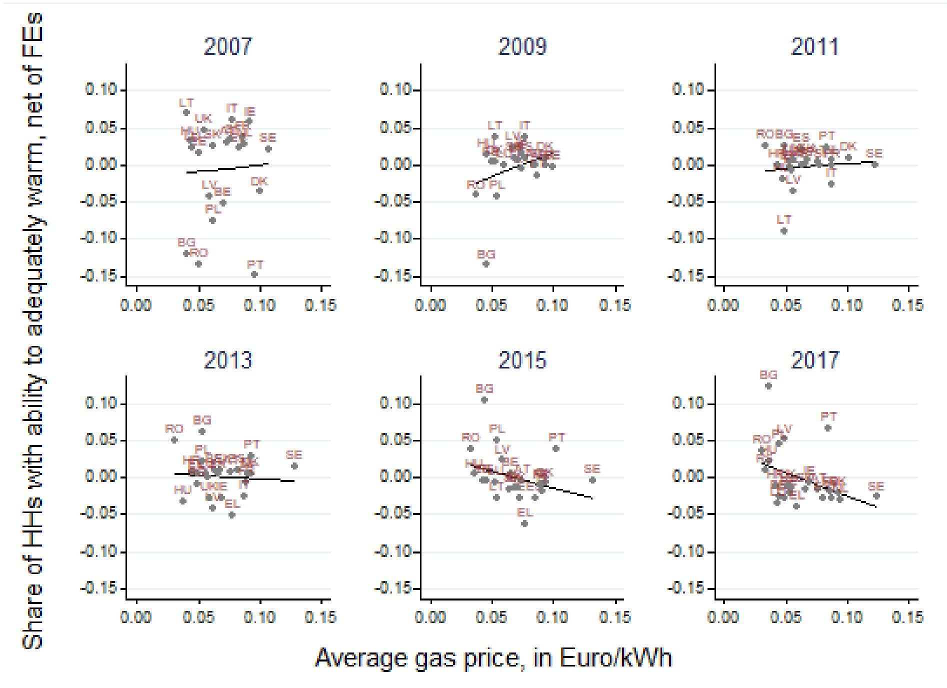
Figure 10 swaps the share of arrears in each country with the share of households with the ability to warm. For many countries this share is close to 1 (100%) and does not very much over time. For several other countries, such as Belgium, Germany and the Czech Republic we observe an improving trend over time. Both Figures 6 and 7 highlight issues with missing data. The next step is to formally combine all of these sources of information into a series of econometric models to assess whether we can quantify and generalise our stylised results.

Figure 6 : Correlation plot between the share of households with the ability to adequately warm their dwellings and the average electricity price (in Euro/kWh), by country, 2007-2017



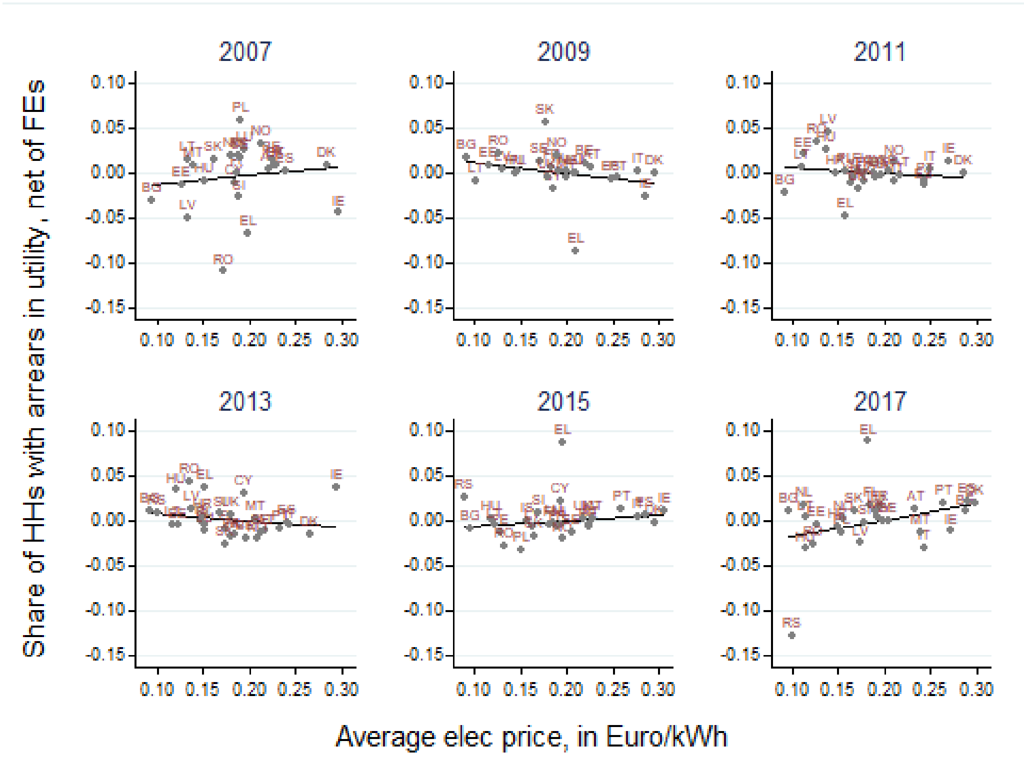
Source of raw data: Ability to adequately warm household (EU-SILC); Electricity price (Eurostat).
Notes: All prices are expressed in 2015 Euros. Results are net of year- and country-specific effects.

Figure 5 : Correlation plot between the share of households with the ability to adequately warm their dwellings and the average gas price (in Euro/kWh), by country, 2007-2017



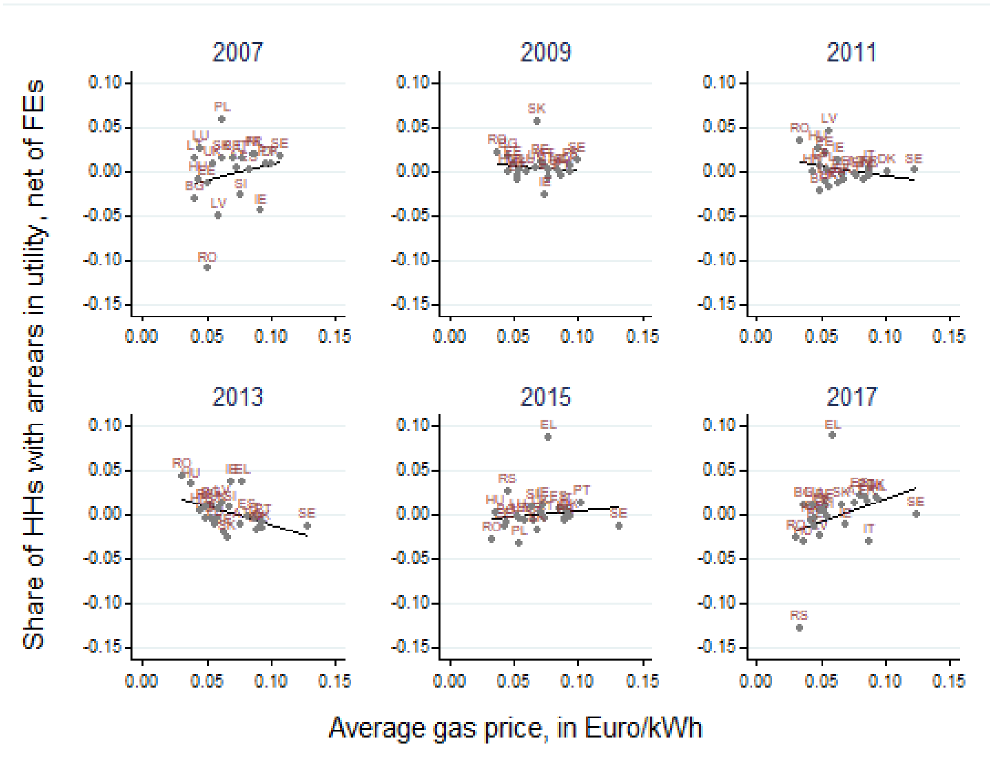
Source of raw data: Ability to adequately warm household (EU-SILC); Gas price (Eurostat).
Notes: All prices are expressed in 2015 Euros. Results are net of year- and country-specific effects.

Figure 8 : Correlation plot between the share of households with arrears in utility and the average electricity price (in Euro/kWh), by country, 2007-2017.



