The effect of regional factors on energy poverty

Elisenda Jové-Llopis* and Elisa Trujillo-Baute~

*Department of Economics, Chair of Energy Sustainability and Barcelona Institute of Economics (IEB), Universitat de Barcelona, Spain. Corresponding author. E-mail: elisenda.jove@ub.edu

~ Serra Hunter Fellow, Department of Economics and Business, University of Lleida, and Chair of Energy Sustainability (IEB-UB), Spain.

OVERVIEW

The EU has been encouraging the reduction of energy poverty and protecting vulnerable consumers, through specific policies, measures and recommendations designed to achieve a significant curtailment to a problem that already affects more than 40 million people in the EU (European Commission, 2023). Although the energy poverty is not an entirely new concept (see, for example, the pioneering contribution of Boardman (1991)), the first EU-wide definition has not been published until 2023 through the Directive (EU) 2023/1791 on energy efficiency. This late standard on its definition across the EU reveals the complexity of the phenomenon and the high policy integration efforts around social, energy, health and climate policies (Vandyck *et al.*, 2023). According to this Directive, energy poverty is understood as “a household’s lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes”.

An overview of the field reveals that energy poverty is an unevenly distributed phenomenon that asymmetrically concerns social groups and strongly depends on the spatial context (Bardazzi *et al.*, 2021; Guevara *et al.*, 2023; Stojilovska *et al.*, 2022). While the academic literature has abandoned the idea of considering energy poor households as a homogeneous group to give special recognition on identifying which social groups and members of a household are most intensely affected by energy poverty –gender, children, pensioner, disable people, etc. (González-Pijuan *et al.*, 2023; Ivanova and Middlemiss, 2021), the links between energy poverty and geographic dimension still remain largely neglected by previous scientific studies despite its relevance in the policy initiatives (EPAH, 2022; Mashhoodi *et al.*, 2019). Tackling energy poverty is a complex process, since it implies the need to coordinate multiple policy areas (Stojilovska *et al.*, 2022), and involve a wide range of agents (Creutzfeldt *et al.*, 2020). In fact, the latest Commission Recommendation on energy poverty[1] emphasis the need to work on effective cooperation of all stakeholders in all areas of action, across national, regional, and local government structures, implying that energy policy occurs also at different levels (national, regional, or local level).

Despite having recognized the importance of the regional dimension in the governance of energy poverty (Bouzarovski and Simcock, 2017), the most common approach employed by previous studies so far has been to consider that the determinants of

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302407

energy poverty are common at the country level, ignoring the possibility that some of the characteristics of the regions may not be generalizable and, therefore, must be addressed by policies at the local level. There continues to be a lack of knowledge, both in academic literature and in public policy documents about the spatial aspects of energy poverty in the transition towards a just energy model (Bardazzi *et al.*, 2021; Okushima, 2019; Robinson *et al.*, 2018). This can be explained both by the fact that the energy poverty is a complex concept with a nascent debate on public policies (Guevara *et al.*, 2023; Stojilovska *et al.*, 2022), and by the lack of official statistical data, not only in terms of disaggregation at the level space, but also regarding the continuity and updating of this data (EPAH, 2022).

