ORIGINAL RESEARCH

Beyond Income and Inequality: The Role of Socio-political Factors for Alleviating Energy Poverty in Europe

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Abstract

In each country, the occurrence of energy poverty among resident households is usually related to low income and its unequal distribution. Like other manifestations of material deprivation, however, such a phenomenon is likely to be also correlated with some internal socio-political factors that allow its persistence by preventing effective solutions. In this paper, we build and analyse a dataset for European countries by assessing the role of the perceived quality of internal public governance on different measures of energy deprivation. Specifically, we rely on the Worldwide Governance Indicators provided by the World Bank and estimate an array of panel models. After controlling for income, income inequality, energy prices, and weather conditions, we find that high government effectiveness, good regulatory quality, widespread property rights, contract enforcement, and corruption control are significantly associated with lower energy poverty. In addition, we consider the policy implications of this broader perspective on energy deprivation.

Keywords Energy poverty · Worldwide governance indicators · Energy transition

JEL Classification I32 · K32 · P36 · P46

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1 Introduction

Over the last twenty years, energy poverty—meant as a situation in which households are unable to access essential energy services and products—became a worldwide prominent research area explored by several scholars endowed with different backgrounds and sensibilities (cf. Bouzarovski, 2014; Bouzarovski et al., 2012; Liddell, 2012).

From a social science perspective, a substantial part of the literature on energy deprivation stresses that the availability of detailed qualitative and quantitative information is crucial to evaluating the relevance of the phenomenon, appreciating its actual impact on people's lives, and implementing successful remedies (cf. Berry, 2018; Bouzarovski, 2018; Nussbaumer et al., 2012). In this direction, the European Commission is carrying out several initiatives to grasp the actual extent of energy poverty. For instance, the Household Budget Survey, administered every five years, focuses on household expenditure on goods and services and collects relevant information on energy expenses (cf. Eurostat, 2021). In the same vein, the European Union Statistics on Income and Living Conditions (EU-SILC) provides cross-sectional and longitudinal data on several indicators, including income, poverty, social exclusion, and living conditions of European citizens.

The possibility of accessing to new indicators and a broad perspective on the phenomenon might strongly impact the ongoing debate on the definition and measurement of energy poverty. Along these lines, the global network of independent experts named OpenEXP emphasized the coincidence between the traditional socio-economic gaps existing among the European countries and the geography of energy deprivation by stressing the importance of an adequate political framework to successfully address the problem (cf. OpenEXP Network, 2019).

The overlapping between socio-political factors and energy poverty suggests that the analysis of the latter may require including issues beyond the strictly economic sphere. In the existing applied literature, energy deprivation is mainly associated with income poverty and unequal earnings distribution as measured by per capita GDP and the associated Gini index (cf. Bardazzi et al., 2021; Galvin, 2019; Galvin & Sunikka-Blank, 2018). Like similar manifestations of material deprivation, however, energy poverty is likely to be also correlated with some internal socio-political factors that may create an environment in which the problem tends to persist by preventing effective solutions. Consequently, in this paper, we fully acknowledge that energy deprivation is a multidimensional phenomenon whose extent depends on several contextual conditions. Therefore, we formally estimate the relationship between a set of energy poverty indicators and some socio-political governance indexes vis-à-vis economic and environmental indicators. In addition, relying on that empirical exploration, we aim at identifing effective policy measures to tackle the issue.

In detail, our econometric strategy relies on the estimation of an array of longitudinal models involving European countries. The Worldwide Governance Indicators (WGIs), provided by the World Bank, are taken as the reference data for the perceived quality of the internal socio-political factors, and we evaluate their correlation with several energy poverty indicators such as the percentage of households unable to keep their house warm, the share of the population with arrears in utility bills and the share of people living in poor dwellings (cf. Thomson & Snell, 2013). Environmental and poverty studies often include socio-political factors in the analysis (cf. Kirsten et al., 2022). To our knowledge, however, WGIs have never been considered in energy deprivation studies.

All else being equal, our empirical findings show that the relation between energy poverty and the perceived quality of internal institutions and regulatory processes is often

significant. Specifically, we find that high quality in public services and regulatory policies, good contract enforcement, widespread property rights, and low perception of corruption are associated with lower levels of energy deprivation. This result recalls the advice of a recent United Nations Development Programme, according to which the inequitable access to energy is due "to political-economic factors that can be dealt with through more participatory decision-making and transparency measures […]; and [*by addressing*] socio-technical factors that modulate energy access" (cf. UNDP, 2018, p. 6). Consequently, our empirical exploration confirms the opportunity to widen the view beyond the economic factors that usually contribute to the definition of energy poverty by considering socio-political boundary conditions.

On the policy ground, as recalled by National Energy and Climate Plans (NECPs) submitted by European countries in 2019, our regression results suggest the need to improve the quality of public institutions, enhance transparency and regulatory efficiency, and adopt participatory processes in energy access/management (cf. De Paoli & Geoffron, 2019; Maris & Flouros, 2021; Williges et al., 2022). Moreover, given the undergoing energy market liberalization and the rising trend of energy prices driven by the train of the Covid-19 pandemic and the ongoing war in Ukraine, we argue that strengthening public institutions' capacity to regulate and manage the influence of private actors on collective interests is an additional precondition for effectively contrasting energy poverty.

The paper is arranged as follows. Section 2 explores the complex relationship between energy poverty and socio-political factors. Section 3 presents the dataset. Section 4 describes the empirical analysis's methodology and its results. Section 5 discusses some critical interventions for contrasting energy poverty. Section 6 addresses the socio-political challenges and the implications of governing liberalized energy systems. Finally, Sect. 7 concludes.

2 The Nexus Between Energy Poverty and the Socio-Political Context

2.1 Energy Deprivation at the Time of the European Clean Energy Package

Since 2009, the European Fuel Poverty and Energy Efficiency Project has offered the background for a common definition of energy poverty (cf. Fuel Poverty & Energy Efficiency Project, 2009; European Commission, 2010). Drawing on the European Pillar of Social Rights, the European Commission recognized energy as an essential service everyone should access (cf. European Commission, 2020a). More recently, in 2018, the European Commission launched the Energy Poverty Observatory (EPOV) by acknowledging that energy poverty is a significant challenge for European countries (cf. European Commission, 2020a). On the one side, the EPOV remarks that the rights of energy-vulnerable customers have to be protected and—at the same time—specific obligations to alleviate energy deprivation have to be simultaneously undertaken (cf. European Commission, 2009a; European Commission, 2009b; European Commission, 2018; Gangale & Mengolini, 2019). On the other side, the EPOV also signaled that over forty million people in Europe were still unable to keep their homes adequately warm or have arrears on their utility bills (cf. Thomson & Bouzarovski, 2019).

The ongoing European Green Deal initiative aims at preparing the European Union for climate neutrality before 2050 by boosting the adoption of renewable energy technologies. Within this context, the European Commission presented a new energy policy

framework—the Clean Energy for all Europeans Package—to facilitate the ecological transition (cf. European Union, 2019). This package aims at creating an energy governance system grounded on the efforts put forward by all the European countries to achieve their respective targets. Such an arrangement is supplemented by the 2020 State of the Energy Union Report, which auspicates that all European citizens will access adequate domestic and transport energy (cf. European Commission, 2020a).

The problem of energy poverty has thus gained momentum just because dedicated policies were deemed necessary to tackle the common but differentiated energy deprivation conditions, especially in the ongoing scenario of energy market liberalization (cf. European Commission, 2019). Moreover, the European Commission issued a set of customized suggestions to enhance the alleviation of energy poverty across Europe. These guidelines, which are available in the form of specific recommendations and a staff-working document, provide the member states with precise information on how to define, quantify, and manage energy deprivation at the national level, as well as a sample of best practices for addressing the problem (cf. European Commission, 2009b; European Commission, 2020c).

On the definitional side, energy poverty represents a condition in which an individual—or a household—has difficulty obtaining the necessary energy to meet basic needs, such as keeping the house heat and/or cool at an affordable cost (cf. Bouzarovski & Petrova, 2015; Pye et al., 2017). Initially, the international debate focused on the material deprivations induced by fuel poverty (cf. Boardman, 1991; Liddell & Morris, 2010; Moore, 2012). Thereafter, the analysis of energy poverty gradually evolved "to a more nuanced understanding of the multi-layered political economies and relations of power that drive the emergence and persistence of energy poverty" (cf. Bouzarovski & Petrova, 2015, p. 33). Today, an updated view of the energy poverty concept entails the capacity to meet material necessities and the "energy service standards that allow for [*active*] participation in society" (cf. Thomson & Bouzarovski, 2019, p. 6). The arguments put forward above suggest that the definition of energy poverty is progressively broadening its scope by also including some essential issues related to mobility and transport (cf. Berry, 2018; Leung et al., 2019; Mattioli et al., 2018).

Academic research has already demonstrated that a combination of low household income, high energy prices, the poor thermal efficiency of buildings (cf. Csiba, 2016), misuse, and limited availability of infrastructural facilities (cf. Thomson & Bouzarovski, 2019)—further than specific energy needs—may cause energy poverty (cf. Bouzarovski, 2014; Fuel Poverty & Energy Efficiency Project, 2009; King Baudouin Foundation, 2015). Notably, in 2009 the European Fuel Poverty and Energy Efficiency Project indicated low income as the primary determinant of the probability of experiencing energy deprivation (cf. Fuel Poverty & Energy Efficiency Project, 2009). Interpreting energy deprivation as a manifestation of income poverty led thus to "end-use" stage solutions, i.e., consumers' protection measures (cf. Bouzarovski, 2014; Katsoulakos, 2011). The implied compensatory measures were seen as straightforward ways to address the problem. Still, it soon became clear that energy poverty was also rooted in several factors not strictly related to households' spending capacity. In this direction, Bouzarovski (2014) pointed out that different geographical and socio-economic issues might contribute to the emergence of this phenomenon. In his own words, "the driving forces of energy poverty are themselves embedded in locally specific social, political, and environmental circumstances." Consequently, addressing energy poverty only by providing remedies for disparities in energy access uproots neither the problem nor the associated access inequalities.

2.2 Analytical Approaches to Assess Energy Poverty

Understanding energy poverty is essential for implementing effective policy interventions (cf. Primc & Slabe-Erker, 2020). From an analytical perspective, the ongoing academic research proposes an expenditure-based and a consensus-based approach for assessing the extent of energy deprivation. On the one hand, the former evaluates the energy poverty of households by fixing a threshold for selected energy expenditures over their total purchasing power (cf. Alkireet al., 2017; Liddell & Morris, 2010; Miniaciet al., 2014; Moore, 2012; O'Meara, 2016). For instance, Boardman (1991) defines fuel-poor a household whose fuel expenditure exceeds 10% of its disposable income. The available literature, however, suggests several weaknesses in using such an approach. These weaknesses relate to the threshold definition's arbitrariness (cf. Castaño-Rosa et al., 2019) or the impossibility of assessing the quality of some crucial factors related to households' welfare, such as the characteristics of the buildings in which they live (cf. Healy, 2016). On the other hand, the consensus-based approach is grounded on subjective and objective assessments of energy poverty intensity related to households' dwellings, such as the lack of central heating, incapacity to keep residences warm, thermal discomfort, arrears in utility bills, and so on.

At the European level, there are some prominent examples of studies adopting a consensus-based approach that compare energy deprivation across countries using data from the EU-SILC survey (cf. Bollino & Botti, 2017). Relying on this vast dataset, Thomson and Snell (2013) built a composite energy poverty index based on three proxy indicators: arrears on utility bills, household leaking or damages, and the ability to keep the home adequately warm. Their findings show that energy poverty is more recurrent in rural areas and southern and eastern European countries. Relying on the same data, Cadoret and Thelen (2020) test the presence of a Kuznets curve between energy poverty and GDP per capita by estimating a panel model for 28 European countries. They find a U-shaped relationship between fuel poverty and the intensive measure of income, which is at odds with the expected inverted U-shape of the traditional Kuznets relation. Similarly, Rodriguez-Alvarez et al. (2021) estimate an energy poverty threshold grounded on GDP, energy costs, energy intensity, and other country-specific characteristics retrieved once again from the EU-SILC survey. Their results suggest that financial aid to vulnerable groups, reductions in energy prices, and improvements in energy efficiency may be beneficial against energy deprivation.