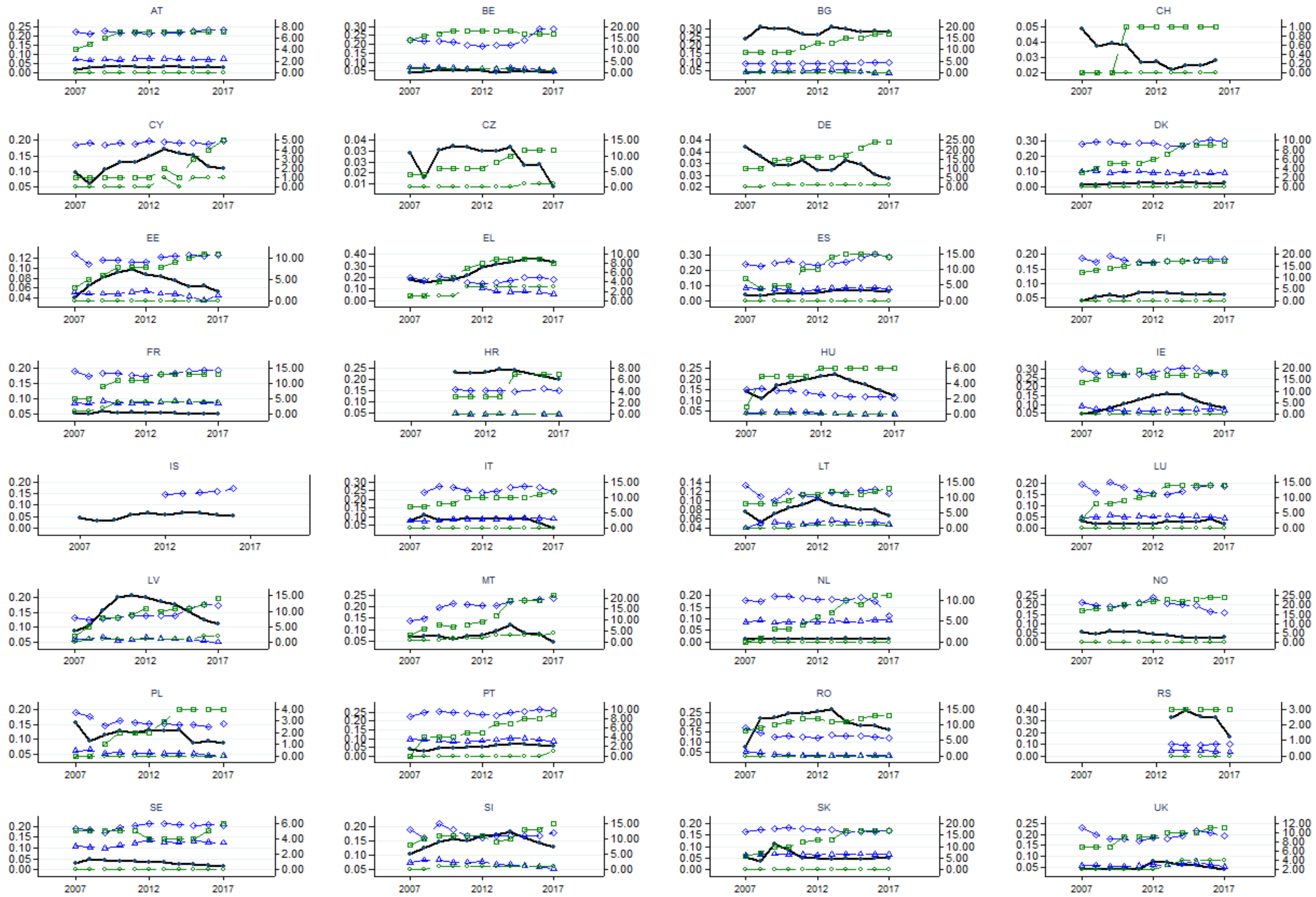
Source of raw data: Ability to adequately warm household (EU-SILC); Electricity price (Eurostat).
Notes: All prices are expressed in 2015 Euros. Results are net of year- and country-specific effects.

Figure 7 : Correlation plot between the share of households with arrears in utility and the average gas price (in Euro/kWh), by country, 2007-2017



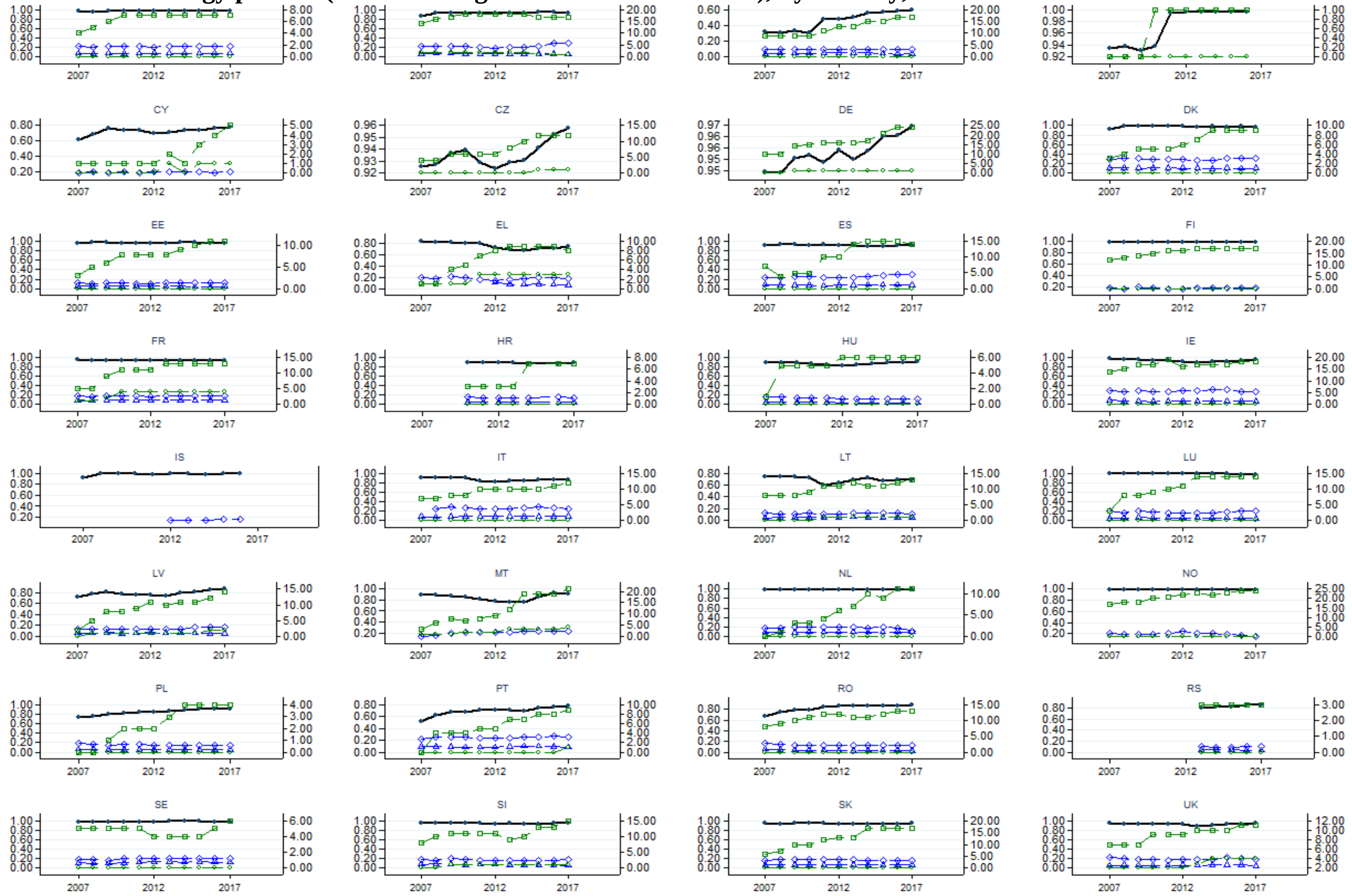
Source of raw data: Ability to adequately warm household (EU-SILC); Gas price (Eurostat).
Notes: All prices are expressed in 2015 Euros. Results are net of year- and country-specific effects.

Figure 9 : Share of households with arrears in utility, average gas and electricity prices (in Euro/kWh), and number of energy policies (total and targeted to low-income HHs), by country, 2007-2017



Source of raw data: HHs with arrears in utility (EU-SILC); electricity and gas prices (Eurostat), energy policies Notes: The solid black line (right axis) is the share of HHs with arrears in their utility bills; gas and electricity prices (left axis, in Euro/kWh) are represented by blue dashed lines with hollowed triangle and diamond markers, respectively; the total number of policies and those targeted to low income HHs (right axis) are represented by green dashed lines with hollowed square and circle markers, respectively. All prices are expressed in 2015 Euros. The bottom panel is net of year- and country-specific effects.

Figure 10 : Share of households with ability to warm dwellings, average gas and electricity prices (in Euro/kWh), and number of energy policies (total and targeted to low-income HHs), by country, 2007-2017



Source of raw data:: Ability to adequately warm household (EU-SILC); electricity and gas prices (Eurostat), energy policies

Notes: The solid black line (right axis) is the share of HHs with the ability to adequately warm their dwellings; gas and electricity prices (left axis, in Euro/kWh) are represented by blue dashed lines with hollowed triangle and diamond markers, respectively; the total number of policies and those targeted to low income HHs (right axis) are represented by green dashed lines with hollowed square and circle markers, respectively. All prices are expressed in 2015 Euros. The bottom panel is net of year- and country-specific effects.

5.2 Econometric Results

5.2.1 Baseline Results

We next estimate a series of econometric models. In each case we run a separate regression for each dependent variable "Arrears" and "Warm". In addition to the policy and price variables we also control for average disposable income, property size (average no of rooms), and the share of owned properties in a country. By controlling for these factors, we aim to isolate the impact of both energy prices and policies on our two outcome variables. The models are as follows:

1. Model 1: Ordinary least squares (OLS) linear regression model
2. Model 2: Fractional logit regression model
3. Model 3: OLS with country-specific effects
4. Model 4: OLS with country and time specific effects (**our preferred specification**)

Model 1 is the baseline OLS specification. An OLS specification assumes a normally distributed dependent variable, in our case our dependent variable is the share or proportion of households in arrears and able to keep their home adequately warm, using a specification which allows for a fractional dependent variable might be more appropriate. For that reason, we also estimate a Fractional logit regression model, Model 2. Models 3 and 4 expand the OLS model to specifically account for any unobserved country-specific and time-specific effects which might otherwise be omitted and not captured by our control variables.

