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Energy Poverty and Life Satisfaction: Structural Mechanisms and Their Implications

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Abstract: This paper investigates the distinct mechanisms through which energy poverty is linked to life satisfaction, via health status and one's satisfaction with one's own socioeconomic status, using data from the Life in Transition survey. Our sample contains 19,598 individuals from 11 former communist states located in Central and Eastern Europe, and two developed countries for comparison. We estimated a partial least squared–path model and found that both health status and socioeconomic status are relevant mediators. Our results also indicate that gender moderates the relation between health status and life satisfaction. Energy poverty has a low contribution to health status but a larger contribution to satisfaction with socioeconomic status, thus indicating that interventions on energy poverty may not greatly improve the level of health, but can have an influence on how people feel about their life. The contribution of our paper is twofold. On the one side, we continue to consolidate the existing link between energy poverty and self-reported health status with a new focus on the Central and Eastern European countries; on another side, we propose a theoretical framework expansion by including totally novel factors to be analyzed in this context: satisfaction with socioeconomic status, economic environment improvement, and intolerance.

Keywords: energy poverty; life satisfaction; PLS–PM; health status; socioeconomic status

1. Introduction

Expressed under different labels—ranging from efficiency towards sustainability and conservation—energy continues to be a central topic to many contemporary debates in economics [1]. A key challenge around the energy concept is posed by the attempt to reach an accurate understanding of its multidimensional impact in terms of current patterns of consumption [2,3]. To this extent, the energy–poverty–climate nexus [4] is one of the comprehensive approaches shedding light on this direction, with a focus on energy poverty as a main concept of interest. From the environmental perspective, reducing energy poverty raises concerns related to potential negative impact on climate, while from the energy justice perspective, energy poverty is more than a mere technical or economic issue, turning into a fundamental social and political problem [5], as unjust social structures and institutions can exacerbate vulnerabilities and drive into energy poverty the susceptible groups of populations [6,7].

The concept of energy poverty seems somewhat self-explanatory in relation to its components—the minimum energy consumption needed to sustain lives—unlike other forms of "traditionally" defined poverty such as income or nutritional poverty. Nevertheless, it is hard to be articulated in an operational and quantifiable manner [8] that is able to cover all its facets, any metrics being prone to provide at best a better, but yet incomplete, understanding of the phenomenon. Despite the difficulty of devising

a good measurement for energy poverty [9], this is essential for national policy-makers, as it can have a powerful influence on establishing targets and monitoring progress. With this aim in view, even custom-made indicators accounting for particular geographical characteristics of a region have been devised [10].

With respect to concrete metrics, different authors advocate either the simplicity of a single indicator, or the capacity of a block of individual indicators to illustrate the multiple facets of the phenomenon. Combining the advantages of the previous two options, composite metrics like the Energy Development Index (EDI), the Multidimensional Energy Poverty Index (MEPI) and the Energy Poverty Index (EPI) are synthesizing the information of multiple indicators into one easy to use measure of energy poverty. This comes with the risk of losing significant information through aggregation and compensability between individual indicators, a problem settled in the hybrid method by additionally reporting individual variables alongside the composite index [9].

Energy poverty metrics cover a wide range of aspects related to energy access (the supply side perspective), energy affordability or deprivation (the demand side), energy security (reliable energy service), energy costs, domestic energy expenditures relative to household income, energy inputs and outputs, as well as many other dimensions [11–15]. Both objective quantitative indicators and subjective ones have their supporters. Among the popular quantitative measures of energy poverty there are the minimum level of energy necessary for domestic establishments (World Energy Assessment, UNDP 2000), household energy expenditures exceeding a certain share, as a symptom of energy hardships [16], and the "low income high cost" measure [17], which identifies energy poor households as having energy spending over the median and the remaining income under the relative poverty line. Many such measures have to rely largely on uncertain estimations and various approximations, and therefore can fail to reflect accurately the phenomenon. In contrast, qualitative measures based on surveys capture the particular impact of energy poverty on individuals, in their specific economic, social, and geographic contexts, which are highly relevant for designing narrow targeted, effective policy actions. Periodic surveys provide self-reported assessments of energy poverty, such as affordability of adequate heating, presence of dampness and mold in the house, or delays in energy payments. These measures represent consequential effects of energy poverty. They reflect, through personal evaluations, the specific impact of energy poverty at the household level, in the particular context of the actual living conditions. Some critics reject such energy poverty measures based on the desire to avoid subjective answers [18] or the need to take into account the specific cultural context [19].