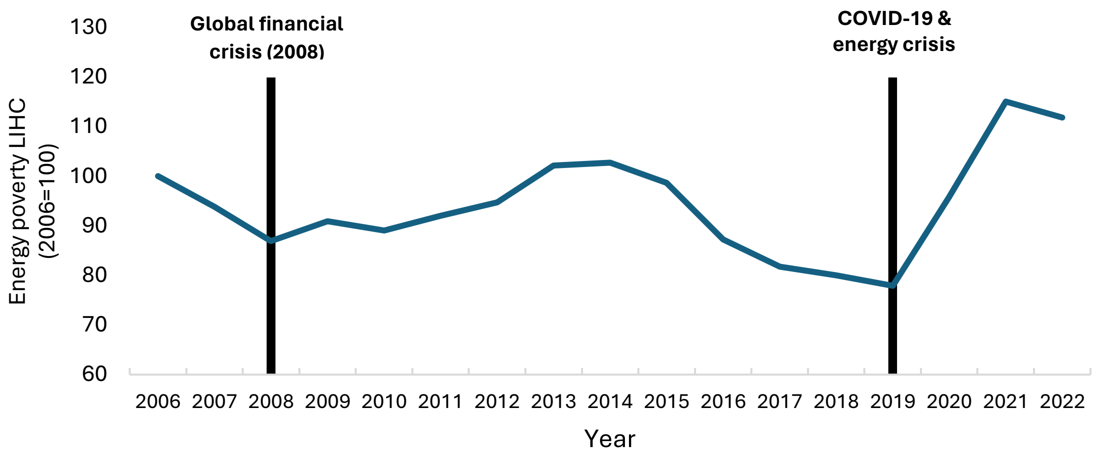
This is an important shortcoming since, as we have already stated, energy poverty instruments should be also designed and implemented at the regional level. Against this background, this study aims to analyse the spatial distribution of energy poverty at the regional level, which we believe helps greatly to policy makers to improve the scope of energy poverty strategies. Specially, data from the Spanish Household Budget Survey (HBS) for the period 2006–2022, provides the opportunity to investigate the following research questions: Does the geographic dimension affect the probability of being energy poor? Are similar or different the main drivers associated of being energy poor in different regions?

DATA AND STATISTICAL ANALYSIS

The database used in this study is drawn mainly on the Household Budget Survey (HBS) for Spain. The HBS is carried out by the National Statistics Institute annually and contains detailed *information* about consumer spending in approximately 24,000 Spanish households per year. Specifically, the database used in the empirical analysis is made up of a total of 329,653 Spanish households – 20,603 per year on average- and covers the period 2006-2022. We use the Low-Income High-Cost indicator (LIHC) to measure the energy poverty in our sample. Accordingly, a household is defined as energy poor if its energy costs are above the national median level and the residual income, after energy expenditures, is below the 60% median residual income (poverty line).

Based on the data described, here we analyse the trends and main regional characteristics of the energy poverty in Spain. A number of features stand out when considering the evolution of the problem over the past two decades (see Figure 1). Firstly, the intensity of energy poverty varied significantly during the period, with positive and negative fluctuations in the order of up to 20% with respect to the first year in the sample. Secondly, fluctuations are related to the economic cycle, with the two recent crises breaking the positive trajectory of lower energy poverty rates, where important differences exist depending on the crisis nature. While the global financial crisis led to a rebound of 15% in the energy poverty intensity with respect to the pre-crisis level, more recently, the crisis linked to COVID-19 and energy prices, led to a rebound of almost 40% with respect to the pre-crisis level. Thirdly, the economic recovery after the global financial crisis allowed to achieve the lowest levels of energy poverty rate during the observed period and, finally, the policy measures implemented to counteract the COVID-19 and energy prices crisis seems to be having the expected effects during the last year of the sample.

Figure 1. Average trend in the energy poverty intensity, 2006–2022 (LIHC indicator)