The above contributions reveal that adopting a consensus-based approach might have pros and cons. On the one hand, the main benefit is the possibility of conducting comparative research at the European level by drawing up a ranking of energy deprivations among countries (cf. Healy & Clinch, 2004). On the other hand, some caveats are necessary because of the exploited indicators' subjective and culturally dependent character (cf. Bollino & Botti, 2017; Castaño-Rosa et al., 2019). Within this setting, in the remainder of this section, we aim at widening the current understanding of energy poverty across European countries by exploring additional potential factors associated with such a phenomenon.

2.3 Linking Energy Poverty to Socio-Political Factors

A more comprehensive appreciation of the contextual conditions related to the existence of energy poverty at the European level can be beneficial to identifying appropriate

policies to cope with it. For this purpose, while we acknowledge the crucial importance of socio-economic determinants of energy deprivation and the related intervention measures, we aim at widening the analysis horizon by also including socio-political conditions (cf. Rodriguez-Alvarez et al., 2021). The actual and/or the perceived quality of these conditions may allow countries to adopt governance processes that effectively tackle households' energy deprivation. In this way, we may also derive a complete understanding of the phenomenon and suggest wide-ranging and long-term solutions to successfully address the problem.

Several authors have already stressed the need to include socio-political aspects together with economic factors in the analysis of energy poverty (cf. Dubois & Meier, 2016). For instance, Bouzarovski and Tirado Herrero (2017) show the spatially contingent and path-dependent nature of countries' exposure to energy deprivation in relation to socio-political conditions. Similarly, Cadoret and Thelen (2020) and Filippidis et al. (2021) signal the importance of wide-ranging political interventions against energy poverty, especially on the environmental ground.

From an institutional perspective, the analysis of the internal conditions and the planned strategies to deal with energy deprivation described in the NECPs—which European countries had to submit to the European Commission for the implementation of the Clean Energy Package—confirms the need for a broader perspective (cf. European Commission, 2019b). As argued by Thomson and Bouzarovski (2019), by drawing on the information collected from the EPOV, the conditions prevailing in each country and the scheduled interventions are very diversified across Europe. Nevertheless, most NECPs corroborate the importance of context-specific and systemic consideration of energy poverty further than its linkage with the social, political, and environmental framework. These documents identify multiple contextual factors related to energy deprivation and, thus, call for dedicated actions in both the social and environmental areas. Specifically, together with compensatory, infrastructural, and mobility-related measures against energy poverty, in the NECPs, we also find regulatory, policy, communication, and participation interventions that, according to the different governments, should go in the same direction (cf. Maris & Flouros, 2021). Such an emphasis on interventions not strictly related to the economic sphere confirms that each Member State considers socio-political factors as potentially relevant to address energy poverty.

Unsurprisingly, a welfare system that supports vulnerable citizens' material needs can effectively mitigate the adverse effects of energy deprivation (cf. Della Valle & Czako, 2022). Consequently, the different political conditions that shape its design prevailing in each country may explain the variety of interventions. For instance, some countries—usually the ones in the north of Europe—that perform better in mitigating energy poverty do not report any specific plan in their NECPs (cf. Viljevac, 2020). By contrast, wherever the welfare system is not that strong—as it often happens in eastern and southern European countries—integrating the fight against energy poverty into the design of the whole energy system and creating ad hoc plans to deal with it seems to be of crucial importance (cf. Ferrara, 2005).

Several scholars confirm that cheap energy service availability and energy efficiency measures might contribute to reducing overall energy deprivation (cf. Wang et al., 2015). This finding supports countries' decision to invest in energy efficiency through incentives for the renovation of buildings rather than providing direct subsidies to income. In addition, public interventions on energy infrastructures are often envisaged alongside social house renovation. Specifically, while eastern countries generally focus on the need for modernization of energy infrastructures, measures to restore and retrofit both public and

private residential building stocks transversally interest all the European countries (cf. De Paoli & Geoffron, 2019).

As recalled above, interventions against energy poverty collected in the NECPs include communication, information, and data disclosure initiatives often accompanied by awareness-raising, legal provisions, and subsidies for citizens' participation. Moreover, especially in central, southern, and eastern Europe, specific attention is paid to citizens and civil society organizations' agencies and participatory processes for planning energy interventions (cf. Williges et al., 2022).

In conclusion, all the measures described in the NECPs that appear to be relevant for achieving a significant reduction in energy poverty are subject to the presence of a sound public governance. How a country is governed may guarantee equitable distribution of subsidies, provide an appropriate and efficiently implemented legal framework, and pursue information, communication, and awareness about the initiatives. Consequently, sustainable and equitable energy access requires solid and coherent governance at all political levels (cf. Karlsson-Vinkhuyzen et al., 2012). Obviously, this implies that energy policy is not just an economic or technical issue but also a political one, which may be subject to different perspectives. The literature on energy deprivation primarily investigates the role of energy prices, energy-saving practices, available alternative technologies, weather conditions, and incentive schemes. In light of the above arguments, however, this view is likely to be biased, so we stress the importance of a broader framework that accounts for the institutional quality and the structural attributes of public governance (cf. Goldthau & Sovacool, 2012). Therefore, in the remainder of this paper, we explore the link between energy poverty indicators and a set of socio-political factors authoritatively summarised by the World Bank WGIs.

3 Data and Descriptive Analysis

Our empirical investigation explores a longitudinal dataset that covers the period from 2005 to 2020 by collecting information for 28 European countries, namely, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Since data are not available for all countries over the entire period, our panel dataset is unbalanced.[1] In what follows, we review all the exploited indicators by starting from the dependent variables before moving to independent ones.[2]

3.1 Energy Poverty Indicators

Acknowledging that energy deprivation is a multidimensional concept, in our econometric analysis we introduce a set of different energy poverty (EP) indicators (cf. Thema & Vondung, 2020). First, we use three consensual self-reported indexes based on the EU-SILC

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[1] For instance, some data obtained from Eurostat are unavailable for the United Kingdom in 2019 and 2020. For some other countries (e.g., Croatia, Romania, or Bulgaria), data are available only for the years following their accession to the European Union.

[2] A full description of all variables is given in the Appendix Table A1.

Table 1 Summary statistics

Variable	Unit of measure	Mean	Std. Dev	1st quartile	Median	3rd quartile
Home − Warm	%	21.28	16.26	9.00	16.20	29.80
Arrears	%	20.53	12.94	10.90	17.20	25.10
Poor − Dwell	%	24.99	10.41	18.85	23.15	30.45
GDP	Euro per capita	25,634.60	16,538.00	12,685.00	22,260.00	35,065.00
log(*GDP*)	Logarithmic	9.96	0.64	9.45	10.01	10.47
GINI	0–100	31.22	3.74	28.10	31.20	34.30
ECPI	Index: 2015 = 100	96.04	13.07	88.62	99.10	105.20
HEATDD	Number	2,785.88	1,141.50	2,119.71	2,771.86	3,338.97
Political − Stability	0–100	64.93	7.61	60.10	65.70	70.40
Voice − Accountability	0–100	72.27	6.65	68.50	72.20	77.60
Government − Effectiveness	0–100	72.62	11.48	64.10	71.90	82.20
Regulation − Quality	0–100	74.16	8.60	68.20	73.40	82.20
Rule − of − Law	0–100	72.92	11.90	64.40	72.50	84.90
Control − Corruption	0–100	70.74	15.64	56.90	69.70	84.80

Total number of observations is 436

data commonly adopted in the literature on energy deprivation (cf. Galvin, 2019; Galvin & Sunikka-Blank, 2018; Streimikiene et al., 2021; Thomson & Snell, 2013). In detail, the first indicator is the "Ability to keep home adequately warm" (*Home − Warm*). Specifically, we use the share of the population below 60% of the median equivalised income unable to keep their home adequately warm. The second indicator is "Arrears on utility bills" (*Arrears*). Again, we use the share of the population below 60% of the median equivalised income unable to pay on-time utility bills. The third indicator is the share of the population below 60% of the median equivalised income living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floors (*Poor − Dwell*).[3]

In addition, we consider two synthetic indicators of energy poverty, namely the geometric mean (cf. OpenEXP Network, 2019) and the arithmetic mean (cf. Thomson & Snell, 2013) of the three EP variables described above. We indicate the former by *Geom − Mean*, and the latter by *Arithm − Mean*. The advantage of exploiting a synthetic measure of energy poverty is combining several proxy indicators to produce a single composite index. Moreover, given the properties of the respective aggregation procedure, *Arithm − Mean* will be higher than *Geom − Mean*, the higher the variance between *Home − Warm*, *Arrears*, and *Poor − Dwell*.

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[3] We also experimented with two expenditure-based indicators, namely the share of total consumption expenditure for energy products (electricity, gas, and other fuels) by the first income quintile of the population (*Energy − Share*), and the share of total consumption expenditure for transport services (*Transport − Share*) by the first income quintile of the population. These data are based on the Household Budget Survey, which we obtained from Eurostat. Their availability, however, is quite limited; indeed, we have information only for 2005, 2010, and 2015. Furthermore, we considered the synthetic energy poverty index provided by OpenEXP Network (2019), a consensus-based energy deprivation indicator dubbed as European Energy Poverty Index (EEPI). Again, EEPI is not available for every year. Estimation results using these alternative measures are quite imprecise due to the small number of observations. Results are available from the authors upon reasonable request.

3.2 Worldwide Governance Indicators

Since we are primarily interested in the correlation of socio-political factors with energy poverty across European countries, we introduce in the analysis as independent variables the WGIs released by the World Bank, which offer six national governance indicators (cf. Kaufmann & Kraay, 2002). Specifically, WGIs aim at grasping the perceived levels of political stability (*Political − Stability*), voice and accountability (*Voice − Accountability*), government effectiveness (*Government − Effectiveness*), regulation quality (*Regulation − Quality*), the rule of law (*Rule − of − Law*), and control of corruption (*Control − Corruption*).

From a statistical point of view, the WGIs represent a rich and unique dataset that summarizes the views, perceptions, experiences, and opinions of citizens, entrepreneurs, and experts in the public, private, and NGO sectors on the quality of various aspects of public governance. Former economic governance research widely used the WGIs for estimating development potentialities and the quality of international agencies' aid (cf. Han et al., 2014; Huque & Jongruck, 2018; Kaufmann & Kraay, 2007; Zaman & Brudermann, 2018). A few examples of studies exist in the literature using WGIs to interpret energy-related issues. Specifically, Zaman and Brudermann (2018) used that set of indicators to assess Bangladesh's electricity system's energy service security perspectives. Moreover, Ahlborg et al. (2015) exploit the WGIs to analyse the relationship between the per capita household electricity consumption and the quality of democratic institutions in African countries. The use of WGIs to explain poverty phenomena is not limited to developing countries. For instance, Bosco (2019) considers WGIs among the determinants of the risk of income poverty in a macro panel model for 31 European countries.

We collect WGI data for the 28 European countries explored in our analysis over the considered timespan. From a numerical perspective, these indicators range from − 2.5 (weak) to 2.5 (strong) governance performance. To ease the interpretation of the estimated coefficients, however, we rescale them all on the 0–100 scale, where 0 is low governance quality or performance, whereas 100 means high governance quality.

3.3 The Other Covariates

In our empirical specifications, we include a set of additional variables that control for several other factors that may influence the actual level of energy poverty over time in each country. First, we include Eurostat's real annual GDP per capita (*GDP*)—taken in logs—to control for households' average income. After that, we consider the Gini index (*GINI*), a summary measure of income inequality. Specifically, a Gini index equal to 0 represents an equal income distribution across individuals, while a value of 100 implies maximum concentration and unequal distribution. We collected a harmonized measure of that index from the World Bank Poverty and Inequality Platform.

In addition, we include the annual average harmonized consumer price index for energy products (*ECPI*) and the heating degree days (*HEATDD*) both obtained—except for the United Kingdom—from Eurostat. While the consumer price index controls for energy prices that—for a given level of income—may directly affect energy poverty in each country, the heating degree days describe the corresponding need for the heating requirements of buildings according to the prevailing weather conditions.

3.4 Descriptive Analysis

Table 1 shows the descriptive statistics (mean, standard deviation, median, first and third quartiles) for all the involved variables, whereas Table 9 in the Appendix reports their correlation matrix.

The figures in Table 1 reveal that the average share of European households living below 60% of the median equivalised income and unable to keep their home adequately warm is 21.3%. The proportion of those unable to pay utility bills on time is quite similar, whose average is 20.5%. By contrast, the share of the population below 60% of the median equivalised income living in a dwelling with a leaking roof, damp walls, or floors is somehow higher, achieving 25%. Regarding poverty indicators, the interquartile range, i.e., the difference between the third and first quartile of the distribution, is relatively high, suggesting the presence of high variability in our dataset. In figures, we have 20% for *Home − Warm*, 14% for *Arrears*, and 12% for *Poor − Dwell*.