In this paper, we take the energy affordability approach, selecting the negative response to the question "Can you afford adequate heating?" as an indication of energy poverty. This is an appropriate indicator for our research because the dependent variable—life satisfaction—is also self-assessed and the entire model addresses subjective dimensions. Energy poverty defined in terms of insufficient heating is frequently used in the literature [17,20–22] and a proxy variable very similar to our own (the response to the question whether a household can afford to keep their home adequately warm) was employed in many other studies [18,19,23–26].

As our paper will argue, this household approach on energy poverty assessment can have potential for designing welfare-enhancing energy efficiency policies. The information provided by our analysis shows that significant progress in achieving wellbeing objectives can be achieved by directly addressing energy poverty challenges. Specifically, the objective of the current work is to investigate the distinct mechanisms through which energy poverty is linked to life satisfaction, via health status and one's satisfaction with one's own socioeconomic status. Our research aims to promote awareness and recognition of the final well-being implications of inadequate energy supply, thus responding to increased interest in better understanding individual and household level effects of energy poverty. In the meanwhile, we acknowledge the fact that our results are relevant only for the 11 countries located in Central and Eastern Europe, and may not be generalizable to different areas of the globe.

To this aim, the rest of the paper proceeds as follows. Section 2 provides a short overview of the variables considered in our analysis and their hypothesized relationships in the context of the international literature. Section 3 describes the framework of analysis, based on data from the 2016 Life in Transition Survey (LITS) and the exploratory partial least squares–path modeling (PLS–PM) method. The results are discussed in Section 4, with a highlight on the mediating role of perceived improvement in one's personal life. Finally, in Section 5 we conclude the study and discuss the potential of a combined social and economic policy in the energy area.

2. Theoretical Background

The exploration of the relevant literature for our research agenda was guided by the key indicators involved in our modeling approach and the structure of the subsequent review was built around the main hypothesis of the empirical investigation.

Energy poverty. Energy poverty is a very complex and multifaceted concept, lacking a unified theoretical framework and measurement. Each of the measures used in the literature capture some aspects, leaving other dimensions uncovered [8,9,25]. The choice of measuring energy poverty through a micro (or consensual) approach, based on survey items, is in line with the need for more precise assessments of consumer vulnerabilities and the impact of energy poverty on people's wellbeing [9,27]. Even if such a modus operandi is limited in the sense of not being able to provide a benchmark for what constitutes an acceptable level of expenditure on energy, the item we took as a proxy—"Can you afford adequate heating of your dwelling?"—still captures indirectly the access dimension from the income and price perspective. While we are aware that insufficient heating is not an all-encompassing measure for energy poverty, it has been previously validated as a good proxy of it [18,19,23–26]. As it is stated in different working papers of the Vulnerable Consumer Working Group (VCWG), a structure of the European Commission, the common threads around the attributes of affordability and adequacy are converging into specific meanings: (1) affordable refers to accessing energy without going into debt, and (2) adequate mostly designates the energy level that provides a minimum state of comfort and health.

Qualitative insights illustrate the crucial role of understanding the social dimension of the region in choosing a particular indicator for energy poverty [28]. Interviews and focus groups reveal a lack of awareness of the topic and even a shameful aspect connected to the idea of struggling with such expenses [29]. The view that this is a private issue, thus under individual responsibility, may suggest a tailored approach, capturing how this perspective has potential to increase stress and social isolation, which act towards decreasing well-being. This angle also echoes the more nuanced definition of energy poverty formulated in [7] in terms of a household's inability to secure materially and socially necessitated levels of domestic energy services.