Results from Model 1 suggest that energy prices are negatively correlated with Arrears, and positively correlated with Warm. Energy policies have mixed effects on both Arrears and Warm, depending on whether they are targeting low income households or not. Average household income is negatively associated with both Arrears and Warm. Average number of rooms is negatively associated with Arrears and positively with Warm, while the opposite is true for the share of owned properties. These results are similar qualitatively to the correlation analysis we previously presented, and they highlight the need to control for idiosyncratic country and year affects as there are likely to be omitted factors affecting the results, which we are not controlling for. We do this in Models 3 and 4.

Before undertaking this analysis, we need to ensure that our functional form is appropriate. In order to do this, we compare the results from an OLS specification (Model 1) with that of a Fractional logit (Model 2). Comparing Models 1 and 2 the key feature is that the results from both are qualitatively similar. Both the magnitude and significance of all variables are similar. This result gives us reassurance that we can continue with our baseline OLS but enhance it by adding additional fixed effects.

Model 3 includes country fixed effects. We can see now that the sign and significance of a number of variables begins to change. Moreover, the model fits significantly better, with our adjusted R-squared increasing by almost four times that of Model 1. This clearly shows that there are potentially unobserved country-specific systematic differences that are time invariant and which were not accounted for model 1. Finally Model 4, our preferred specification, includes country- and year- fixed effects. The year-fixed effect account for unobserved shocks that are common to all countries (e.g., macroeconomic or region-wide economic shocks). Model 4 its relatively better than Model 3, which compels us to opt for the former as our preferred specification.

Table 4a presents results. We observe a positive association between energy prices and Arrears (although not statistically significant) and a negative association with Warm. To interpret the coefficients, a 1 percent increase in prices is associated with a 2 percent increase in households in arrears, and a 6 percent reduction in the households who can adequately warm their home. We find that a 1 percent increase in the number of policies in place is associated with a 1.5 percent increase in the households in arrears, and 0.9

percent reduction in the households able to adequately warm their homes (although not statistically significant). It would appear that this result is counter-intuitive, however it might be the case that, on average, policies have exacerbated some measures of energy poverty. Further work is required to refine our policy variables and explore this relationship in more detail. The results on our control variables makes intuitive sense: higher incomes are associated with lower Arrears and higher Warm; larger dwellings (other things being equal) are associated with higher Arrears and lower Warm; finally more owner occupied properties is associated with lower Arrears and higher Warm.

We are confident that the specification in Model 4 is providing the most robust results and proceed on that basis.

5.2.2 Expanding the Range of Energy Poverty Indicators

The previous section relied on two self-reported measures of energy poverty: the share of households able to adequately heat their home and the share of households falling into arrears in any year. Thompson and Snell (2013) undertake a comparative analysis of energy poverty with EU-SILC but use a broader set of outcome variables. For example, they include household ability to make ends meet and whether the household has a leaky or damp dwelling. By broadening our set of measures, we can get a more comprehensive view of the impact of policies and prices on energy poverty.

We expand our set of energy poverty indicators to include the share of HHs with great difficulty in meeting ends (Meet Ends) and those with leaking roofs, damp walls and ceilings (which indicates the condition of the dwelling) (Leaks).

Table 4b illustrates that our results consistently suggest that higher electricity prices are associated with higher share of HHs with great difficulty in Meet Ends and Leaks, and lower share of HHs with the ability to adequately warm their homes (Warm). Meanwhile, increasing the count of energy policies intensity is associated with higher shares of HHs in Arrears and with great difficulty in Meet Ends. The number of policies targeted to benefit low income HHs seem to have no effect on the share of HHs in any of the energy poverty indicators.

5.2.3 Policy Heterogeneity

As described in Section 2.1.2 policies are categorised into different types: (i) financial and fiscal incentives; (ii) information and (iii) energy performance standards. So far, we have aggregated them and not explicitly examined the impact of alternative types of policy. In this subsection, we explore policy heterogeneity in more detail. We do this by running separate regressions for each energy policy applied to heating, electricity and all end-use. Results are presented in Tables 5a (for the outcome Arrears), 5b (for the outcome Warm), 5c (for the outcome Ends Meet) and 5d (for the outcome Leaks).

Note, that the policy variable here and for all subsequent analysis is calculated as the weighted sum of energy policies calculated as per the Bertoldi & Mosconi (2020) weighting described in Table 3.

Focusing first on the share of HHs with arrears in utility bills in Table 5a, we find evidence to suggest that a higher intensity of financial and fiscal policies is associated with a higher share of HHs in Arrears. Policies focused on electricity consumption seem to the driving most of the results.

Table 5b illustrates that a higher intensity of energy policies relating financial and fiscal, information and standards is associated with a reduced share of HHs with the ability to adequately warm their homes. The coefficients on standards have the largest magnitude.

Interestingly, we do not see significant results when we aggregate the policies, suggesting that there may be opposing forces taking place, with some policies counteracting the negative effect of others on the outcome variable. Across most specifications higher electricity prices is associated with a reduced share of households able to adequately warm their homes.

Table 5c presents results on the share of households who have difficulty making ends meet. For this outcome variable we find that energy policy and electricity prices are generally positively related – in both cases an increase in policy intensity or prices is associated with an increased share of households with difficulties. These associations are predominantly driven by policies on energy performance and standards.

In terms of the share of HHs with issues on leaking roofs, Table 5d, we do not see strong evidence to suggest that energy policies increase the share of HHs with these problems. Results suggest strong opposing effects between financial/fiscal and standards-related policies. It is notable that the negative results associated with financial and fiscal policies for this measure is the only time we see policy measures associated with a reduction in energy poverty. Finally, higher electricity prices are generally associated with higher share of HHs with this issue.

5.2.4 Interaction between policies and prices

Thus far, we have been concerned with the average effect of energy policies or prices on the outcome variables. In this subsection, we will try to explore the varying effect of changes in energy policies at different levels of energy prices, or the varying effect of price changes at different levels of energy policy intervention. This section aims to shed further light on the relationship between policies and prices, by examining whether the impact of energy policies is the same regardless of the cost of energy, or whether the underlying energy price is a mediating factor in the impact of policy.

To answer these questions, we augment our estimating equation with an interaction term between energy prices and the energy policy that is being analysed. This interaction term allows us to assess the impact of energy policies at different levels of energy price, and vice-versa. We describe the graphical results, which we presented below in Figures 11a and 11b. All regression tables are in the Appendix.

Interpretation of the estimated results is not obvious. To show the varying effect of electricity price and policies on key outcome variables, we plot the estimated parameters for each energy policy being examined.

In general, the results show that energy policies do not appear to have a strong varying effect on any of the energy poverty outcome variables across different levels of electricity prices, except for the share of HHs with ability to adequately warm their homes (upper right) and those with leaking roofs, etc (bottom right).

In particular, we see that energy policies are negatively associated with the share of HHs with the ability to adequately warm their HHs for areas with sufficiently high electricity prices. This is true for all types of energy policy. Meanwhile, energy policies are positively related to the share of HHs with leaking roofs in areas with sufficiently high electricity prices. This pattern is also seen for policies relating to energy performance and standards, but not in other types of energy policies.

The same pattern applies when we look at the differential effect of electricity prices at varying levels of energy policy. In particular, we see that the impact of increased energy prices is greater when more stringent policies are in place. It is worth noting that the level of significance here at higher levels of energy policy intensity could be driven by a higher number of observations in the upper part of the distribution of energy policies.

5.2.5 Heterogeneity by tenure type

In general, the observed association between increases in electricity prices, the intensity of energy policies and our measures of energy poverty is consistent across renters and owner occupants, regardless of the energy poverty indicators being discussed. However, considerable differences are observed in the magnitude of potential effects between the two groups.

The results are presented in Table 6. Electricity price seems to be more positively associated with the share of HHs with arrears in utility bills for renters than for owner occupants. In particular, a 1% increase in electricity price is associated with a 6% increase in HHs with arrears in utility bills, compared to an approximately 2% increase for owner occupants.

An increase in electricity prices is associated with a lower proportion of both owners and renters with the ability to adequately warm their homes. The effect size is similar in both cases but the estimated is more precise for owner occupiers and is significant at 5% level. The effect of electricity price increases on the share of HHs with great difficulty in making ends meet is greater for owner occupants than for renters, while the magnitude of potential effects of energy policies seems to be fairly consistent across both groups.

We do not see substantial differences between the groups in terms of the potential effect of increases in electricity price and energy policies on the share of HHs with leaking roofs.

5.2.6 Heterogeneity by income

The next set of results, Table 7a, presents heterogeneity by income group. We split households into low (income less than 75% of median, medium (75-200% of median) and high (greater than 200% of median) income groups.

We find that the estimated coefficients for the regressors are generally consistent across income groups (except for the highest income groups) and outcome variables. However, we do observe some differential impact across groups.

While increases in electricity prices and energy policy intensity are associated with an increased share of households with arrears in their utility bills for low- and medium-income households, the result is the opposite for high-income households. However, we should note that none of the estimated effects are statistically different from zero.

Similarly, electricity price and energy policy intensity seem to reduce the share of HHs with adequate warming abilities except those in the higher income groups. Again though, the estimated parameter is not statistically significant.