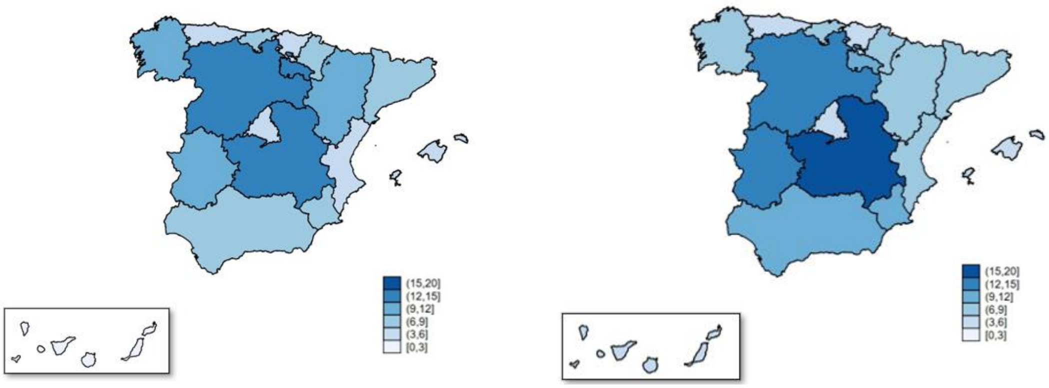
Source: Own elaboration

In the regional analysis of energy poverty, it is highly relevant to explore the trends on the spatial distribution of this phenomenon across the territory (see Figure 2). While some of the feature varies depending on the economic condition, there is a group of regions, surrounding the centre of Spain, that consistently have the highest energy poverty rates, this is we named the energy poverty ring. Varying trends are presents in groups of regions, that is the case of the Mediterranean regions, which having mid-low levels of energy poverty where strongly affected by the crises. The same is true in the case of the richest regions, where the recovery after the global financial crisis led to historically lower levels of energy poverty.

Figure 2. Geographical trend in the energy poverty (LIHC indicator)

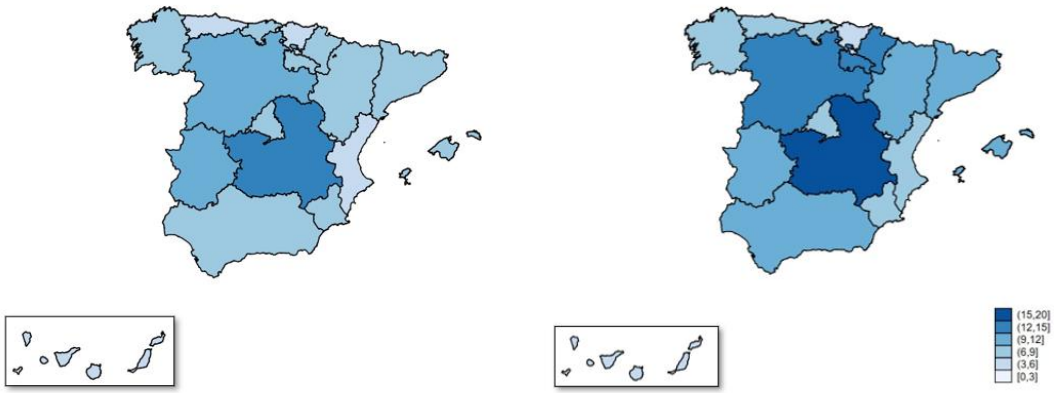
Pre-2008 crisis
(2006-2008)

Global financial crisis (2008)
(2009-14)



Recuperation
(2015-2019)

COVID-19 & energy crisis
(2020-22)