Bollino and Botti [30] highlight the rather limited effects of policy interventions on people's wellbeing, as a result of insufficient coverage and inadequate targeting processes. This matches the gap addressed by the paper as it bears upon the proper understanding of the mechanisms through which energy poverty affects population at personal and social levels, and not only the economic one.

As such, we formulate the first hypothesis:

H1: Energy poverty has a negative impact on life satisfaction.

Health status. Looking into the concrete channels through which energy poverty diminishes life satisfaction, the first choice, as signaled by the literature, refers to its health impact. The evidence varies, from the most obvious link with winter mortality [19,24,31–33], to more intricate problems such as heart and chronic respiratory diseases [34–36].

Furthermore, [26] make a compelling case in showing the prevalence of poor health in the energy poor versus non-energy poor populations, for a number of 32 European countries. Within their unequal distribution, Central and Eastern European countries occupy the first places in expressing the low health status in relation with energy poverty. Not least in importance, the impact of poverty on mental and emotional health is also to be accounted for, as it stands illustrated by a higher prevalence

of depression and anxiety [37]. Specifically, energy poverty seems to follow a similar pattern of influencing health through the proliferation of stigma and shame [38]. Thus, we argue that health status may play the role of a mediator in the relationship between energy poverty and life satisfaction.

H1a: Energy poverty has a negative impact on health status.

H1b: Poor health has a negative impact on life satisfaction.

The item used as a proxy for assessing health status—*How would you assess your health?*—is also considered as being revealing enough as an indicator for mortality [39]. Therefore, the significant impact of perceived health on life satisfaction is not surprising at all, with a wide array of evidence for different segments: older population [40], adolescents [41], medical students [42], etc.

Satisfaction with socioeconomic status. Socioeconomic status covers in the literature several dimensions like material wealth (including personal finance), occupation (directly related to job), and participation in various institutions involving educational and social dimensions [43], and it is considered the essence of the material life [44]. While socioeconomic status, in its either objective or subjective type of measurement, proved to be of great importance in predicting satisfaction with life, we hypothesize its mediating role in the relationship between various facets of poverty and life satisfaction.

To explain its relevance as potential mechanism through which the relationship between energy poverty and satisfaction with life holds, we will address two dimensions. On the one side, we discuss its role in predicting life satisfaction. On the other side, we explain that satisfaction with socioeconomic status varies with one's ability to meet basic needs, in particular in this case one's capability of affording enough heating. These two relationships are the building blocks of the indirect effect we expect from our mediator.

H1c: Energy poverty has a negative impact on satisfaction with socioeconomic status.

H1d: Satisfaction with socioeconomic status has a positive impact on life satisfaction.

In supporting H1c we depart from the idea that being unable to afford sufficient heating, however subjective its self-assessment may be, is a "basic-needs" type of scarcity [45]. Lack of resources is a signal of low economic status and entails self-questioning regarding evolution in life, self-efficacy, and self-esteem [46] which eventually harms one's satisfaction with the current situation in terms of finance and job. Previous research focused on how people experience energy poverty in the particular setting of not being able to afford enough fuel for heating [47], emphasizing its harmful role in building life satisfaction.

In support of H1d we argue that the role of satisfaction with job and finances is largely documented as crucial in building satisfaction with life [48]. Perception of socioeconomic life trajectory is also documented as predicting life satisfaction, or the stress associated with the dissatisfaction with life. The research explores self-assessed life satisfaction using direct measurements that proved to be consistent [49,50], or goes as deep as exploring biomarkers related to the stress associated with dissatisfaction with life [51,52].

We depart from the Oakes and Rossi [43] as well as Kraus and Keltner [44] perspectives and measure satisfaction with socioeconomic status based on three items from the 2016 LIT survey capturing individuals' satisfaction with household living conditions, job satisfaction, and financial situation. We applied a factor analysis and found that these three items load high in their corresponding latent variable, as Table 1 presents.