We observe considerable differences are in the potential effect of electricity price increases and energy policies on the outcome variable Ends Meet, with the low-income groups having the largest (and statistically significant) effect. This result is not significant for medium- or high-income households.

5.2.7 Hetergoneity by income and policy type

Thus far, the quantitative exercises previously performed all point to the potential regressive effects of increasing electricity prices and implementing more stringent/aggressive energy policies. By regressive we mean that policies seem to have adversely impacted measures of energy poverty. In this section, we want to dig deeper as to how regressive these policies are by looking at the varying effects each energy policy at different proportions of policies targeting to benefit low income groups. One hypothesis could be that the regressive effects of policies could be tempered by the share of policies directly targeting low income households.

To do this, we augment our initial estimating equation with an interaction term between our energy policy metric and the proportion of policies targeting low income HHs. Results are presented in Table 7b.

In general, there are indications that increased proportion of policies targeted to low income HHs could result in a decline in share of HHs suffering from some energy poverty indicators. This is true for the share of HHs with leaking roofs and the share of households with arrears. In these cases, more policies for low-income groups seem to temper the regressive nature of energy policies. However, none of these estimates are statistically significant and need to be treated with a degree of caution as a result

In contrast, an increased proportion of policies targeted to low income HHs seems to have the opposite effect for the outcome variables Warm and Ends Meet. This effect is consistent across income groups but greater for low income households. These results suggest that these measures of energy poverty are exacerbated by a greater proportion of policies targeting low income groups.

5.2.8 Heterogeneity by country

Finally, we provide additional analyses to examine potential differences in the effect of energy prices and policies on the key outcome variables. To do this, we run the model on each country separately (but not incorporating country-specific effects obviously). Note also that these estimates are estimated imprecisely due to low number of observations, suggesting we should exercise a degree of caution when interpreting the results. Notwithstanding, we observe significant variations in the estimated elasticities across countries. We plot these estimates against the distribution of average electricity prices to see if we can observe significant patterns. The broad trend across all outcomes is that in countries with higher underlying energy prices we observe a positive and increasing relationship between policies, prices and energy poverty. In countries with lower prices, this impact may be zero or negative. This result would suggest again that the regressive impact of prices and policies is exacerbated by high underlying prices.

6. Discussion

We examine four measures of self-reported energy poverty. Results show that a one percent increase in electricity prices is associated with a 2.3 percent increase in households with arrears on their utility bills (though not statistically significant), a 6.3 percent reduction in households able to adequately warm their homes, a 3.4 percent increase in households struggling to make ends meet and a 4.3 percent increase in the households with leaky or damp homes. The signs on our control variables, income, dwelling size and share of owned properties are all intuitive and in line with expectations.

We find that both the count of policies implemented in a country and the policy intensity, as measured by the expected quantitative impact of the policy has a statistically significant impact on energy poverty. More specifically 1 percent increase in the number of policies in place is associated with a 1.4 percent increase in households in arrears and a 1.2 percent increase in the households struggling to make ends meet. Policies also impact the share of households with the ability to warm their home and the share reporting a leaky or damp home but these results are not statistically significant. While not all statistically significant, the striking feature about our results is that policies appear to be adversely associated with all measures of energy poverty.

To further understand these results we create a variable to capture policy intensity and disaggregate by the type of policy, financial and fiscal, information and energy performance standards. Different policy categories have different impacts but broadly speaking energy performance standards have the strongest adverse association with self-reported measures of energy poverty. We also disaggregate by policies targeting heating, electricity and all fuel consumption, and results seem to generally support our overall findings.

It is not entirely surprising that some standards can lead to this sort of effect, since they can be thought of as implicit taxes. However, correctly targeted fiscal and financial tools should make it cheaper to adopt energy-saving technologies, and further research should uncover why some of those instruments fail. It should be noted that there is convincing evidence, mainly from US studies, that imprecise targeting of subsidies can be welfare-reducing (Allcott et. al, 2015; Allcott & Greenstone, 2017). The non-monetary costs of enrolling in energy efficiency programs can be substantial and can act as a disincentive, in particular to low-income households (Fowlie et. al, 2015).

When we examine the varying impact of policies with underlying changes in prices, we find that in particular, energy policies are negatively associated with measures of energy poverty for areas with sufficiently high electricity prices.

The results are consistent in terms of direction, for both renters and owner-occupiers, but do change in magnitude. Similarly, we find that the results are broadly consistent across income groups in terms of direction, but do change in magnitude.

When we examine the impact of the share of policies targeted at low income households, we find that this potentially mediates the impact of policies and may reduce some of the adverse associations we observe. These results are not statistically significant though. In other cases the adverse impact appears more pronounced and satisfy statistical significance.

We acknowledge that these results may appear counter-intuitive and certainly there are limitations with this analysis. In particular, analysis at an aggregate country-level may mask important variation within individual countries. The use of self-reported measures, while allowing a comparison across countries does not allow for an objective assessment of energy poverty.

We cannot say that we present evidence of a causal relationship between increased number or intensity of energy policies and an increase in energy poverty. While our estimation procedure takes into account a number of potentially confounding unobserved country- and year-specific effects, it is possible that the method employed may not capture the bias associated with the endogeneity of the policy variable. For example, countries that have more energy poverty-related issues may implement more measures to address them, which can then make our estimates too large compared to the true value of the parameter of interest. One way to deal with this issue is to use an instrumental variable that is strongly correlated with energy policy variables but does not affect our energy poverty measures except through the policies of interest. In reality, however, it is extremely difficult to find country-specific variables that satisfy these requirements. Another way to deal with the endogeneity issue is to use dynamic panel estimators such as the system Generalized Method of Moments (Arellano and Bover, 1995). This procedure is, however, complicated and can easily generate invalid estimates, thus bringing in more problems that solutions (Roodman, 2009).

Our estimation procedure also remains silent on the potential role of social policies (e.g., unemployment benefits, income supports etc.) in addressing energy poverty. For one, they can indirectly affect energy poverty by increasing poor households' disposable income.
Despite these limitations, it is worth noting that the models are well estimated, include country and time fixed effects to control for a range of unobserved factors that may confound results. The coefficients on our control variables are broadly as one would expect. And the direction of our results is consistent across four measures of energy poverty and to different sample disaggregations. Further analysis is beyond the scope of this report, but we would argue is warranted on the basis of our results.

Table 5a: Econometric Results: Baseline Specifications

Variable	Model 1 OLS		Model 2 Fractional Logit		Model 3 OLS		Model 4 OLS	
	Arrears	Warm	Arrears	Warm	Arrears	Warm	Arrears	Warm
Log(average electricity price, Euro/kWh)	-0.062***	0.117**	-0.059***	0.117***	0.003	-0.050	0.023	-0.063*
	(0.02)	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.03)
Policies, low income HHs	0.007***	-0.009***	0.007***	-0.009***	0.001	0.000	0.001	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Policies, all	-0.012**	0.037***	-0.012**	0.037***	0.018***	0.010	0.014**	-0.008
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Average disposable Income, in Euro	-0.005	-0.010***	-0.003	-0.008***	-0.086***	0.119***	-0.093***	0.104***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.03)	(0.03)	(0.03)
Average number of rooms	-0.087***	0.069**	-0.068***	0.032	0.054*	-0.083*	0.015	-0.080*
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	(0.05)
Share, owned properties	0.178***	-0.302***	0.178***	-0.299***	-0.153**	0.021	-0.192***	0.125
	(0.04)	(0.06)	(0.04)	(0.06)	(0.06)	(0.08)	(0.06)	(0.09)
Constant	0.059	1.210***						
	(0.05)	(0.09)						
Counry-specific effects	No	No	No	No	Yes	Yes	Yes	Yes
Year-specific effects	No	No	No	No	No	No	Yes	Yes
Observations	312	312	312	312	312	312	312	312
R sq (adj.)	0.417	0.251			0.900	0.912	0.920	0.916

Table 4b: Econometric Results: Different Energy Poverty Indicators

Variable	Arrears	Warm	Ends Meet	Leak
Log(average electricity price, Euro/kWh)	0.023	-0.063*	0.034*	0.043*
	(0.02)	(0.03)	(0.02)	(0.02)
Policies, low income HHs	0.001	-0.000	0.000	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Policies, all	0.014**	-0.008	0.012*	0.002
	(0.01)	(0.01)	(0.01)	(0.01)
Average disposable Income, in Euro	-0.093***	0.104***	-0.114***	-0.007
	(0.03)	(0.03)	(0.02)	(0.02)
Average number of rooms	0.015	-0.080*	0.030	-0.047
	(0.03)	(0.05)	(0.03)	(0.04)
Share, owned properties	-0.192***	0.125	-0.195***	-0.169**
	(0.06)	(0.09)	(0.06)	(0.07)
Country-specific effects	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes
Observations	312	312	312	312
R sq (adj.)	0.920	0.916	0.948	0.846