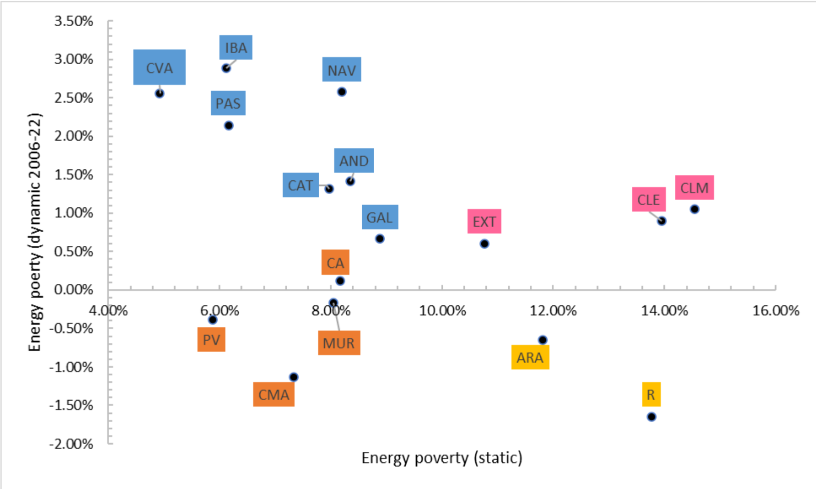
Source: Own elaboration

In order to obtain deeper insights on the regional characteristics of the problem we have map and classify the Spanish regions according to their energy poverty static and dynamic performances (see Figure 3). Each Spanish autonomous community is placed on the graph based on a pair of values determined by the static dimension of energy poverty performance, (namely the level of energy poverty at the beginning of the period) (x-axis) and to the dynamic evaluation of the energy poverty performance (considered in terms of growth from a starting year to a final one) (y-axis). This framework makes possible to classify the Spanish regions in the following terms.

The first group “on the right track” (the bottom left quadrant) is characterized by low levels of energy poverty at the beginning of the period analysed (base level) and has reduced the energy poverty over time (2006-2022), possibly due to the good level of attention paid to problem. The group include some of the richest regions in Spain (Pais Vasco and Madrid) but also Cantabria and Murcia. The second group “pay attention” (the top left quadrant) have moderate levels of energy poverty (base level) but have shown important growth in terms of energy poverty, suggesting a loss of strength in terms of combating energy poverty. In this group there are many of the autonomous communities of the Mediterranean coast (Catalonia, Valencia, Andalucia and Balearic Islands), and some of the Nordic autonomous communities (Navarre, Asturias, and Galicia). The third group “trapped in energy poverty” (the top right quadrant) is characterized by high energy poverty rates around the Community of Madrid. This is the energy poverty ring, composed by Castilla-La Mancha, Castile and León, and Extremadura. Finally, the fourth group “fighters” (the bottom right quadrant) given by the autonomous communities of Aragón and La Rioja presents a high incidence of energy poverty at the beginning of the analysis but has experienced negative growth rate in terms of energy poverty.

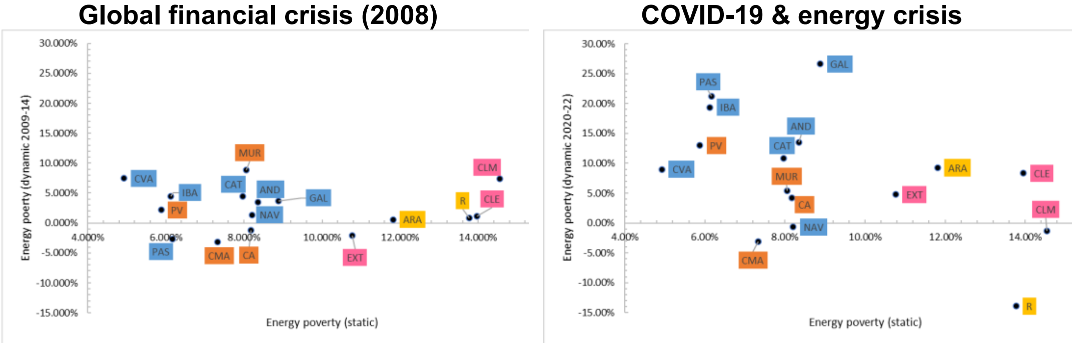
Figure 3. Diagram of the Spanish autonomous communities according to energy poverty performance

Period of time: 2006-2022



Global financial crisis (2008)

COVID-19 & energy crisis



Note: AND (Andalusia), ARA (Aragon), CA (Cantabria), CLM (Castilla-La Mancha), CLE (Castile and León), CAT (Catalonia), CMA (Madrid), CVA (Valencia), EXT (Extremadura), GAL (Galicia), IBA (Balearic Islands), R (La Rioja), MUR (Murcia), NAV (Navarre), PV (Basque Country), PAS (Asturias).

Source: Own elaboration

ECONOMETRIC ANALYSIS

Our econometric analysis is centred in the characterization of the probability that a household is in a situation of energy poverty according to the different groups of regions identified in the previous section. Accordingly, we use a discrete choice univariate probit model, where the dichotomous dependent variable (Y_{it}) takes the value 1 when a household is in a situation of energy poverty and 0 when is not considered to be energy poor.