Considering the socio-political indicators, whose inclusion represents a novelty in studies on energy poverty, all the WGIs are, on average, between 64 and 74, indicating a generally good quality of internal governance across European countries. In addition, their variability is relatively low, probably because these measures—related to political institutions' characteristics—tend to move very slowly over time.

Switching to the other covariates, we observe that the average per capita GDP amounts to 25,635 euros, whereas the Gini index averages 31.2. Furthermore, the average number of heating degree days is 2,786, a figure with a high variability because of the vast geographical area under scrutiny.

Table 2 reports the average value of the adopted energy poverty indicators in each country taken into consideration. The three measures of energy deprivation are highly consistent, and we observe that the countries with the highest levels of energy poverty are Bulgaria, Cyprus, Greece, and Hungary. On the contrary, the countries with the lowest levels of energy deprivation are Austria, Finland, Luxembourg, the Netherlands, and Sweden.

From a longitudinal perspective, the diagrams in Figs. 1 and 2 allow us to explore further the variability in energy poverty and governance indicators over time and across countries. Specifically, we gather our 28 European countries according to the four United Nations geo-scheme sub-regions: Eastern Europe, Northern Europe, Southern Europe, and Western Europe. Each panel of the figures shows how the considered indicator moves over time and across regions.

Unsurprisingly, according to the three diagrams in Fig. 1, the degree of energy poverty tends to be persistently higher in Eastern and Southern Europe (cf. Karpinska & Śmiech, 2020). Consistently with the arguments put forward in Sect. 2, this finding is mirrored by the paths of the six WGIs illustrated in the panels of Fig. 2, according to which the perceived quality of public governance in Eastern and Southern Europe remains parallelly low all over the period.

	Home − Warm	Arrears	Poor − Dwell
Table 2 Poverty indicators by country (average values)			
Austria	7.63	9.21	16.24
Belgium	19.54	14.71	26.24
Bulgaria	68.34	49.15	31.57
Croatia	21.55	36.81	21.35
Cyprus	48.22	23.95	38.49
Czech Republic	13.56	14.66	20.88
Denmark	9.31	8.83	18.01
Estonia	6.20	14.79	26.87
Finland	3.51	14.32	7.47
France	15.16	19.30	22.38
Germany	14.14	8.72	20.79
Greece	40.00	51.30	22.61
Hungary	23.99	41.13	44.09
Ireland	13.19	23.66	19.79
Italy	31.25	21.91	27.55
Latvia	29.89	25.29	39.25
Lithuania	35.79	19.76	32.84
Luxembourg	3.30	7.66	24.06
Malta	21.53	15.75	11.55
Netherlands	7.56	7.40	24.63
Poland	26.27	24.81	29.00
Portugal	46.96	13.50	33.52
Romania	26.46	28.66	29.69
Slovakia	17.04	19.00	16.38
Slovenia	12.03	27.48	37.75
Spain	18.71	16.60	24.13
Sweden	4.25	10.12	10.19
United Kingdom	13.80	13.08	21.22
Total	21.28	20.53	24.99

4 Empirical Analysis

4.1 Modelling Framework

On the econometric ground, we aim at augmenting the relationship between energy poverty indicators, income, and inequality by including socio-political factors measured by the WGIs. Specifically, we want to test whether such socio-political factors, like the quality of public services, the political stability, the effectiveness of the regulation, or the quality of contract enforcement, may be negatively correlated with the degree of energy deprivation across European countries. In that direction, we estimate the following model:

$$EP_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GINI_{it} + WGI'_{it}\beta_3 + X_{it}'\beta_4 + \sum_{t=1}^{T-1} \delta_t D_t + u_i + \varepsilon_{it} \quad (1)$$

where EP_{it} is one of the indexes of energy deprivation of the i-th country in year t that we alternatively consider for the appraisal of energy poverty, namely, *Home − Warm*, *Arrears*, *Poor − Dwell*, *Geom − Mean* or *Arithm − Mean*.
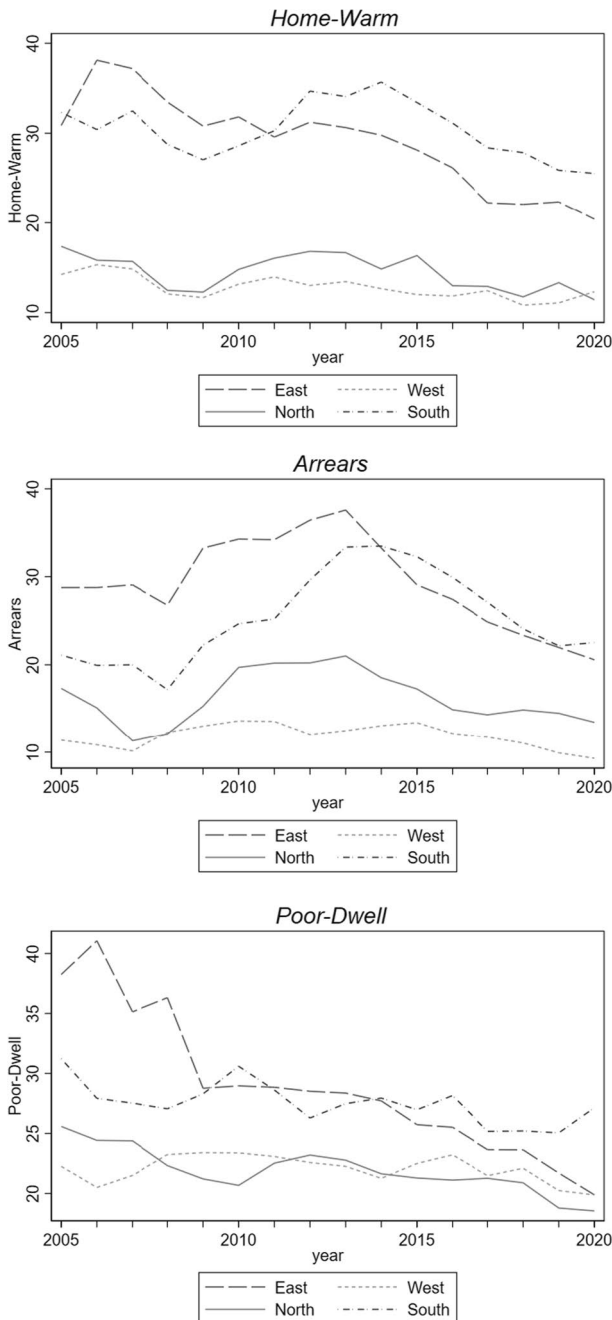

Fig. 1 Energy poverty indicators over time and across UN geo-scheme sub-regions for Europe. Data source: EU-SILC (Eurostat)
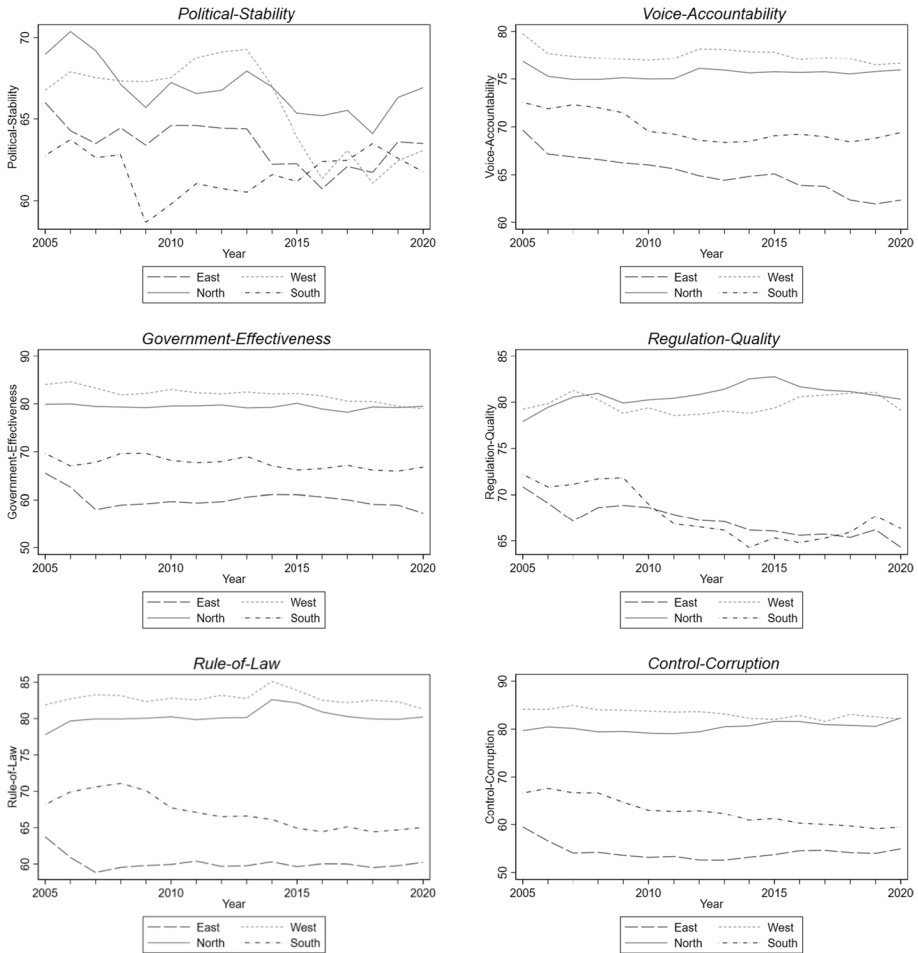
Fig. 2 Governance indicators over time and across UN geo-scheme sub-regions for Europe. Data Source: Worldwide Governance Indicators (World Bank)

The variables on the right-hand-side of Eq. (1) are described as follows. *GDP* is the log-transformed per capita real GDP, *GINI* is the Gini index, and *WGI* is a row vector for the six indicators of perceived socio-political quality. We compute the Variance Inflation Factors (VIF) for all the included regressors. Many WGIs have a VIF larger than a point value of 10, confirming collinearity among the independent variables. To avoid multicollinearity issues in estimating specification (1), the WGIs are included individually. We also show specifications with no WGIs, to ease the comparison with other models in the literature and to explore plausible moderation effects of WGIs. The row vector X'_{it} collects some additional control variables, namely, the consumer price index for energy ($ECPI_{it}$), and the heating degree days ($HEATDD_{it}$). β_0 is the common intercept, while D_t is the dummy variable for year t. The term u_i is the country-specific effect, capturing unobserved individual-specific heterogeneity. Finally, ε_{it} is the idiosyncratic error term, while subscripts i, t refer to country i and year t, respectively. The β, δ 's are the coefficients we estimate.

On the methodology ground, we estimate Eq. (1) using a two-way fixed effects model, where the country-specific error term u_i is partialled out to obtain unbiased estimates of the coefficients of interest (cf. Wooldridge, 2010).[4] Moreover, we test for the presence of cross-sectional dependence, heteroscedasticity, and serial autocorrelation.

Cross-sectional dependence may be present if there are omitted common effects or some form of spatial dependence among the considered countries. The presence of dependence between the units of a panel violates the assumption of an independent and identically distributed error term and may lead to inconsistent estimates. We thus perform the cross-sectional dependence (CD) test suggested by Pesaran (2004), Pesaran (2015), and Chudik and Pesaran (2015). The null hypothesis is that there is no cross-sectional dependence, i.e., that the correlation between unit i in time t and unit j in time t is zero. This test is powerful for static and dynamic panels and is especially valid with small T and large N. The test rejects the null hypothesis of cross-sectional independence. We also checked for the presence of heteroscedasticity and serial correlation, adopting many different strategies.[5] Tests confirm the presence of both issues.

We thus present Prais–Winsten regression estimation results where standard errors are correlated panels corrected standard errors, PCSE (cf. Beck & Katz, 1995; Moundigbaye et al., 2018). The standard errors reported for the estimation results are all robust to cross-sectional dependence while accounting for heteroscedasticity of general form and the autoregressive structure of the errors.

4.2 Regression Results

Tables 3, 4, 5, 6 and 7 show the estimation results for Eq. (1), where we alternatively use different energy poverty measures as the dependent variable. Specifically, all columns of each table include a common set of regressors (per capita GDP, Gini index, consumer price index for energy products, and the heating degree days). Columns (2) to (7) also include one of the socio-political indicators WGIs in turn.