Table 6a: Econometric Results (Policy Heterogeneity, Dependent Variable : Arrears)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Energy Policy	0.005	0.006**	0.006*	0.001	-0.001	0.004	-0.005	0.002	0.005	-0.001	0.001	0.007
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Log(average electricity price, Euro/kWh)	0.040**	0.015	0.028	0.001	0.024	0.038	0.033	0.026	0.031	0.026	0.023	0.025
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average disposable Income, in Euro	-0.141***	-0.086***	-0.084***	-0.121***	-0.098***	-0.144***	-0.126***	-0.098***	-0.097***	-0.111***	-0.097***	-0.095***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Average number of rooms	0.007	0.010	0.006	-0.026	0.020	0.026	0.011	0.021	0.021	0.015	0.021	0.020
	(0.03)	(0.02)	(0.03)	(0.06)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Share, owned properties	-0.170**	-0.177***	-0.195***	-0.309***	-0.176***	-0.091	-0.196***	-0.176***	-0.145**	-0.195***	-0.172***	-0.174***
	(0.07)	(0.05)	(0.07)	(0.09)	(0.06)	(0.11)	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Country-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.931	0.920	0.932	0.937	0.918	0.911	0.927	0.918	0.918	0.931	0.918	0.919

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table 5b: Econometric Results : (Policy Heterogeneity, Dependent Variable : Warm)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Energy Policy	0.003	-0.006*	0.003	-0.000	-0.005	-0.011***	-0.022*	-0.003	-0.010**	-0.008	-0.000	-0.004
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
Log(average electricity price, Euro/kWh)	-0.041	-0.045	-0.061*	0.039	-0.051	-0.014	-0.032	-0.057	-0.053	-0.065*	-0.054	-0.064*
	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)
Average disposable Income, in Euro	0.120***	0.085**	0.138***	0.019	0.099***	0.101***	0.104**	0.098***	0.102***	0.101**	0.098***	0.105***
	(0.02)	(0.04)	(0.03)	(0.06)	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
Average number of rooms	-0.058	-0.061	-0.115**	-0.077	-0.079	-0.072	-0.145***	-0.072	-0.095*	-0.100**	-0.073	-0.082*
	(0.04)	(0.05)	(0.05)	(0.08)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Share, owned properties	0.051	0.217***	0.009	0.367**	0.195**	0.027	0.155*	0.216***	0.130	0.123	0.211***	0.115
	(0.07)	(0.08)	(0.07)	(0.18)	(0.08)	(0.09)	(0.09)	(0.08)	(0.08)	(0.10)	(0.08)	(0.09)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.929	0.911	0.934	0.943	0.911	0.939	0.925	0.910	0.917	0.918	0.910	0.916

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table 5c: Econometric Results (Policy Heterogeneity, Dependant Variable : End Meet)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Energy Policy	0.002	0.006**	0.003	0.004	-0.001	0.004	0.005	0.003*	0.010***	0.005	0.003	0.011**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log(average electricity price, Euro/kWh)	0.014	0.030	0.025	-0.008	0.040**	0.015	0.044*	0.041**	0.043**	0.033*	0.038**	0.037*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average disposable Income, in Euro	-0.157***	-0.107***	-0.109***	-0.144***	-0.119***	-0.159***	-0.120***	-0.120***	-0.116***	-0.122***	-0.117***	-0.113***
	(0.03)	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average number of rooms	0.018	0.020	0.019	0.094	0.031	0.037	0.032	0.031	0.039	0.037	0.028	0.032
	(0.03)	(0.03)	(0.03)	(0.07)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Share, owned properties	-0.190***	-0.216***	-0.158**	-0.179	-0.215***	-0.084	-0.170***	-0.216***	-0.165***	-0.228***	-0.211***	-0.191***
	(0.06)	(0.05)	(0.07)	(0.12)	(0.05)	(0.10)	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.941	0.949	0.957	0.953	0.947	0.953	0.946	0.948	0.948	0.946	0.948	0.949

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table 5d Econometric Results (Policy Heterogeniety, Dependant Variable : Leak)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Energy Policy	-0.006*	-0.003	-0.008**	0.015**	0.002	0.005	0.023**	0.001	0.012**	0.009	0.001	0.005
	(0.00)	(0.00)	(0.00)	(0.01)	(0.0)	(0.0)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Log(average electricity price, Euro/kWh)	0.041**	0.066***	0.042**	0.016	0.060**	0.020	0.014	0.063**	0.036	0.043*	0.062**	0.045**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average disposable Income, in Euro	-0.014	-0.023	-0.045**	0.024	-0.017	-0.000	0.001	-0.017	-0.000	-0.001	-0.016	-0.006
	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average number of rooms	-0.087***	-0.034	-0.028	0.008	-0.037	-0.045	-0.027	-0.040	-0.030	-0.067*	-0.042	-0.041
	(0.03)	(0.04)	(0.04)	(0.08)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Share, owned properties	0.003	-0.383***	-0.046	-0.109	-0.378**	-0.133	-0.228***	-0.388***	-0.186***	-0.175**	-0.387***	-0.176**
	(0.06)	(0.15)	(0.07)	(0.12)	(0.15)	(0.09)	(0.07)	(0.15)	(0.07)	(0.08)	(0.15)	(0.07)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.929	0.830	0.863	0.945	0.829	0.904	0.863	0.829	0.850	0.865	0.829	0.847

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Figure 11a : Estimated elasticities of energy policies at varying electricity prices, by energy policy (all)