In order to capture the diversity of energy poverty drivers, we include a set of independent variables that the empirical literature lists as determinants of energy poverty in capturing factors related to four dimensions (see Table 1): dwelling characteristics, socio-economic characteristics of the household, climate factors showing the extreme temperatures, and regional.

PRELIMINARY RESULTS

Preliminary results support that there are significant differences between groups of regions in terms of energy poverty intensity for all periods considered (Table 1).

Particularly, the estimates show that when a household is located in the regions of Group 3 "trapped in energy poverty" is more likely for this to be energy poor than in the case of households located in the other groups. This result is in line with the energy poverty ring observed in the maps.

Table 1. Determinants LIHC energy poverty indicator (marginal effects) 2006-2022

		(1)	(2)	(3)	(4)	(5)
Dwelling characteristics	Rural	0.0205***	0.0191***	0.0195***	0.0137***	0.0207***
		(0.00162)	(0.00162)	(0.00162)	(0.00158)	(0.00163)
	Old home	0.0145***	0.0148***	0.0147***	0.0158***	0.0145***
		(0.00111)	(0.00111)	(0.00111)	(0.00111)	(0.00111)
	Apartment building	-0.0286***	-0.0278***	-0.0289***	-0.0258***	-0.0286***
		(0.00144)	(0.00143)	(0.00144)	(0.00143)	(0.00144)
	Number of rooms	0.000391	0.000292	0.000313	-0.000197	0.000394
		(0.000462)	(0.000462)	(0.000463)	(0.000463)	(0.000462)
Socioeconomic characteristics of the households	Unemployment	0.135***	0.134***	0.135***	0.133***	0.135***
		(0.00393)	(0.00393)	(0.00394)	(0.00393)	(0.00393)
	Retired	0.0292***	0.0291***	0.0294***	0.0295***	0.0292***
		(0.00129)	(0.00129)	(0.00129)	(0.00130)	(0.00129)
	Higher education	-0.0624***	-0.0620***	-0.0625***	-0.0612***	-0.0625***
		(0.00105)	(0.00106)	(0.00106)	(0.00106)	(0.00105)
	One parent	0.120***	0.120***	0.121***	0.120***	0.120***
		(0.00551)	(0.00549)	(0.00553)	(0.00552)	(0.00550)
	One person	0.0692***	0.0690***	0.0692***	0.0684***	0.0693***
		(0.00177)	(0.00177)	(0.00177)	(0.00176)	(0.00177)
Climate factors	HDD	0.0464***	0.0490***	0.0348***	0.0261***	0.0474***
		(0.00233)	(0.00228)	(0.00264)	(0.00257)	(0.00244)
	CDD	0.00812***	0.00845***	0.00679***	0.00573***	0.00823***
		(0.000471)	(0.000467)	(0.000484)	(0.000501)	(0.000479)
Regional factors	Group 1		-0.00827***			
			(0.00124)			
	Group 2			-0.00970***		
				(0.00117)		
	Group 3				0.0335***	
					(0.00171)	
	Group 4					-0.00484***
						(0.00175)
	Observations			328,862		

Estimations control for time dummies. Level of statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Group 1: the Basque Country, Madrid, Murcia, and Cantabria. Group 2: Catalonia, Andalusia, Navarre, Asturias, the Balearic Islands, Valencia, and Galicia. Group 3 Castile and Leon, Castilla-La Mancha, and Extremadura. Group 4: Aragon and La Rioja. Source: Own elaboration.

The households located in the regions of Group 3 "trapped in energy poverty" are those suffering the most from the negative effects of the crises, with a stronger incidence in the case of the recent COVID-19/Energy crisis. In the opposite situation are the households located in Group 1 "on the right track", which are relatively less vulnerable to energy poverty during the crisis than on average. The intensification of differences observed during the crises is potentially the result of a confluence of factor including, the regional or local policies that have been implemented in the wealthier regions and the lack of additional resources in the energy poverty ring area.