In Table 3, the involved dependent variable is *Home − Warm*. In all columns, per capita GDP enters with a negative sign, which is statistically significant. Given the logarithmic transformation of GDP, its coefficient is a semi-elasticity: a ten percent increase in per capita GDP is associated with a reduction in the share of households unable to adequately heat their home between 2.2 (in column 6) and 2.6 (in columns 1 and 3) percentage points. The regression coefficients for *GINI* are positive and significant, revealing that greater income inequality is associated with a higher share of households unable to keep their homes warm. The regressors *ECPI*, and *HEARDD* are imprecisely estimated in all specifications.

Government − Effectiveness in column 4, *Rule − of − Law* in column 6, and *Control − Corruption* in column 7 are significant at conventional levels.

The coefficient for *Rule − of − Law* is the largest in magnitude and significance level. The *Home − Warm* variable decreases by around four percentage points if the

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[4] We also perform Hausman tests to check whether the country-specific errors u_i are correlated with the regressors, under the null hypothesis that they are not, so that the random effects model is appropriate. The null hypothesis is always rejected at conventional significance levels. We also use the heteroscedastic and cluster-robust versions of the Hausman test (cf. Arellano, 1993, and Schaffer and Stillman, 2006).

[5] We tested for the presence of heteroscedasticity by Wald test. We tested for serial correlation using the Wooldridge test for autocorrelation (cf. Wooldridge, 2010). However, the latter may unreliable for small panels (cf. Drukker, 2003). Therefore we also performed the test of Bhargava et al. (1982) that confirmed the presence of autocorrelation for the error.

Table 3 Fixed effects regressions. Dependent variable $Home - Warm$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (GDP)	− 25.849***	− 25.297***	− 25.948***	− 24.679***	− 25.189***	− 22.146***	− 24.428***
	(4.510)	(4.650)	(4.510)	(4.500)	(4.370)	(4.65)	(4.410)
GINI	0.329*	0.328*	0.328*	0.322*	0.327*	0.327*	0.349**
	(0.180)	(0.170)	(0.180)	(0.170)	(0.180)	(0.170)	(0.180)
ECPI	− 0.000	− 0.003	− 0.001	0.002	− 0.001	0.014	0.011
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
HEATDD	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Political-Stability		− 0.068					
		(0.080)					
Voice-Accountability			0.035				
			(0.140)				
Government-Effectiveness				− 0.120*			
				(0.080)			
Regulation-Quality					− 0.099		
					(0.090)		
Rule-of-Law						− 0.396***	
						(0.130)	
Control-Corruption							− 0.143*
							(0.090)
Constant	272.429***	271.865***	270.795***	270.577***	273.599***	267.655***	268.240***
	(49.780)	(50.210)	(50.760)	(49.560)	(49.060)	(48.280)	(48.520)
# of observations	436	436	436	436	436	436	436
R^2	0.83	0.83	0.83	0.83	0.83	0.83	0.83
AR(1) ρ	0.58	0.59	0.59	0.59	0.58	0.59	0.58
χ^2 test Country FE [p-value]	13,404 [0.00]	2,868 [0.00]	24,253 [0.00]	214,738 [0.00]	19,185 [0.00]	56,286 [0.00]	20,852 [0.00]

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2 test on Year FE [p-vaule]	65,431 [0.00]	47,421 [0.00]	35,837 [0.00]	61,420 [0.00]	62,396 [0.00]	33,882 [0.00]	55,234 [0.00]

Panel Corrected Standard Errors adjusted for heteroscedasticity and autoregression of order one in parenthesis below the coefficients. Country and Year dummy variables are included in all specifications. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 4 Fixed effects regressions. Dependent variable *Arrears*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (*GDP*)	− 24.065***	− 23.824***	− 23.694***	− 23.612***	− 22.601***	− 21.673***	− 21.750***
	(4.740)	(4.810)	(4.720)	(4.550)	(4.610)	(4.400)	(4.420)
GINI	0.132	0.132	0.136	0.131	0.141	0.147	0.173
	(0.180)	(0.180)	(0.180)	(0.180)	(0.180)	(0.180)	(0.180)
ECPI	0.039	0.038	0.041	0.041	0.042	0.056	0.060
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
HEATDD	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.00)	(0.000)	(0.00)	(0.000)
Political-Stability		− 0.031					
		(0.080)					
Voice-Accountability			− 0.135				
			(0.170)				
Government-Effectiveness				− 0.051			
				(0.080)			
Regulation-Quality					− 0.245***		
					(0.090)		
Rule-of-Law						− 0.297**	
						(0.120)	
Control-Corruption							− 0.231***
							(0.080)
Constant	250.996***	250.857***	257.440***	250.541***	254.664***	250.338***	243.430***
	(50.840)	(50.830)	(50.000)	(50.230)	(49.260)	(49.070)	(47.370)
# of observations	436	436	436	436	436	436	436
R^2	0.74	0.74	0.74	0.74	0.76	0.76	0.75
AR(1) ρ	0.54	0.54	0.54	0.54	0.51	0.50	0.52
χ^2 test Country FE [*p*-value]	4,639 [0.00]	3,920 [0.00]	2,843 [0.00]	8,450 [0.00]	16,677 [0.00]	8,535 [0.00]	7,185 [0.00]

Table 4 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2 test on Year FE [*p*-value]	9,823 [0.00]	7,508 [0.00]	9,013 [0.00]	5,127 [0.00]	8,237 [0.00]	8,549 [0.00]	8,910 [0.00]

Panel Corrected Standard Errors adjusted for heteroscedasticity and autoregression of order one in parenthesis below the coefficients. Country and Year dummy variables are included in all specifications. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 5 Fixed effects regressions. Dependent variable *Poor – Dwell*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (GDP)	− 17.906***	− 16.991***	− 17.370***	− 15.502***	− 16.291***	− 13.737***	− 12.567***
	(2.990)	(2.980)	(2.880)	(2.910)	(2.890)	(2.780)	(3.000)
GINI	0.128	0.127	0.131	0.116	0.125	0.122	0.197
	(0.140)	(0.140)	(0.140)	(0.140)	(0.150)	(0.140)	(0.140)
ECPI	− 0.255***	− 0.263***	− 0.252***	− 0.248***	− 0.255***	− 0.241***	− 0.216***
	(0.040)	(0.04)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
HEATDD	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Political-Stability		− 0.149**					
		(0.070)					
Voice-Accountability			− 0.167				
			(0.170)				
Government-Effectiveness				− 0.264***			
				(0.090)			
Regulation-Quality					− 0.213**		
					(0.090)		
Rule-of-Law						− 0.487***	
						(0.110)	
Control-Corruption							− 0.508***
							(0.090)
Constant	216.148***	218.022***	223.421***	213.681***	216.535***	214.741***	198.351***
	(33.050)	(31.930)	(36.850)	(32.140)	(33.430)	(30.850)	(33.500)
# of observations	436	436	436	436	436	436	436
R^2	0.70	0.71	0.70	0.71	0.70	0.72	0.72
AR(1) ρ	0.51	0.49	0.51	0.50	0.52	0.49	0.49
χ^2 test Country FE [p-value]	26,254 [0.00]	13,339 [0.00]	9,802 [0.00]	10,223 [0.00]	33,515 [0.00]	15,353 [0.00]	32,178 [0.00]

Table 5 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2 test on Year FE [p-value]	15,203 [0.00]	16,984 [0.00]	7,664 [0.00]	16,105 [0.00]	14,019 [0.00]	15,531 [0.00]	12,574 [0.00]

Panel Corrected Standard Errors adjusted for heteroscedasticity and autoregression of order one in parenthesis below the coefficients. Country and Year dummy variables are included in all specifications. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 6 Fixed effects regressions. Dependent variable *Geom − Mean*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (*GDP*)	− 21.705***	− 21.307***	− 21.569***	− 20.628***	− 20.753***	− 19.229***	− 19.145***
	(2.330)	(2.410)	(2.340)	(2.310)	(2.170)	(2.270)	(2.130)
GINI	0.099	0.097	0.099	0.091	0.099	0.102	0.142
	(0.130)	(0.130)	(0.130)	(0.130)	(0.130)	(0.120)	(0.120)
ECPI	− 0.072**	− 0.074**	− 0.072**	− 0.070**	− 0.074**	− 0.061*	− 0.052
	(0.040)	(0.040)	(0.040)	(0.040)	(0.030)	(0.030)	(0.040)
HEATDD	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.00)	(0.000)	(0.000)	(0.000)
Political-stability		− 0.047					
		(0.050)					
Voice-accountability			− 0.044				
			(0.130)				
Government-effectiveness				− 0.107*			
				(0.060)			
Regulation-quality					− 0.174***		
					(0.060)		
Rule-of-law						− 0.306***	
						(0.080)	
Control-corruption							− 0.271***
							(0.060)
Constant	239.159***	238.627***	241.116***	237.187***	243.196***	239.244***	232.395***
	(25.920)	(26.030)	(26.370)	(25.670)	(24.490)	(23.970)	(22.780)
# of observations	436	436	436	436	436	436	436
R^2	0.82	0.81	0.82	0.81	0.83	0.83	0.83
AR(1) ρ	0.58	0.58	0.58	0.59	0.55	0.54	0.55

Table 6 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2 test Country FE [p-value]	8,446 [0.00]	6,081 [0.00]	7,780 [0.00]	4,100 [0.00]	16,302 [0.00]	11,370 [0.00]	3,851 [0.00]
χ^2 test on Year FE [p-value]	717,539 [0.00]	754,517 [0.00]	615,766 [0.00]	377,817 [0.00]	174,324 [0.00]	432,221 [0.00]	882,284 [0.00]

Panel Corrected Standard Errors adjusted for heteroscedasticity and autoregression of order one in parenthesis below the coefficients. Country and Year dummy variables are included in all specifications. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 7 Fixed effects regressions. Dependent variable: *Arithm − Mean*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (GDP)	− 22.128***	− 21.490***	− 21.870***	− 20.825***	− 21.113***	− 19.111***	− 19.376***
	(2.540)	(2.64)	(2.510)	(2.500)	(2.350)	(2.400)	(2.320)
GINI	0.193	0.191	0.195	0.185	0.191	0.195	0.236*
	(0.130)	(0.120)	(0.130)	(0.130)	(0.130)	(0.120)	(0.120)
ECPI	− 0.069**	− 0.072**	− 0.068**	− 0.066**	− 0.071**	− 0.055*	− 0.048
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
HEATDD	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Political-stability		− 0.079					
		(0.060)					
Voice-accountability			− 0.094				
			(0.130)				
Government-effectiveness				− 0.130**			
				(0.060)			
Regulation-quality					− 0.179***		
					(0.060)		
Rule-of-law						− 0.391***	
						(0.090)	
Control-corruption							− 0.286***
							(0.060)
Constant	241.613***	241.004***	246.172***	239.228***	245.461***	243.322***	234.086***
	(28.140)	(28.250)	(28.510)	(27.630)	(26.590)	(25.220)	(25.070)
# of observations	436	436	436	436	436	436	436
R^2	0.83	0.83	0.83	0.83	0.84	0.85	0.84
AR(1) ρ	0.58	0.58	0.58	0.59	0.56	0.53	0.56
χ^2 test Country FE [p-value]	8,560 [0.00]	4,904 [0.00]	15,084 [0.00]	16,788 [0.00]	10,637 [0.00]	9,958 [0.00]	7,255 [0.00]

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2 test on Year FE [p-value]	162,000 [0.00]	111,695 [0.00]	281,189 [0.00]	226,300 [0.00]	156,089 [0.00]	63,157 [0.00]	67,574 [0.00]

Panel Corrected Standard Errors adjusted for heteroscedasticity and autoregression of order one in parenthesis below the coefficients. Country and Year dummy variables are included in all specifications. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Rule − of − Law indicator increases by ten percentage points. Stated in other terms, a one standard deviation increase in the rule of law indicator encompasses a decrease in the EP indicator of 4.6 percentage points, which approximately corresponds to one-third of the standard deviation for *Home − Warm.*

The coefficients for the *Government − Effectiveness* and the *Control − Corruption* indicators are smaller in magnitude and less precisely estimated: the dependent variable decreases by 1.2, and 1.4 percentage points if the governance indexes increase by ten percentage points, respectively (columns 4, and 7 of Table 3).