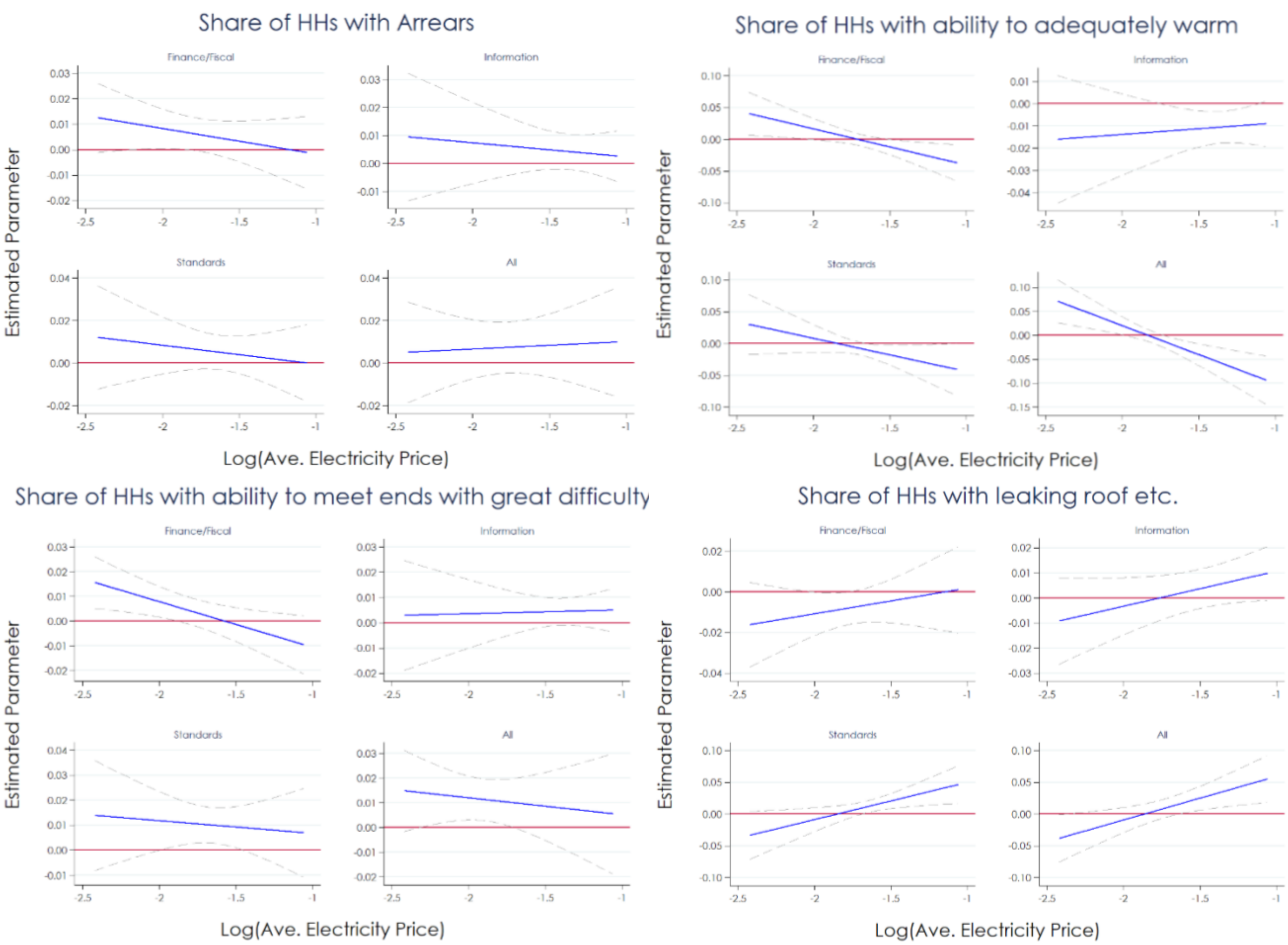


Figure 11b : Estimated electricity price elasticities of varying energy policies

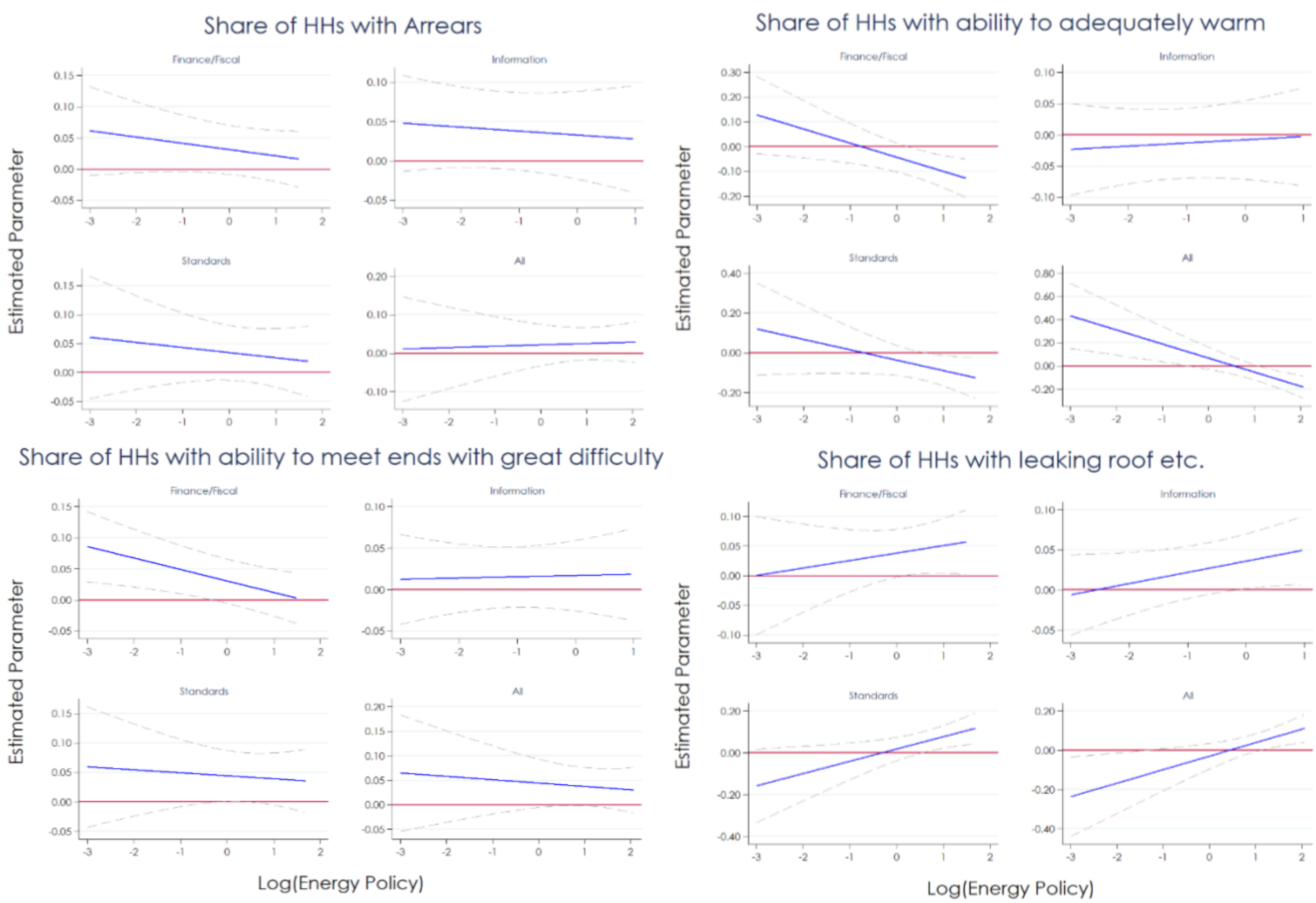


Table 7 : Econometric Results (Renters versus Owners Occupants)

Variable	Sample / Parameter Estimate and t-statistic / Dependent Variable			
	Renter		Owned	
	Estimate	t	Estimate	t
	Share of HHs with Arrears in Utility			
Log (electricity price)	**0.059**	**2.024**	0.017	0.808
Log (energy policy, all)	0.008	1.104	0.006	1.058
	Share of HHs with ability to adequately warm			
Log (electricity price)	-0.057	-1.452	**-0.065**	**-1.971**
Log (energy policy, all)	-0.009	-1.146	-0.003	-0.514
	Share of HHs with ability to meet ends with great difficulty			
Log (electricity price)	0.016	0.685	**0.041**	**2.029**
Log (energy policy, all)	**0.012**	**2.322**	**0.009**	**2.027**
	Share of HHs with leaking roofs, etc.			
Log (electricity price)	0.038	1.211	**0.045**	**2.114**
Log (energy policy, all)	0.003	0.393	0.003	0.537

Notes: Each regression has the usual controls but not shown for brevity. Figures in bold are significant at 5% level.

Table 8a: Econometric Results (HHs in different income groups)

Variable	Sample / Parameter Estimate and t-statistic / Dependent Variable					
	income<75%		200% > income >75%		income >200%	
	Est	t	Est	t	Est	t
	Share of HHs with Arrears in Utility					
Log (electricity price)	0.062	1.887	0.015	0.705	0.013	0.713
Log (energy policy, all)	0.006	0.853	0.007	0.959	-0.003	-1.279
	Share of HHs with ability to adequately warm					
Log (electricity price)	-0.079	-1.880	-0.063	-1.801	**-0.050**	**-1.969**
Log (energy policy, all)	-0.006	-0.805	-0.003	-0.520	0.002	0.413
	Share of HHs with ability to meet ends with great difficulty					
Log (electricity price)	**0.099**	**2.762**	0.022	1.203	0.008	0.500
Log (energy policy, all)	**0.012**	**1.961**	0.008	1.933	**0.010**	**2.248**
	Share of HHs with leaking roofs, etc.					
Log (electricity price)	0.052	1.785	**0.053**	**2.248**	**0.040**	**2.455**
Log (energy policy, all)	0.004	0.348	0.003	0.631	0.001	0.325

Notes: Each regression has the usual controls but not shown for brevity. Figures in bold are significant at 5% level.

Table 7b : Econometric Results (Interaction between energy policies and HHs across income groups

Variable	Sample / Parameter Estimate and t-statistic / Dependent Variable							
	income<75%		200% > income >75%		income >200%		All HHs	
	Est	t	Est	t	Est	t	Est	t
	Share of HHs with Arrears in Utility							
Log (energy policy, all)	0.010	0.949	0.000	0.074	-0.002	-1.097	0.002	0.589
Proportion for LIH	0.018	0.529	0.018	0.454	0.012	0.702	0.031	0.786
interaction term	-0.038	-1.670	**0.081**	**4.291**	0.016	1.013	**0.059**	**3.042**
	Share of HHs with ability to adequately warm							
Log (energy policy, all)	-0.001	-0.156	0.004	0.721	0.004	0.943	0.002	0.403
Proportion for LIH	-0.010	-0.213	-0.017	-0.412	-0.033	-1.672	-0.014	-0.367
interaction term	**-0.078**	**-3.009**	**-0.071**	**-3.372**	**-0.036**	**-2.954**	**-0.072**	**-3.401**
	Share of HHs with ability to meet ends with great difficulty							
Log (energy policy, all)	**0.013**	**1.975**	0.005	1.488	0.007	1.869	0.007	1.765
Proportion for LIH	0.071	1.429	0.039	1.119	-0.009	-0.346	0.045	1.248
interaction term	**0.049**	**2.005**	**0.055**	**3.444**	0.021	1.555	**0.053**	**3.124**
	Share of HHs with leaking roofs, etc.							
Log (energy policy, all)	0.010	0.949	0.006	1.357	0.003	0.907	0.007	1.247
Proportion for LIH	0.018	0.529	0.022	0.849	0.005	0.212	0.021	0.813
interaction term	-0.038	-1.670	-0.010	-0.710	-0.011	-0.974	-0.016	-1.010

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7. Data Appendix

Table A1: Summary statistics for all variables in dataset

Variables	N	Mean	SD
Share, ability to meet, great difficulty	340	0.114	0.091
Share, ability to meet, difficulty	340	0.172	0.102
Share, ability to meet, some difficulty	340	0.278	0.115
Share, ability to meet, fairly easily	340	0.230	0.101
Share, ability to meet, easily	340	0.144	0.125
Share, ability to meet, very easily	339	0.061	0.076
Share, dwelling, detached house	337	0.412	0.156
Share, dwelling, semi-detached house	337	0.191	0.164
Share, dwelling, apartment < 10	337	0.140	0.111
Share, dwelling, apartment >= 10	337	0.257	0.144
Share, HH type, one person	340	0.251	0.055
Share, HH type, 2 adults, 0 dependent, both < 65	340	0.154	0.035
Share, HH type, 2 adults, 0 dependent, at least 1 < 65	340	0.156	0.029
Share, HH type, other, with dependent children	340	0.093	0.046
Share, HH type, 1 parent, 1 or more dependents	340	0.040	0.015
Share, HH type, 2 adults, 1 dependent	340	0.091	0.016
Share, HH type, 2 adults, 2 dependents	340	0.104	0.026
Share, HH type, 2 adults, 3 or more dependents	340	0.041	0.021
Share, HH type, other, with dependent children	340	0.068	0.041
Share, HH type, others	198	0.005	0.007
Share, HH with mortgage arrears	340	0.100	0.084
Share, HH with utility arrears	340	0.092	0.080