Besides, we performed a set of four estimations with subsamples, corresponding to each of the regional groups (see Table 2). The results confirm that there are important regional differences in the intensity of effects exert by the energy poverty drivers, and that these are relevant in all three types of divers considered. Regarding the dwelling characteristics it is interesting to highlight the differentiated effects from living in a rural area or in an old home. These are always positively associated with the probability of being energy poor, but this effect is considerable stronger in the case of rural areas for Group 4 and old homes for Group 3.

When looking at the socio-economic characteristics of the households the results highlight that households with low levels of income (i.e. unemployed) are in danger of energy poverty in all autonomous communities of Spain, illustrating that this driver could be spatially homogeneous. In contrast, all the other elements present important differences with stronger effects over Group 3 or Group 4.

Finally, regarding the energy poverty effect from climate factors, the households located in regions of the Groups 3 are those who suffer more. The climatic condition in this area is characterized by having extreme temperatures, both in winter and summer (part of the central plateau, with a more continental climate than the rest of the country).

Table 2: Determinants LIHC energy poverty indicator (marginal effects) by group 2006 - 2022

		Total	Group 1	Group 2	Group 3	Group 4
Dwelling characteristics	Rural	0.0205***	0.0126***	0.0161***	0.00908**	0.0216***
		(0.00162)	(0.00367)	(0.00231)	(0.00373)	(0.00545)
	Old home	0.0145***	0.0151***	0.0132***	0.0289***	0.0258***
		(0.00111)	(0.00203)	(0.00151)	(0.00333)	(0.00366)
	Apartment building	-0.0286***	-0.0145***	-0.0251***	-0.0401***	-0.0339***
		(0.00144)	(0.00310)	(0.00182)	(0.00386)	(0.00626)
	Number of rooms	0.000391	-0.000925	-0.000285	-0.000287	0.000468
		(0.000462)	(0.001000)	(0.000599)	(0.00132)	(0.00175)
Socioeconomic characteristics of the households	Unemployment	0.135***	0.134***	0.130***	0.144***	0.141***
		(0.00393)	(0.00842)	(0.00512)	(0.00948)	(0.0162)
	Retired	0.0292***	0.0243***	0.0271***	0.0486***	0.0522***
		(0.00129)	(0.00247)	(0.00176)	(0.00362)	(0.00456)
	Higher education	-0.0624***	-0.0588***	-0.0536***	-0.0996***	-0.0622***
		(0.00105)	(0.00198)	(0.00142)	(0.00333)	(0.00357)
	One parent	0.120***	0.0878***	0.125***	0.140***	0.171***
		(0.00551)	(0.00879)	(0.00752)	(0.0157)	(0.0231)
	One person	0.0692***	0.0626***	0.0567***	0.124***	0.106***
		(0.00177)	(0.00346)	(0.00233)	(0.00511)	(0.00631)
Climate factors	HDD	0.0464***	0.00444	0.0189***	0.148***	0.0227
		(0.00233)	(0.00509)	(0.00352)	(0.0134)	(0.0951)
	CDD	0.00812***	0.00583***	0.00406***	0.0353***	-0.0202**
		(0.000471)	(0.000754)	(0.000626)	(0.00369)	(0.00940)
	Observations	328,862	87,729	157,249	57,537	26,347

Estimations control for time dummies. Level of statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Source: Own elaboration.

CONCLUSIONS

We have examined if geographic dimension affects the probability of being energy poor. The literature has highlighted that energy poverty drivers are influenced by internal factors such as socio-economic characteristics of a household and dwelling characteristic; however, our results support that regional factors have an impact on the probability of being energy poor. In fact, only one driver related to socio-economic characteristics of the household (i.e. unemployed) has been identified as spatially homogenous, positioning it as a national-level driver. In contrast, all the other elements present important differences with stronger effects, illustrating that there are local-level drivers.