The inclusion of WGIs, in columns (2) to (7) of Table 3 mainly affects the magnitude of the coefficient of the per capita GDP: when the governance indexes are statistically significant, the magnitude of the coefficients of per capita GDP lowers, reducing its effect.

We assume a common autoregressive structure for the error term, and the estimated coefficient ρ of the AR(1) process, shown at the bottom of Table 3, is around 0.6 in all specifications.[6]

At the bottom of Table 3, we also show two statistical tests. First, we test the joint significance of country fixed effects included in the specifications. We always reject the null hypothesis that the country fixed effects are equal to zero. Then we jointly test the significance of year dummy variables included in all specifications. Again, we reject the null hypothesis.

Table 4 replicates the same analysis using *Arreas* as the dependent variable. GDP has a negative sign, and the magnitude of its coefficients is similar to the one in Table 3. The Gini index, the energy consumer price index, and the heating degrees days are imprecisely estimated in all specifications.

Among the governance indicators, *Regulation − Quality* (column 5)*, Rule − of − Law* (column 6), and *Control − Corruption* (column 7) are significant at conventional levels. For instance, an increase of ten percentage points in the quality of regulation index is associated with a reduction of 2.5 percentage points in the share of households with arrears in utility bills. Similarly, an increase of ten percentage points in the *Rule − of − Law* indicator encompasses a decrease of three percentage points in *Arreas*. Moreover, if the control of the corruption index increases by ten percentage points, then *Arreas* decrease by 2.3 percentage points. At the bottom of Table 4, we show the estimated coefficient ρ of the AR(1) process, which is approximately 0.5 in all columns. The tests for the country and year dummies always reject the null hypothesis that they are jointly equal to zero.

Table 5 shows the results for the third energy poverty indicator, *Poor − Dwell*. The coefficients for GDP are always negative and significant, even if smaller in magnitude than the previous EP indicators. The coefficient on the Gini index and the one on the heating degree days are not precisely estimated. The energy consumer price index is negatively associated with the dependent variable under scrutiny. This negative relationship is also in the unconditional correlation matrix of Table 8. In fact, in our data, we find several countries with low energy prices (below the sample mean) and a high share of the population living in a dwelling in poor conditions (e.g., Estonia, Latvia, Slovakia, and Slovenia) and several countries with high energy prices (above the sample mean) and a small share of *Poor − Dwell* (e.g., Belgium, Luxembourg, Sweden, and the Netherlands).

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[6] We also experiment with the estimation of a PCSE model where there is first-order autocorrelation within panels and the coefficient of the AR(1) process is specific to each panel. Results barely change. Moreover, we also estimated a specification where we substitute time dummies with country-specific time trends, while assuming an AR(1) process for the error terms. Again, results are almost unchanged.

Turning to the WGIs, we find that the estimated coefficients for *Political − Stability, Government − Effectiveness, Regulation − Quality, Rule − of − Law*, and *Control − Corruption* are negative and statistically significant in columns 2, 4, 5, 6, and 7. The share of households living in a dwelling in poor conditions decreases by 1.5, 2.6, 2.1, 4.9, or 5.1 percentage points when *Political − Stability, Government − Effectiveness, Regulation − Quality, Rule − of − Law*, or *Control − Corruption* increases by ten percentage points.

To put these magnitudes into context, the *Rule − of − Law* indicator (significant for all energy poverty indexes) increased by about 7–8 percentage points over the observed period in Latvia, Lithuania, and Estonia. A predicted decrease in *Home − Warm* accompanies this increase in the governance indicator by about 2.8–3.2 percentage points. Similarly, *Arrears* decrease by about 2.1–2.4 percentage points, while the associated reduction in *Poor − Dwell* is about 3.4–3.9 percentage points, all else equal. On the other hand, countries like Greece, Hungary, and Italy decreased their *Rule − of − Law* index by 6–9 percentage points from 2005 to 2020, encompassing an expected increase in *Home − Warm*, *Arrears,* and *Poor − Dwell* of about 2 to 4 percentage points.

Similarly, the *Control − Corruption* index (whose coefficient is significant for all energy poverty indexes) decreased by around ten percentage points in Spain between 2012 and 2018. All else equal, this worsened governance quality perception may be associated with increased energy poverty indicators, ranging from 1.4 to 5.1 percentage points. The same *Control − Corruption* index rose by about eight percentage points in Estonia between 2012 and 2018. All else equal, this better perception of the socio-political environment may decrease energy poverty indicators between 1.1 and 4.1 percentage points.

Furthermore, Tables 6 and 7 show the estimation results for Eq. (1) when the dependent variables are the synthetic energy poverty indicators, i.e., the geometric mean and the arithmetic mean of *Home − Warm*, *Arrears,* and *Poor − Dwell*. The findings are consistent with our previous analysis by revealing that the variance between the three consensual indicators taken into consideration does not overturn the findings in Tables 3–5.[7] Specifically, per capita GDP has a negative relationship with the synthetic energy poverty indicators, while the Gini index and the heating degree days coefficients are not precisely estimated. In addition, the energy consumer price index has a negative and significant coefficient in almost all specifications.

The statistically significant governance indicators are *Government − Effectiveness*, *Regulation − Quality*, *Rule − of − Law*, and *Control − Corruption* in columns 4, 5, 6, and 7 of Tables 6 and 7. All have the expected negative sign, and the magnitude of the coefficients is consistent with those found for the single EP indicators.

As a further check on the reliability of results, we re-estimate our specification in Eq. (1) separately for each year in our sample. We thus estimate 16 equations, for the years from 2005 to 2020, on the cross-section of available countries, using the three main EP indicators in turn as dependent variables. The estimated coefficients for the WGIs are reported in Tables 10, 11, and 12 in the Appendix. Figure 3 in the Appendix plots the same coefficients.[8]

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[7] We also experiment with different weighted arithmetic averages of the energy poverty indicators as dependent variables (cf. Thomson and Snell, 2013). Results barely change.

[8] Results are very similar (but not shown) for the two synthetic indicators, namely, *Geom − Mean* and *Arithm − Mean*.

When the dependent variable is *Home − Warm* (Table 10), the governance indicators that show statistical significance in at least some years are *Regulation − Quality*, *Rule − of − Law*, and, to a lesser extent, *Control − Corruption*. The significant coefficients vary slightly over time and are somehow larger (in absolute value) than their panel counterpart, which may pose them as lower bounds. We find a similar pattern for *Arrears* in Table 11, where many year-by-year coefficients are significant, negative, and larger in magnitude (in absolute value) than the pooled panel estimates of Table 4. Results for the *Poor − Dwell* indicators are in Table 12. Most significant coefficients are in the years before 2013, and the magnitudes are reasonably close to the values obtained for the pooled regression. Overall we might be confident that estimation results from our panel data analysis are pretty reliable and may, at worst, represent some lower bound of the association between energy poverty and governance indicators.[9]

5 On the Key Measures for Contrasting Energy Poverty: Compensation, Regulation, and Participation

Although providing a comprehensive account of a complex phenomenon such as energy poverty might be pretty challenging, our regression results may provide some guidance for some preliminary interpretation. In the first place, we find a significant negative correlation between per capita GDP—taken in logs—and the different dimensions of energy deprivation taken into consideration. This result is far from surprising; indeed, the availability of resources at the individual and/or country level is a natural prerequisite to coping with material deprivation (cf. Abbas et al., 2020). In this direction, the wake of the Covid 19 pandemic and the rising path of energy prices triggered by the war in Ukraine suggest that European countries may be less proficient in reducing energy deprivation in the future. On the economic ground, such a situation of "permacrisis" calls for new levers to counteract the raising of old and new poverties.

Second, concerning how earnings are distributed, our results are only partially consistent with previous research exploring the relationship between income inequality and energy poverty indicators. Most of the regression coefficients for the Gini index are very imprecisely estimated (cf. Bardazzi et al., 2021; Galvin, 2019; Galvin & Sunikka-Blank, 2018), and such a divergent result can probably be ascribed to the non-linear relation that often involves the level of income and its degree of concentration experienced at the country level (cf. Acemoglu & Robinson, 2002).

The added value of our work is the inclusion of indicators of governance quality in the empirical analysis of energy poverty. As shown above, most of the estimated WGI coefficients have the expected negative sign and a statistically significant magnitude when included individually in the different specifications of our econometric model. This finding

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[9] We also considered the possibility of non-stationary variables in our data. Since the panel data show cross-sectional dependence, we must apply the so-called second-generation unit root tests that allow for cross-sectional correlations. However, most of these tests need relatively large cross-section (N) and/or time (T) dimensions (above 50). In our case, both N (28 countries) and T (16) dimensions are quite small, and the analysis can proceed only under very restrictive assumptions (cf. Breitung and Pesaran, 2008). Given the limited validity of these tests (in size and power) within our framework, we refrain from further deepening the analysis, and we rely on the assumption of stationarity.

confirms our starting hypothesis that tackling energy poverty is not only a matter of income availability and earnings distribution but also entails setting multiple adequate socio-political conditions, even if they are not directly related to the prevailing economic situation. In what follows, we briefly comment on the role of each single governance indicator.

First, the index for voice and accountability is never statistically significant, while the index for political stability is negative and significant only in one specification (where the dependent variable is $Poor - Dwell$). These two WGIs show the lowest variability over time and across countries, possibly triggering the result.

Second, the index for government effectiveness that assesses the perceived quality of public services and the credibility of government negatively affects $Home - Warm$ (marginally significant), $Poor - Dwell$, and the two synthetic indicators $Geom - Mean$, and $Arithm - Mean$. Unsurprisingly, a better perception of the quality of public services is associated with lower energy deprivation along each dimension. This result suggests that wherever a government is credible in its commitments, energy poverty does not bite, probably because households' claims will likely attract the government's attention to that issue. Previous research on poverty points precisely in the same direction by suggesting that policy formulation and implementation quality enhancements might reduce poverty through greater institutional awareness of citizens' needs and pro-poor policies (cf. Tebaldi & Mohan, 2010). In addition, that pattern also confirms that participatory processes in energy services management can reduce disparities in their access (cf. Bouzarovski & Petrova, 2015).

Third, the regulation quality index measures the ability of the government to formulate and implement sound policies that allow a fair development of the private sector, and it negatively correlates with $Arrears$ and $Poor - Dwell$, and the two synthetic EP indicators $Geom - Mean$, and $Arithm - Mean$. When people think that the government is carrying out sound regulatory policies that allow the orderly development of the private sector, the performance in mitigating energy poverty usually improves (cf. Stratford, 2020). This finding suggests that public policies that fight the rent-seeking behaviour of private firms may be a significant driver for reducing energy deprivation. In the same vein, regulatory measures also modulate the system of public assistance and the management of funds against energy poverty. In this context, the perception of the importance of regulatory measures might also relate to incentives provided to mitigate energy deprivation. For this reason, $Regulation - Quality$ may represent an essential driver of energy poverty indexes. This pattern is confirmed by recent research where the perception of energy poverty is influenced by how local regulation distributes aid to households (cf. Lovei & Mckechnie, 2000).

Forth, the index for the rule of law grasps the perceived degree of compliance with the rules of society. According to our findings, it significantly correlates with the ability of a country to cope with energy poverty. The indicator has a negative, large, and significant coefficient in all the model specifications. Intuitively, restricting the arbitrary exercise of power by subordinating it to well-defined and established laws is crucial in addressing the different dimensions of energy deprivation.

Finally, the index for corruption control, which measures the perception of the extent to which public power is exercised for private gain, negatively correlates with all energy poverty measures. This latter finding points out that a lower perception of corruption might be crucial to guarantee the energy system's efficient and just functioning. According to the Sustainable Development Goals, a decline in the prevalence of corruption and bribery is critical to good governance and solid political institutions because "peace, justice, and strong institutions" are essential for just and sustainable development. This concluding result also aligns with previous research investigating energy deprivation issues

in non-European countries where government ineffectiveness and corruption are critical factors hindering electricity access to deprived population sectors (cf. Sarkodie & Adams, 2020).

6 Governing a Liberalised Energy System: Socio-Political Challenges and Implications

Our empirical findings echo the current scholarly debate on energy poverty by linking that problem to the quality of public institutions and governance processes. At the same time, they challenge the effectiveness of the socio-economic measures undertaken to support the ongoing liberalization of European energy markets.