Share, capacity for 1 week holiday	340	0.626	0.217
Share, capacity for a meal	340	0.888	0.110
Share, capacity to face unexpected financial expenses	340	0.623	0.169
Share, own, telephone	331	0.975	0.037
Share, own, TV	332	0.977	0.015
Share, own, PC	340	0.693	0.165
Share, own, washing machine	333	0.947	0.066
Share, own, car	339	0.727	0.158
Share, ability to keep home adequately warm	340	0.886	0.123
Share, with problem: too dark	340	0.062	0.024
Share, with problem: noise from neighbours	340	0.172	0.056
Share, with problem: environmental	340	0.139	0.066
Share, with problem: crimes	340	0.120	0.050
Share, tenure: owner	340	0.760	0.118
Share, with bath or shower	336	0.959	0.083
Share, with indoor flushing toilet	336	0.951	0.093
Share, overcrowded household	324	0.141	0.127
Share, Disposable income < at risk of poverty threshold	340	0.168	0.059
Average disposable income	340	29627.587	19006.067
Average disposable income before transfers, excl old -age	340	26759.720	16978.036
Average disposable income before transfers, inc old -age	340	20611.468	14007.607
Average monthly rent, imputed, net	198	3035.938	2534.700
Average monthly rent, imputed, gross	325	3676.598	2874.411
Average number of rooms	337	3.856	0.764
Average monthly rent, current	340	362.144	263.765

Average monthly rent, subjective, in national currency	168	578.713	778.029
Average household size	340	1.696	0.117
Average disposable income, equivalised, in 2015 Euro	340	13581.593	11535.599
Average monthly rent, current, in 2015 Euro	340	275.326	265.263
Number of policies, financial/fiscal: elec & light	330	0.464	1.225
Number of policies, financial/fiscal: heat, cool & water	330	1.973	2.043
Number of policies, financial/fiscal: total final & fuel	330	2.327	2.207
Number of policies, information: elec & light	330	0.433	0.659
Number of policies, information: heat, cool & water	330	0.473	0.826
Number of policies, information: total final & fuel	330	1.112	1.593
Number of policies, standards: elec & light	330	1.061	1.263
Number of policies, standards: heat, cool & water	330	2.194	2.051
Number of policies, standards: total final & fuel	330	1.930	1.863
Number of policies: Total targeted to low income	330	0.548	1.031
Number of policies: Total	330	9.394	5.482
Average gas prices, Euro/kWh	271	0.068	0.021
Average electricity prices, Euro/kWh	324	0.189	0.055
No of countries	32		
Period covered	2007-2017		

Source : EU-SILC, MURE and Eurostat

Figure A1: Distribution of Key Variables

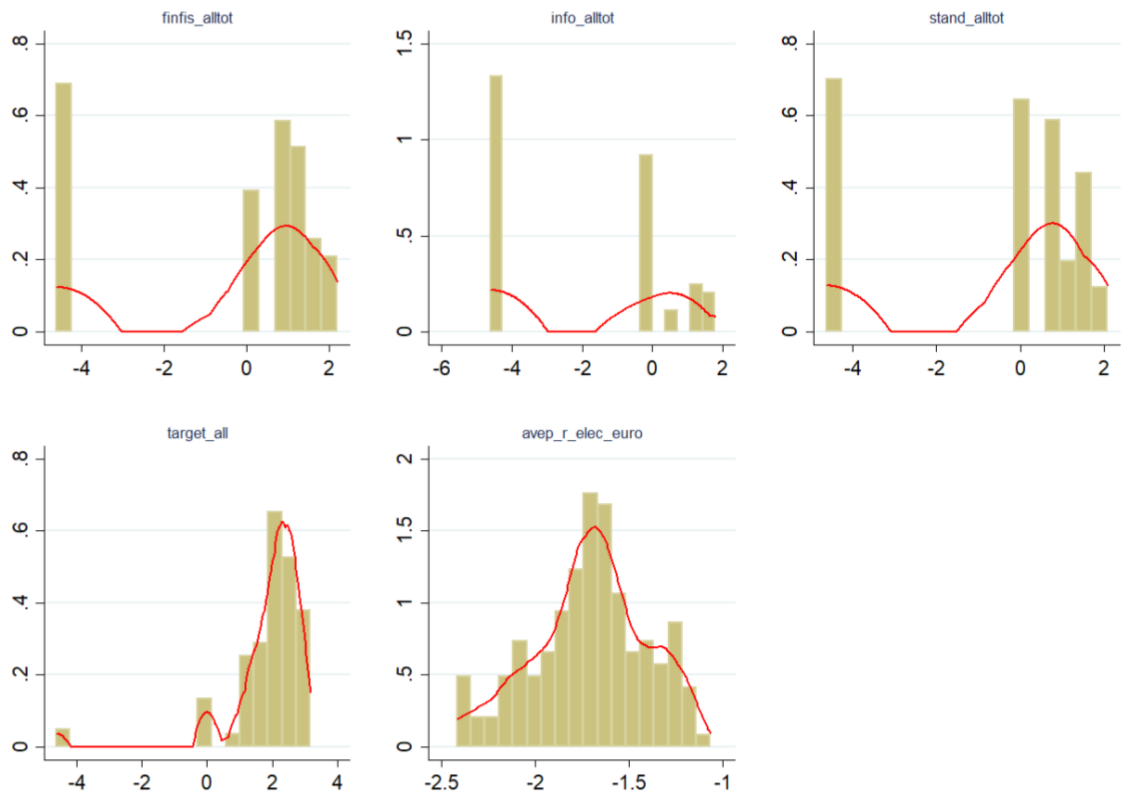


Table A2a: Econometric Results (Interaction between Price and Policy, Dependent variable: Arrears)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Log(average electricity price, Euro/kWh)	0.031	0.014	0.031	-0.071*	0.011	0.033	0.033	0.020	0.034	0.035	0.015	0.022
	(0.02)	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Energy Policy	-0.036	0.005	-0.012	-0.047**	-0.008	-0.003	-0.006	-0.000	-0.009	-0.043	-0.007	0.014
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.02)	(0.03)	(0.01)	(0.03)
Interaction (policy * price)	-0.022*	-0.000	-0.010	-0.039**	-0.004	-0.005	-0.001	-0.002	-0.009	-0.024	-0.005	0.004
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Average disposable Income, in Euro	-0.143***	-0.086***	-0.087***	-0.125***	-0.098***	-0.144***	-0.126***	-0.099***	-0.099***	-0.114***	-0.097***	-0.094***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Average number of rooms	0.001	0.010	-0.002	-0.008	0.018	0.024	0.011	0.019	0.017	0.003	0.011	0.022
	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Share, owned properties	-0.146**	-0.177***	-0.187**	-0.317***	-0.172***	-0.101	-0.197***	-0.179***	-0.151**	-0.209***	-0.170***	-0.173***
	(0.07)	(0.05)	(0.07)	(0.09)	(0.06)	(0.11)	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.931	0.920	0.932	0.939	0.917	0.911	0.927	0.918	0.918	0.931	0.917	0.919

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table A2b: Econometric Results (Interaction between Price and Policy, Dependent variable: Warm)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Log(average electricity price, Euro/kWh)	-0.035	-0.048	-0.043	0.191**	-0.048	-0.008	-0.047	-0.049	-0.038	-0.047	-0.060	0.068
	(0.03)	(0.05)	(0.03)	(0.08)	(0.05)	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)
Energy Policy	0.033	-0.007	-0.098**	0.101***	-0.004	-0.004	-0.151***	0.002	-0.096*	-0.089*	-0.006	-0.222***
	(0.03)	(0.01)	(0.04)	(0.04)	(0.01)	(0.02)	(0.05)	(0.02)	(0.06)	(0.05)	(0.02)	(0.06)
Interaction (policy * price)	0.016	-0.001	-0.057**	0.081***	0.001	0.005	-0.075***	0.003	-0.052	-0.046	-0.004	-0.121***
	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)	(0.03)
Average disposable Income, in Euro	0.122***	0.085**	0.122***	0.027	0.099***	0.101***	0.111***	0.098***	0.091**	0.096**	0.098***	0.081***
	(0.03)	(0.04)	(0.03)	(0.06)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Average number of rooms	-0.054	-0.063	-0.159***	-0.115	-0.079	-0.070	-0.191***	-0.069	-0.116**	-0.124**	-0.080	-0.165***
	(0.04)	(0.05)	(0.05)	(0.08)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Share, owned properties	0.034	0.217***	0.052	0.385**	0.195**	0.037	0.089	0.220***	0.100	0.096	0.213***	0.091
	(0.07)	(0.08)	(0.07)	(0.17)	(0.08)	(0.10)	(0.09)	(0.07)	(0.08)	(0.09)	(0.08)	(0.07)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.928	0.911	0.937	0.947	0.910	0.938	0.929	0.910	0.919	0.918	0.910	0.924

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table A2c: Econometric Results (Interaction between Price and Policy, Dependent variable: Ends Meet)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Log(average electricity price, Euro/kWh)	-0.004	-0.010	0.030*	-0.078	-0.009	0.017	0.047**	0.034	0.044**	0.036*	0.022	0.044*
	(0.02)	(0.03)	(0.02)	(0.05)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Energy Policy	-0.084***	-0.016	-0.029**	-0.043	-0.025***	0.007	0.030	-0.001	0.002	-0.009	-0.013	-0.002
	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.03)
Interaction (policy * price)	-0.046***	-0.013**	-0.018**	-0.037	-0.015**	0.001	0.015	-0.002	-0.005	-0.008	-0.009**	-0.007
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)
Average disposable Income, in Euro	-0.162***	-0.107***	-0.114***	-0.147***	-0.118***	-0.159***	-0.121***	-0.120***	-0.117***	-0.122***	-0.117***	-0.115***
	(0.03)	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average number of rooms	0.006	-0.007	0.005	0.111	0.020	0.038	0.041	0.029	0.037	0.033	0.009	0.028
	(0.03)	(0.03)	(0.03)	(0.08)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Share, owned properties	-0.141**	-0.209***	-0.144**	-0.187	-0.200***	-0.082	-0.157***	-0.219***	-0.168***	-0.233***	-0.207***	-0.193***
	(0.07)	(0.05)	(0.07)	(0.12)	(0.05)	(0.11)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.943	0.950	0.957	0.953	0.949	0.953	0.947	0.948	0.948	0.946	0.948	0.949

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology).