6.1 The Importance of Public Institutions and Democratic Processes for a Just Energy System

Reliable, efficient, and inclusive public governance processes are essential in determining a country's capacity to address energy deprivation because they are the underpinnings for the provision of adequate welfare, the regulation and control of private interests, and the guarantee of civic participation. Using the WGIs to describe how power is exercised, we aimed to deconstruct the complex power geometries and the uneven geographies of energy poverty (cf. Thomson & Bouzarovski, 2019). In the European energy system, "The dynamics that allow energy poverty to arise and persist within specific material sites also shape wider political and social processes—as well as processes of institutional change in the energy sector itself" (cf. Bouzarovski, 2018, p.110). Therefore, as several scholars have already pointed out in their investigation of the social justice implications of energy production, distribution, and use, a systemic perspective to address the problem is essential (cf. Bazilian et al., 2014; Goldthau & Sovacool, 2012; Guruswamy, 2010; Pachauri & Spreng, 2004; Sovacool, 2014).

The studies above frame energy poverty issues not merely as an effect of social and spatial injustice at its end-user stage but, on the contrary, as an effect of the multiple conditions of inequalities arising along with the whole energy system (cf. Sovacool, 2014). Beyond mere income poverty, energy justice research points to the complexity of societies where energy deprivation emerges through multiple dimensions. On the one hand, the distributive approach to energy justice more closely refers to the fair allocation of economic and energy resources, and it confirms the association between energy poverty, economic poverty, and compensatory measures (cf. Heffron & Mccauley, 2017). On the other hand, the procedural (cf. Hall, 2013) and the recognition-based approaches (cf. Graham & Rudolph, 2014) focus on the formal aspects that allow the mitigation of energy deprivation (cf. Łapniewska, 2019).

Along these lines, our results show the importance of reinforcing public authority in the governance processes to provide an acceptable solution to the inescapable trade-off between fairness and efficiency in managing a market economy where the resources spent for energy needs are significant. They also signal the relevance of the socio-cultural context toward systematic information disclosure by government and industry, the implementation of participation and engagement mechanisms that can encourage more sustainable practices, and the direct inclusion of households in resolving distributive injustices (cf. Łapniewska, 2019). The significant role of government effectiveness, regulatory quality, rule of law, and the control of corruption confirms the energy justice claim, according to which setting up

socio-political conditions that prevent the emergence of energy poverty is crucial. Most importantly, our findings support the justice-related assertion that "alleviation [*of energy deprivation*] is a fundamental political duty" (cf. Bouzarovski & Simcock, 2017, p. 640).

6.2 Contrasting Energy Poverty in a Liberalized Energy System

In the vision of the European Union, market liberalization and energy transition plans presented in the Clean Energy Package conceive the creation of a harmonized and accurate measurement system and define different stakeholders' roles and responsibilities in a precise manner. Furthermore, under certified conditions of need, the Clean Energy Package is supposed to provide tools for protecting energy-poor and vulnerable customers by derogating market rules (cf. European Parliament, 2019).

As signaled in most NECPs, economic policies aimed at achieving energy and climate targets encompass the adjustment of regulation to flexibility and efficiency goals, the reduction of external dependency—very important in the aftermath of the war in Ukraine—and the liberalization of monopolistic markets. In addition, they stress that it is necessary to reduce access and information barriers in countries characterized by a massive bureaucratic apparatus and to create new skills and jobs in emerging sectors. Few NECPs, however, question the relationship between the complete liberalization of the energy market and the relief of energy poverty or make specific reference to the responsibility of energy companies in preventing any form of deprivation. Moreover, some eastern and central European countries foresee a potentially positive impact of liberalization on energy poverty, believing that it might decrease external dependency by strengthening the domestic market. By contrast, as it actually happened in the last period, some others expect energy prices and household expenditures to increase in a liberalized market.

Overall, studies on the distributional effects of energy reforms did not achieve a consensual view (cf. Bouzarovski, 2014). Some demonstrated that energy sector unbundling and privatization do not exacerbate differences in energy affordability (cf. Alkire et al., 2017). Others pointed out that "implicit energy price subsidies benefit the rich more than the poor" (cf. Buzar, 2007, p. 239). In general, social scholars insist that it is unlikely that the energy sector's liberalization will bring positive outcomes in terms of energy poverty reduction (cf. Chester & Morris, 2011; Csiba, 2016).

The complete liberalization of the energy sector might represent a challenge for European countries in regulating private activity, contrasting private pressures in public governance, and establishing a rule of law that creates and maintains fair conditions. For instance, research documented that deregulation and privatization in European post-soviet countries increased fuel prices worldwide (cf. Fankhauser & Tepic, 2007; Pollitt, 2012). Moreover, climate change-related interventions required by the Clean Energy Package run the risk of rising energy prices and home-renewal interventions, which are too costly for many. Trade unions, charities for poverty as well as environmental NGOs have already signalled the problem (cf. EPSU, 2017, 2019; Euractiv, 2018; Friends of the Earth, 2015).

Thus, it is for the public institutions to guarantee adequate conditions of accountability, freedom, and the rule of law to enable citizens, civic associations, or their representatives to mitigate the market's interests (cf. Ilie et al., 2007). Nevertheless, public opinion possibilities to control and participate in energy governance are not a primary concern in the European Clean Energy Package. For instance, in NECPs, the role of energy communities that brings together users and small-scale energy generators in a certain area to influence the development of the local energy system and increase benefits for people is limited to

providing decentralized renewable energy production. By contrast, the exploration of new market sectors and the acceptability of new energy infrastructures are still debated issues.

7 Conclusion and Policy Implications

Acknowledging the claim by Jenkins et al. (2016), according to which the evaluative dimension provided with data analysis is functional to support normative recommendations, in this paper, we collected data on some energy poverty indicators for a set of European countries, and we wondered whether it was possible to advance the general understanding of the phenomenon by going beyond the strictly economic sphere. Specifically, we explored the relationship between energy poverty—as measured by the inability to keep homes warm in winter, the share of households with arrears on utility bills, and the share of households living in poor dwellings—and some crucial socio-political conditions indexed by the WGIs annually realized by the World Bank, while controlling for income, earnings distribution, energy prices, and weather conditions. Such an analysis was motivated by institutional and academic instances.

Our empirical results confirmed that energy deprivation across European countries is not only connected to economic factors but is strictly coupled with the public perception of the quality of socio-political governance. Notably, our regressions revealed that government effectiveness, regulatory quality, rule of law, and control of corruption significantly correlate with at least one of the scrutinized energy poverty indicators and sometimes even more than one. Given that on the institutional ground, energy poverty is mainly associated with material poverty by calling for compensative interventions such as the provision of a basic income, the reimbursement of energy costs, or the granting of subsidies for improving the energy efficiency of buildings; we argued that most of the planned strategies might be insufficient to effectively uproot the problem.

On the policy ground, our findings suggest that the socio-political conditions, notably the institutional capacity to govern and regulate the market economy—by controlling and contrasting potential breaking and supporting citizens' participation—are crucial for contrasting energy deprivation. These arguments resonate with social science contributions on energy poverty and notably with some considerations on its justice dimensions. Specifically, on account of current research, we put forward some concerns on the role of public participation in alleviating energy deprivation in the context of market liberalization. For example, suppose that the deregulation of energy markets deprives the public of authorities and their intervention capacity. Then, it is doubtful that public institutions will be able to implement adequate socio-political measures and mitigate the impact of market dynamics on the most vulnerable sectors of the population. In this regard, the importance of solid public governance and influential public institutions able to deal with energy poverty in the involved markets envisaged by the Clean Energy for all Europeans Package is crucial.

Appendix

See Tables 8, 9, 10, 11 and 12.
    See Fig. 3.

Table 8 Variables' definition and data sources

Variable	Description	Data source	Unit of measure
Home – Warm	Share of the population with income below 60% of the median equivalised income unable to keep their homes warm in winter	EU-SILC Eurostat	%
Arrears	Share of the population with income below 60% of the median equivalised income with arrears on utility bills	EU-SILC Eurostat	%
Poor – Dwell	Share of the population with income below 60% of the median equivalised income living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor	EU-SILC Eurostat	%
GDP	Real GDP per capita	Eurostat	Euros PPP per capita
GINI	Gini index	World Bank	0–100
ECPI	Energy harmonized consumer price index	Eurostat	Index: 2015 = 100
HEATDD	Heating Degree Days, i.e., outside temperature above which a building needs no heating	Eurostat. For UK data come from DUKES of the UK Department for Business, Energy & Industrial Strategy	Number
Political – Stability	Perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism	Worldwide Governance Indicators—World Bank	0–100
Voice – Accountability	Perceptions of the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and free media	Worldwide Governance Indicators—World Bank	0–100
Government – Effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	Worldwide Governance Indicators—World Bank	0–100
Regulation – Quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	Worldwide Governance Indicators—World Bank	0–100
Rule – of – Law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, particularly the quality of contract enforcement, property rights, the police, and the courts	Worldwide Governance Indicators—World Bank	0–100

Table 8 (continued)

Variable	Description	Data source	Unit of measure
Control – Corruption	Perceptions of the extent to which public power is exercised for private gain, including petty and grand forms of corruption and "capture" of the state by elites and personal interests	Worldwide Governance Indicators—World Bank	0–100

Table 9 Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) *Home-Warm*	1.00											
(2) *Arrears*	0.61***	1.00										
(3) *Poor-Dwell*	0.51***	0.41***	1.00									
(4) *Log (GDP)*	-0.60***	-0.60***	-0.45***	1.00								
(5) *GINI*	0.58***	0.34***	0.35***	-0.35***	1.00							
(6) *ECPI*	-0.08	0.03	-0.21***	0.14**	-0.11*	1.00						
(7) *HEATDD*	-0.45***	-0.21***	-0.22***	0.05	-0.25***	-0.00	1.00					
(8) *Political-Stability*	-0.46***	-0.46***	-0.31***	0.42***	-0.52***	0.04	0.35***	1.00				
(9) *Voice-Accountability*	-0.60***	-0.70***	-0.44***	0.86***	-0.38***	0.03	0.25***	0.56***	1.00			
(10) *Government -Effectiveness*	-0.62***	-0.67***	-0.44***	0.82***	-0.44***	0.09	0.29***	0.56***	0.91***	1.00		
(11) *Regulation-Quality*	-0.62***	-0.69***	-0.44***	0.74***	-0.32***	0.04	0.37***	0.51***	0.88***	0.87***	1.00	
(12) *Rule-of-Law*	-0.68***	-0.70***	-0.47***	0.83***	-0.39***	0.09	0.30***	0.56***	0.93***	0.95***	0.91***	1.00
(13) *Control-Corruption*	-0.64***	-0.68***	-0.45***	0.84***	-0.37***	0.08	0.32***	0.51***	0.93***	0.94***	0.90***	0.95***

* 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 10 Estimation results from year-by-year regressions. Dependent variable *Home − Warm*

Year	Political-sta-bility	Voice-account-ability	Government-effectiveness	Regulation-quality	Rule-of-law	Control-cor-ruption
2005	0.508*	0.102	0.035	− 0.524	0.063	− 0.058
2006	0.005	− 1.047	0.229	− 0.536*	− 0.372	− 0.010
2007	0.095	− 0.919	0.247	− 0.476	− 0.407	− 0.047
2008	0.197	− 1.242	0.033	− 0.662*	− 0.499*	− 0.029
2009	0.097	− 0.954	0.184	− 0.768*	− 0.537*	− 0.075
2010	0.103	0.154	0.091	− 0.378	− 0.318	0.036
2011	0.008	− 0.713	− 0.065	− 0.637**	− 0.590*	− 0.230
2012	− 0.163	− 0.252	− 0.014	− 0.255	− 0.273	− 0.093
2013	− 0.066	− 0.180	− 0.053	− 0.132	− 0.311	− 0.123
2014	− 0.153	− 0.153	− 0.403	− 0.288	− 0.346*	− 0.283*
2015	− 0.197	− 0.406	− 0.192	− 0.194	− 0.230	− 0.192
2016	− 0.257	− 0.402	− 0.325	− 0.545*	− 0.667**	− 0.326
2017	0.079	− 0.068	− 0.061	− 0.283	− 0.470**	− 0.264
2018	0.228	− 0.200	− 0.039	− 0.498**	− 0.511**	− 0.316*
2019	− 0.140	0.526	0.111	− 0.072	− 0.324	− 0.137
2020	− 0.484	0.100	− 0.283	− 0.406	− 0.444	− 0.239

OLS estimation results. Each cell reports the estimated coefficient for the corresponding WGI. Each equation is estimated on a single year for the pool of countries where data are available. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Table 11 Estimation results from year-by-year regressions. Dependent variable *Arrears*

Year	Political-sta-bility	Voice-account-ability	Government-effectiveness	Regulation-quality	Rule-of-law	Control-cor-ruption
2005	− 0.007	− 0.309	− 0.841**	− 1.872**	− 0.891**	− 0.729**
2006	− 0.154	− 2.089**	− 0.756**	− 1.026*	− 0.68**	− 0.608*
2007	− 0.052	− 0.870	− 0.518	− 0.693	− 0.511	− 0.440
2008	− 0.311	− 1.835**	− 0.726**	− 0.834*	− 0.629*	− 0.322
2009	− 0.268	− 2.404**	− 0.664**	− 0.957**	− 0.661**	− 0.403
2010	− 0.453	− 1.640*	− 0.579*	− 0.663*	− 0.563**	− 0.488*
2011	− 0.634*	− 2.041**	− 0.591*	− 0.647**	− 0.661**	− 0.494*
2012	− 0.733*	− 2.321**	− 0.680	− 0.884**	− 0.669	− 0.493
2013	− 0.842*	− 2.547**	− 0.682	− 0.922**	− 0.770	− 0.440
2014	− 0.887*	− 2.310**	− 0.965*	− 0.819**	− 0.840*	− 0.559
2015	− 0.745*	− 2.655**	− 1.007*	− 0.941**	− 0.966*	− 0.630*
2016	− 0.693*	− 2.228**	− 1.027	− 1.064**	− 1.171	− 0.589
2017	− 0.452	− 1.828**	− 0.582	− 0.844**	− 0.808	− 0.500
2018	− 0.246	− 1.503**	− 0.462	− 0.875**	− 0.744	− 0.491
2019	− 0.672	− 0.808	− 0.543	− 1.309*	− 0.866	− 0.474
2020	− 0.771*	− 0.968*	− 0.750*	− 1.151**	− 1.188**	− 0.849*

OLS estimation results. Each cell reports the estimated coefficient for the corresponding WGI. Each equation is estimated on a single year for the pool of countries where data are available. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level
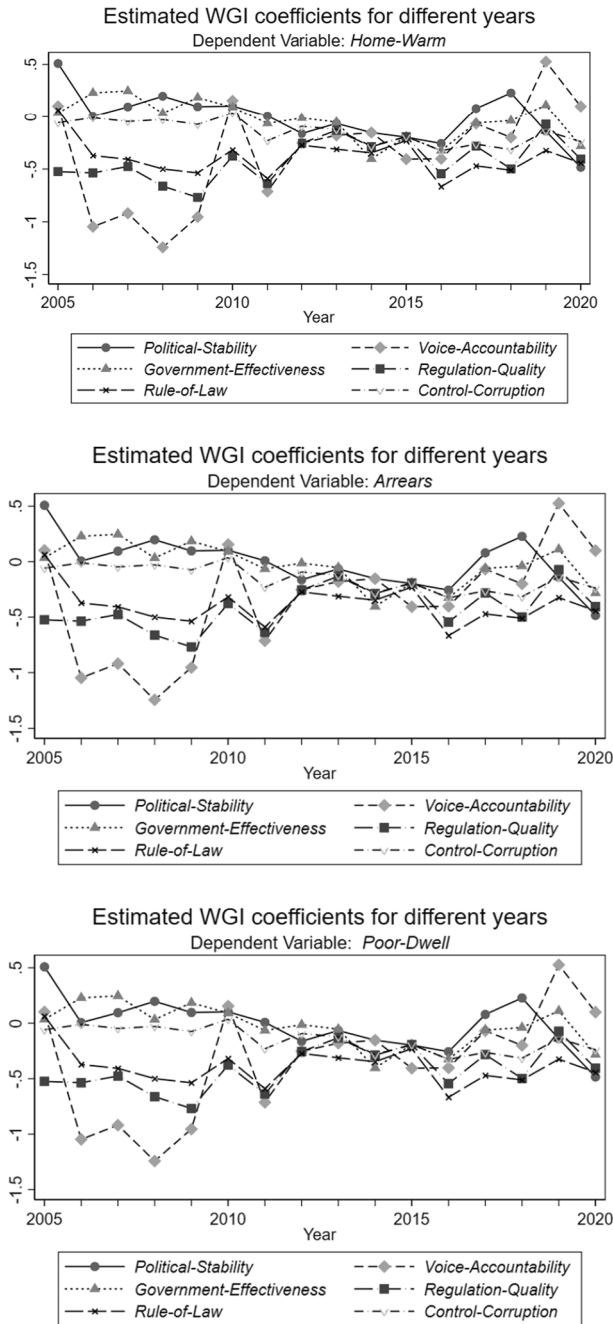
Table 12 Estimation results from year-by-year regressions. Dependent variable *Poor − Dwell*

Year	Political-stability	Voice-accountability	Government-effectiveness	Regulation-quality	Rule-of-law	Control-corruption
2005	0.022	− 0.635	− 0.465*	− 0.870*	− 0.34	− 0.295*
2006	− 0.406	− 1.753*	− 0.461*	− 0.536*	− 0.626**	− 0.414*
2007	− 0.386	− 1.436*	− 0.367*	− 0.302	− 0.549**	− 0.308*
2008	− 0.316	− 1.745**	− 0.402*	− 0.463	− 0.454	− 0.300*
2009	− 0.127	− 0.788	− 0.335*	− 0.711*	− 0.310	− 0.122
2010	− 0.49*	− 0.453	− 0.202	− 0.588*	− 0.175	− 0.035
2011	− 0.450	− 1.063*	− 0.320	− 0.585*	− 0.374	− 0.145
2012	− 0.314	− 0.820	− 0.320	− 0.424	− 0.209	− 0.031
2013	0.135	− 0.444	− 0.042	− 0.622*	− 0.257	− 0.106
2014	0.085	− 0.495	− 0.032	− 0.218	− 0.154	− 0.122
2015	0.155	− 0.543	0.162	− 0.189	− 0.147	− 0.111
2016	0.135	− 0.341	0.262	− 0.194	0.141	0.034
2017	0.215	0.098	0.257	− 0.037	0.132	0.102
2018	0.258	− 0.168	0.476*	− 0.195	0.267	0.111
2019	0.281	0.085	0.493**	0.228	0.337*	0.395*
2020	− 0.282	− 0.845	− 0.101	− 0.588	− 0.218	− 0.143

OLS estimation results. Each cell reports the estimated coefficient for the corresponding WGI. Each equation is estimated on a single year for the pool of countries where data are available. * 0.1 significance level, ** 0.05 significance level, *** 0.01 significance level

Fig. 3 Plots of estimated coefficients from year-by-year regressions

References

Abbas, K., Li, S., Xu, D., Baz, K., & Rakhmetova, A. (2020). Do socioeconomic factors determine household multidimensional energy poverty? Empirical evidence from South Asia. *Energy Policy, 146*, 111754.

Acemoglu, D., & Robinson, J. A. (2002). The political economy of the Kuznets curve. *Review of Development Economics, 6*(2), 183–203.

Arellano, M. (1993). On the testing of correlated effects with panel data. *Journal of Econometrics, 59*(1–2), 87–97.

Ahlborg, H., Boräng, F., Jagers, S. C., & Söderholm, P. (2015). Provision of electricity to african households: The importance of democracy and institutional quality. *Energy Policy, 87*, 125–135.

Alkire, S., Roche, J. M., & Vaz, A. (2017). Changes over time in multidimensional poverty: Methodology and results for 34 countries. *World Development, 94*, 232–249.

Bardazzi, R., Bortolotti, L., & Pazienza, M. G. (2021). To eat and not to heat? Energy poverty and income inequality in Italian Regions. *Energy Research & Social Science, 73*, 101946.

Bhargava, A., & Franzini, L. N. (1982). Serial correlation and fixed effects model. *Review of Economic Studies, 49*, 533–549.

Bazilian, M., Nakhooda, S., & Van De Graaf, T. (2014). Energy governance and poverty. *Energy Research & Social Science, 1*, 217–225.

Beck, N., & Katz, J. N. (1995). What to do (and not to do) with time-series cross-section data. *American Political Science Review, 89*(3), 634–647.

Berry, A. (2018). Measuring energy poverty: Uncovering the multiple dimensions of energy poverty. *HAL Working Papers*, No. 01896838.

Boardman, B. (1991). *Fuel Poverty: From Cold Homes to Affordable Warmth*. Pinter Pub Limited.

Bollino, C. A., & Botti, F. (2017). Energy poverty in Europe: a multidimensional approach. *PSL Quarterly Review, 70*(283), 449–472.

Bosco, B. (2019). One size does not fit all: quantile regression estimates of cross-country risk of poverty in Europe. *Economic Analysis and Policy, 62*(1), 280–299.

Bouzarovski, S. (2014). Energy poverty in the European Union: Landscapes of vulnerability. *Wiley Interdisciplinary Reviews: Energy and Environment, 3*(3), 276–289.

Bouzarovski, S. (2018). Concluding thoughts: Embracing and capturing complexity. *Energy Poverty* (pp. 109–113). Palgrave Macmillan.

Bouzarovski, S., & Petrova, S. (2015). A global perspective on domestic energy deprivation: Overcoming the energy poverty-fuel poverty binary. *Energy Research & Social Science, 10*, 31–40.

Bouzarovski, S., Petrova, S., & Sarlamanov, R. (2012). Energy poverty policies in the EU: A critical perspective. *Energy Policy, 49*, 76–82.

Bouzarovski, S., & Simcock, N. (2017). Spatializing energy justice. *Energy Policy, 107*, 640–648.

Bouzarovski, S., & Tirado Herrero, S. (2017). The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the European Union. *European Urban and Regional Studies, 24*(1), 69–86.

Breitung, J., & Pesaran, M. H. (2008). Unit roots and cointegration in panels. In L. Mátyás & P. Sevestre (Eds.), *The Econometrics of Panel Data. Advanced Studies in Theoretical and Applied Econometrics.* (Vol. 46). Berlin: Springer.

Buzar, S. (2007). The 'hidden' geographies of energy poverty in post-socialism: Between institutions and households. *Geoforum, 38*(2), 224–240.

Cadoret, I., & Thelen, V. (2020). Précarité Énergétique en Europe: Existe-t-il une Relation De Kuznets? *Revue Internationale Des Economistes De Langue Francaise, 5*(1), 166–186.

Castaño-Rosa, R., Solís-Guzmán, J., Rubio-Bellido, C., & Marrero, M. (2019). Towards a multiple-indicator approach to energy poverty in the European Union: A Review. *Energy and Buildings, 193*, 36–48.

Chester, L., & Morris, A. (2011). A new form of energy poverty is the hallmark of liberalised electricity sectors. *Australian Journal of Social Issues, 46*(4), 435–459.

Chudik, A., & Pesaran, M. H. (2015), Large panel data models with cross-sectional dependence a survey. In: B. H. Baltagi (Ed.), *Oxford Handbook of Panel Data*. Edition 1.

Csiba, K. (2016). *Energy poverty handbook*. European Union.

Datt, G. (2013). Making every dimension count: Multidimensional poverty without the "dual cut off", *Monash Economics Working Papers*, No. 32.

De Paoli, L., & Geoffron, P. (2019). A critical overview of the European national energy and climate plans. *Economics and Policy of Energy and the Environment, 1*, 31–41.

Della Valle, N., & Czako, V. (2022). Empowering energy citizenship among the energy poor. *Energy Research & Social Science, 89*, 102654.

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *The Review of Economics and Statistics, 80*(4), 549–560.

Drukker, D. M. (2003). Testing for serial correlation in linear panel-data models. *The Stata Journal, 3*(2), 168–177.

Dubois, U., & Meier, H. (2016). Energy affordability and energy inequality in Europe: Implications for policymaking. *Energy Research & Social Science, 18*, 21–35.

EPSU. (2017). Right to Energy for all Europeans. https://www.epsu.org.

EPSU. (2019). Going Public: A Decarbonised, Affordable and Democratic Energy System for Europe. https://www.epsu.org.

EU-SILC. (2021). European Union Statistics on Income and Living Conditions, Eurostat. https://Ec.Europa.Eu/Eurostat/Web/Microdata/European-Union-Statistics-On-Income-And-Living-Conditions.

Euractiv. (2018). Energy Poverty Hinders EU Push to End Regulated Electricity Prices. https://www.Euractiv.

European Commission. (2009a). Directive 2009a/72/EC of the European Parliament and of the Council of July 13rd 2009a Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 2003/54/EC. https://Eur-Lex.Europa.Eu.