Table A2d: Econometric Results (Interaction between Price and Policy, Dependent variable: Leak)

Variable	Financial and Fiscal			Information			Energy Performance and Standards			All Policies		
	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All	Heat	Elec	All
Log(average electricity price, Euro/kWh)	-0.004	-0.010	0.030*	-0.078	-0.009	0.017	0.047**	0.034	0.044**	0.036*	0.022	0.044*
	(0.02)	(0.03)	(0.02)	(0.05)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Energy Policy	-0.084***	-0.016	-0.029**	-0.043	-0.025***	0.007	0.030	-0.001	0.002	-0.009	-0.013	-0.002
	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.03)
Interaction (policy * price)	-0.046***	-0.013**	-0.018**	-0.037	-0.015**	0.001	0.015	-0.002	-0.005	-0.008	-0.009**	-0.007
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)
Average disposable Income, in Euro	-0.162***	-0.107***	-0.114***	-0.147***	-0.118***	-0.159***	-0.121***	-0.120***	-0.117***	-0.122***	-0.117***	-0.115***
	(0.03)	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Average number of rooms	0.006	-0.007	0.005	0.111	0.020	0.038	0.041	0.029	0.037	0.033	0.009	0.028
	(0.03)	(0.03)	(0.03)	(0.08)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Share, owned properties	-0.141**	-0.209***	-0.144**	-0.187	-0.200***	-0.082	-0.157***	-0.219***	-0.168***	-0.233***	-0.207***	-0.193***
	(0.07)	(0.05)	(0.07)	(0.12)	(0.05)	(0.11)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
Counry-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	213	316	283	100	316	240	246	316	305	281	316	312
R sq (adj.)	0.943	0.950	0.957	0.953	0.949	0.953	0.947	0.948	0.948	0.946	0.948	0.949

Note: Energy Policy is policy intensity (i.e. weighted following Bertoldi methodology)

Figure 11a. Estimate electricity price elasticities in different countries, by outcome variable

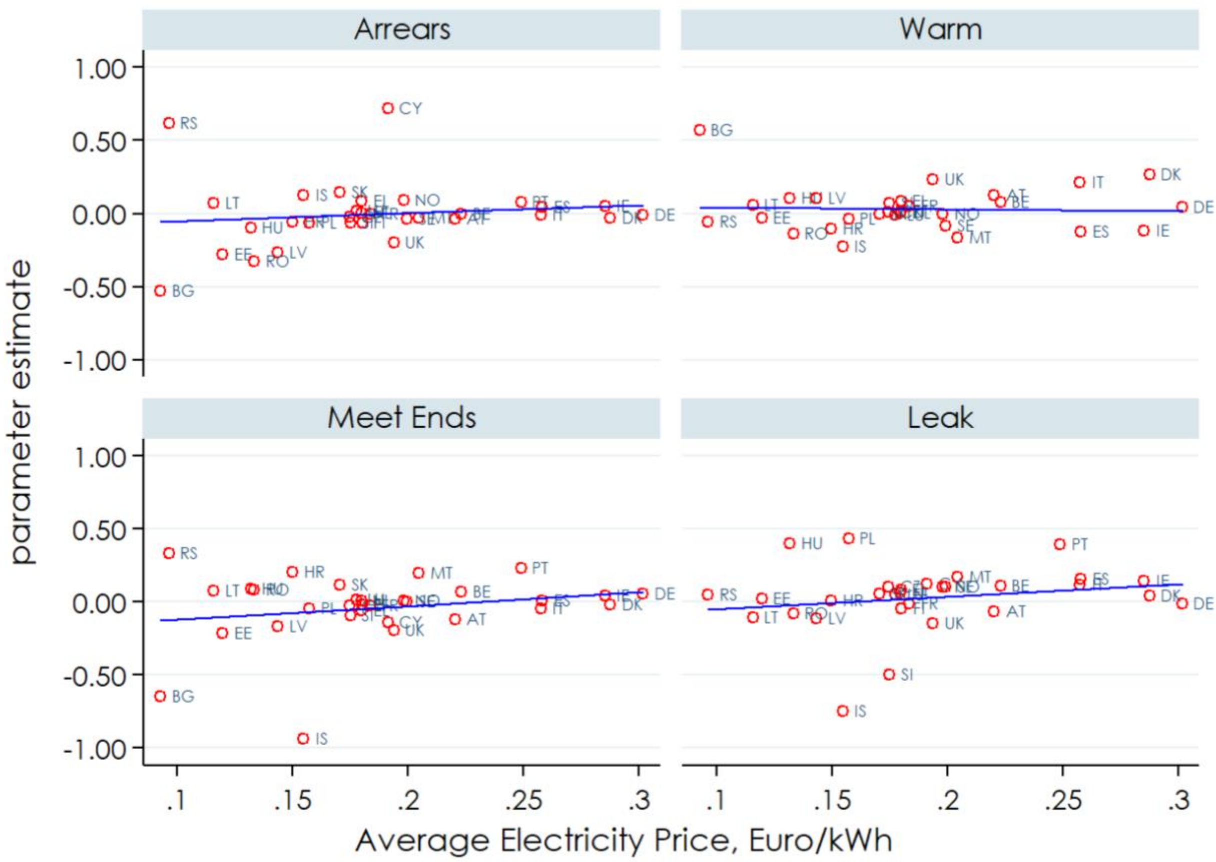
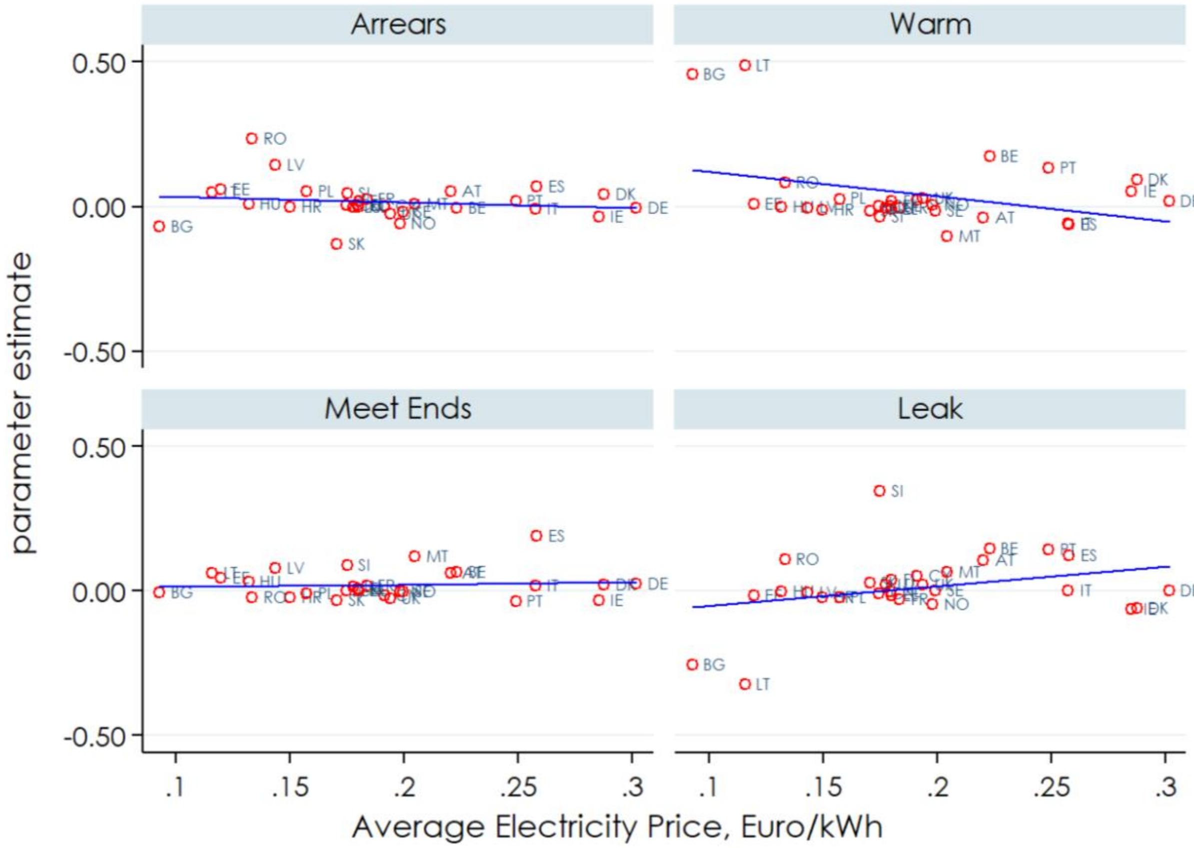


Figure 11b. Estimate elasticities of energy policies in different countries, by outcome variable



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