European Commission. (2009b). Directive 2009b/73/EC of the European Parliament and of the Council of July 13rd, 2009b Concerning Common Rules for the Internal Market in Natural Gas and Repealing Directive 2003/55/EC. https://Eur-Lex.Europa.Eu.

European Commission. (2010). An Energy Policy for Customers. *Commission Staff Working Paper*, No. 1407.

European Commission. (2018). Directive 2018/2002 of the European Parliament and of the Council of December 11st, 2018 amending Directive 2012/27/EU on Energy Efficiency. https://Eur-Lex.Europa.Eu.

European Commission. (2020a). Report on the State of the Energy Union Pursuant to Regulation (EU) 2018/1999 on Governance of the Energy Union and Climate Action, No. 950.

European Commission. (2020c). Commission Staff Working Document EU Guidance on Energy Poverty. https://Ec.Europa.Eu/Energy/Sites/Ener/Files/Swd_On_The_Recommendation_On_Energy_Poverty_Swd2020960.pdf

Parliament, E. (2017). A European pillar of social rights. *Official Journal of the European Union, 242*(C), 24–40.

European Parliament. (2019). Directive (Eu) 2019/944 of the European Parliament and of the Council of June 5th, 2019, on Common Rules for the Internal Market for Electricity and Amending Directive 2012/27/EU. https://Eur-Lex.Europa.Eu.

European Union. (2019). Clean Energy for all Europeans Package. https://Ec.Europa.Eu.

Eurostat. (2021). Household Budget Survey 2015 Scientific-Use Files. https://Ec.Europa.Eu/Eurostat/Documents/203647/7610424/HBS+User+Manual.Pdf/Fb5d8371-08fe-4ecf-Bca6-B40984fde0b6?T=1624343433403. Accessed on Jan 25th, 2022.

Fankhauser, S., & Tepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. *Energy Policy, 35*(2), 1038–1049.

Ferrara, M. (2005). *Welfare state reform in Southern Europe: Fighting poverty and social exclusion in Greece, Italy Spain and Portugal*. Berlin: Routledge.

Filippidis, M., Tzouvanas, P., & Chatziantoniou, I. (2021). Energy poverty through the lens of the energy-environmental kuznets curve hypothesis. *Energy Economics, 100*, 105328.

Friends of the Earth. (2015). Power to the People!, http://foeeurope.org.

Fuel Poverty and Energy Efficiency Project. (2009). *Tackling Fuel Poverty in Europe, Recommendations Guide for Policy Makers*, Brussels: European Fuel Poverty and Energy Efficiency Project.

Galvin, R. (2019). Letting gini out of the fuel poverty bottle? Correlating cold homes and income inequality in European Union Countries. *Energy Research & Social Science, 58*, 101255.

Galvin, R., & Sunikka-Blank, M. (2018). Economic inequality and household energy consumption in high-income countries: A challenge for social science based energy research. *Ecological Economics, 153*(1), 78–88.

Gangale, F., & Mengolini, A. (2019). *Energy poverty through the lens of EU research and innovation projects*. Publications Office of The European Union.

Goldthau, A., & Sovacool, B. K. (2012). The uniqueness of the energy security, justice, and governance problem. *Energy Policy, 41*, 232–240.

Graham, K., & Rudolph, D. (2014). Geography, communities and energy futures: Alternative research paths. *Scottish Geographical Journal, 130*(3), 143–151.

Guruswamy, L. (2010). Energy justice and sustainable development. *Colorado Journal of International Environmental Law and Policy, 21*(2), 231–275.

Halkos, G. E., & Gkampoura, E. C. (2021). Evaluating the effect of economic crisis on energy poverty in Europe. *Renewable and Sustainable Energy Reviews, 144*, 110981.

Hall, S. M. (2013). Energy justice and ethical consumption: Comparison. *Synthesis and Lesson Drawing, Local Environment, 18*(4), 422–437.

Han, X., Khan, H. A., & Zhuang, J. (2014), Do governance indicators explain development performance? A cross-country analysis. *Asian Development Bank Working Paper Economics Series*, No. 417.

Healy, J. D. (2016). *Housing, Fuel Poverty and Health: A Pan-European Analysis*. Routledge.

Healy, J. D., & Clinch, J. P. (2004). Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland. *Energy Policy, 32*(2), 207–220.

Heffron, R. J., & Mccauley, D. (2017). The concept of energy justice across the disciplines. *Energy Policy, 105*, 658–667.

Huque, A. S., & Jongruck, P. (2018). The challenge of assessing governance in Asian States: Hong Kong in the worldwide governance indicators ranking. *Asian Journal of Political Science, 26*(2), 276–291.

Ilie, L., Horobet, A., & Popescu, C. (2007). Liberalization and regulation in the EU energy market, *MPRA Paper*, No. 6419.

Jenkins, K., Mccauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science, 11*, 174–182.

Karlsson-Vinkhuyzen, S. I., Jollands, N., & Staudt, L. (2012). Global governance for sustainable energy: The contribution of a global public goods approach. *Ecological Economics, 83*(C), 11–18.

Karpinska, L., & Śmiech, S. (2020). On the persistence of energy poverty in Europe: How hard is it for the poor to escape? *Energy Research Letters, 1*(3), 1–5.

Katsoulakos, N. (2011). Combating energy poverty in mountainous areas through energy-saving interventions. *Mountain Research and Development, 31*(4), 284–292.

Kaufmann, D., & Kraay, A. (2002). Growth without governance. *Economia, 3*(1), 169–229.

Kaufmann, D., & Kraay, A. (2007), Governance indicators: Where are we, where should we be going?, *Policy Research Working Paper*, No. 4370.

Kaufmann, D., Kraay, A., & Zoido, P. (1999), Governance Matters. SSRN 188568.

King Baudouin Foundation. (2015). *Barometer of Energy Precarity*, Brussels.

Kirsten, F., Biyase, M., & Zwane, T. (2022). The impact of poverty on the ecological footprint in BRICS countries. EDWRG Working Paper Series, No. 06-22.

Łapniewska, Z. (2019). Energy, equality and sustainability? European electricity cooperatives from a gender perspective. *Energy Research & Social Science, 57*, 101247.

Leung, A., Burke, M., Cui, J., & Perl, A. (2019). Fuel price changes and their impacts on urban transport a literature review using bibliometric and content analysis techniques, 1972–2017. *Transport Reviews, 39*(4), 463–484.

Liddell, C. (2012). Fuel poverty comes of age: Commemorating 21 years of research and policy. *Energy Policy, 49*, 1–778.

Liddell, C., & Morris, C. (2010). Fuel poverty and human health: A review of recent evidence. *Energy Policy, 38*(6), 2987–2997.

Lovei, L., & Mckechnie, A. (2000). *The costs of corruption for the poor—The energy sector* (p. 207). Public Policy for the Private Sector.

Mattioli, G., Lucas, K., & Marsden, G. (2018). Reprint of transport poverty and fuel poverty in the UK: From analogy to comparison. *Transport Policy, 65*, 114–125.

Maris, G., & Flouros, F. (2021). The green deal, national energy and climate plans in Europe: Member States' compliance and strategies. *Administrative Sciences, 11*(3), 1–17.

Miniaci, R., Scarpa, C., & Valbonesi, P. (2014). Energy affordability and the benefits system in Italy. *Energy Policy, 75*, 289–300.

Moore, R. (2012). Definitions of fuel poverty: Implications for policy. *Energy Policy, 49*, 19–26.

Moundigbaye, M., Rea, W. S., & Reed, W. R. (2018). Which panel data estimator should I use?: A corrigendum and extension. *Economics, 12*(1), 2–31.

Nussbaumer, P., Bazilian, M., & Modi, V. (2012). Measuring energy poverty: Focusing on what matters. *Renewable and Sustainable Energy Reviews, 16*(1), 231–243.

O'Meara, G. (2016). A review of the literature on fuel poverty with a focus on Ireland. *Social Indicators Research, 128*(1), 285–303.

OpenEXP Network. (2019). European Energy Poverty Index (EEPI). https://www.Openexp.Eu.

Pachauri, S., & Spreng, D. (2004). Energy use and energy access in relation to poverty. *Economic and Political Weekly, 39*(3), 271–278.

Pesaran M. H. (2004). General diagnostic tests for cross section dependence in panels. *CESifo WorkingPaper Series* 1229.

Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews, 34*(6–10), 1089–1117.

Pollitt, M. G. (2012). The role of policy in energy transitions: Lessons from the energy liberalisation era. *Energy Policy, 50*, 128–137.

Primc, K., & Slabe-Erker, R. (2020). Social policy or energy policy? *Time to Reconsider Energy Poverty Policies, Energy for Sustainable Development, 55*, 32–36.

Pye, S., Dobbins, A., Baffert, C., Brajković, J., Deane, P., & De Miglio, R. (2017). Energy poverty across the EU: Analysis of policies and measures. In *Europe's Energy Transition* (pp. 261–280). Academic Press.

Qurat-Ul-Ann, A. R., & Mirza, F. M. (2020). Meta-analysis of empirical evidence on energy poverty: The case of developing economies. *Energy Policy, 141*, 111444.

Rodriguez-Alvarez, A., Llorca, M., & Jamasb, T. (2021). Alleviating energy poverty in Europe: Front-runners and laggards. *Energy Economics, 103*, 105575.

Sarkodie, S. A., & Adams, S. (2020). Electricity access and income inequality in South Africa: Evidence from Bayesian and NARDL analyses. *Energy Strategy Reviews, 29*, 100480.

Scarpellini, S., Hernández, M. A. S., Moneva, J. M., Portillo-Tarragona, P., & Rodríguez, M. E. L. (2019). Measurement of spatial socioeconomic impact of energy poverty. *Energy Policy, 124*, 320–331.

Schaffer, M., & Stillman, S. (2006), XTOVERID: Stata module to calculate tests of overidentifying restrictions after xtreg, xtivreg, xtivreg2, xthtaylor, *Statistical Software Components S456779*. Boston College Department of Economics.

Sovacool, B. K. (2014). What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research & Social Science, 1*, 1–29.

Stratford, B. (2020). The threat of rent extraction in a resource-constrained future. *Ecological Economics, 169*, 106524.

Streimikiene, D., Kyriakopoulos, G. L., Lekavicius, V., & Siksnelyte-Butkiene, I. (2021). Energy poverty and low carbon just energy transition: Comparative study in Lithuania and Greece. *Social Indicators Research, 158*(1), 319–371.

Tebaldi, E., & Mohan, R. (2010). Institutions and poverty. *Journal of Development Studies, 46*(6), 1047–1066.

Thema, J., & Vondung, F. (2020), EPOV indicator dashboard: Methodology guidebook, Wuppertal Institut Für Klima, Umwelt, Energie Gmbh

Thomson, H., & Bouzarovski, S. (2019). Addressing energy poverty in the European Union: State of play and action. EU Energy Poverty Observatory, Manchester.

Thomson, H., Bouzarovski, S., & Snell, C. (2017). Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data. *Indoor and Built Environment, 26*(7), 879–901.

Thomson, H., & Snell, C. (2013). Quantifying the prevalence of fuel poverty across the European Union. *Energy Policy, 52*, 563–572.

Tusalem, R. F. (2015). Democracies, autocracies, and political stability. *International Social Science Review, 90*, 1.

UNDP. (2018). Accelerating SDG 7 Achievement, Policy Brief 08 Interlinkages Among Energy, Poverty and Inequalities, UNDP and University of Bergen. https://Sdgs.Un.Org/Publications/Report-Hlpf-Accelerating-Sdg7-Achievement-Sdg7-Tag-Policy-Brief-33180.

Viljevac, V. (2020). The Nordic model and welfare state. *Economic Thought and Practice, 29*(1), 307–324.

Wang, K., Wang, Y. X., Li, K., & Wei, Y. M. (2015). Energy poverty in China: An index based comprehensive evaluation. *Renewable and Sustainable Energy Reviews, 47*, 308–323.

Williges, K., Van der Gaast, W., de Bruyn-Szendrei, K., Tuerk, A., & Bachner, G. (2022). The potential for successful climate policy in national energy and climate plans: Highlighting key gaps and ways forward. *Sustainable Earth Reviews, 5*(1), 1–17.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Zaman, R., & Brudermann, T. (2018). Energy governance in the context of energy service security: A qualitative assessment of the electricity system in Bangladesh. *Applied Energy, 223*, 443–456.