With respect to the control variables needed in the analysis, in addition to the standard check-ups for age, gender, and work status, we introduce two custom-made variables: economic environment improvement and intolerance.

Economic environment improvement. This latent variable was extracted based on a factor analysis applied to three items expressing the perception of economic and political changes within the country in the last four years and the associated degree of satisfaction (see Table 1 for details), and is relevant to the impact of the transformations of the post-socialist space [53] at the individual level. Moreover,

in general it correlates with quality of life [54] and political freedom [55], and, at its core, there is also the psychological mechanism of hedonic adaption that elicits positive effects on life satisfaction [56].

H2: Economic environment improvement has a positive impact on life satisfaction.

Intolerance. This variable, expressed through a single item measuring the magnitude of negative attitudes towards different social and racial categories as potential neighbors (see Table 1 for a complete description) is conceptualized as part of the personal social capital, viewed as a specific combination between trust and tolerance [57]. Linked with personal ties and social cohesion in general, social capital is proven to have a positive effect on wellbeing and life satisfaction [58,59], but there is a rather poor understanding of the influence of its singular components [60]. The results of the analysis performed by [57], also based on the 2016 wave of the LIT survey, indicate that individuals with greater levels of distrust and intolerance are less satisfied with life. We affiliate ourselves to the same approach when formulating working hypothesis 3:

H3: Intolerance has a negative impact on life satisfaction.

Work status. This variable captures the position in the labor market, identifying the respondents that have worked in the previous year. Work status has benefited from a lot of attention in relation with life satisfaction, most of the literature converging to an aggregate opinion that unemployment diminishes life satisfaction [61–63]. Different psychological pathways are at the basis of this relationship—anxiety, depression, lack of confidence, or low self-esteem—supporting the negative link to our latent variable of personal improvement. The influence of work status is rather similar when referring to health. Bambra and Eikemo [64] have shown that alongside the higher rates of mortality and morbidity, unemployed people expressed higher rates of poor health, for a set of 23 countries comprised in the 2002 and 2004 waves of the European Social Survey. While this view is widespread in the literature [65,66], there are however some concerns that the negative relationship lacks validity at a longitudinal level [67].

H4: Work status (unemployment) has a negative impact on life satisfaction.

H4a: Work status (unemployment) has a negative impact on health status.

H4b: Work status (unemployment) has a negative impact on personal improvement.

Gender. As it is the case with gender differences for many traits and topics, the evidence pertaining to energy poverty is rather mixed and spatially contextual. A somewhat accepted point of view is that women suffer from higher degrees of energy vulnerability [30]. Consistent with the approach that states the scarcity of empirical studies clearly focused on gender relevant factors in relation to energy poverty [68], we prefer to postulate a moderation hypothesis and not one that implies a certain directionality.

H5: Gender moderates the relationship between health status and life satisfaction.

Age. For most studies the age variable is a standard one in the control category, but in our case it does have a naturally salient dimension regarding the impact upon both variables of interest. First, with respect to health status, ageing is usually associated with a significant increase in perceived risks and fears [69,70]. Even if further along the relationship between health beliefs and behavioral change does not follow necessarily a linear path [71], in terms of the self-reported appreciation of health, we can safely postulate hypothesis H6a. Second, the envisaged shape of life satisfaction across the lifespan follows a similar understanding of an inherent relationship with ageing, but with a higher degree of variation regarding directionality [72]. This lack of convergence derives from the complex mix of objective and subjective factors that act as determinants of life satisfaction [54]. Within the vast conceptual heterogeneity, we take upon the perspective brought by the socioemotional selectivity theory [73,74] and posit hypothesis H6b that accounts for becoming more satisfied with life, as one grows older.

H6a: Age has a negative impact on health status.

H6b: Age has a positive impact on life satisfaction.

3. Methods and Data

Aiming to estimate the contemporary relationships between energy poverty and life satisfaction, in conjunction with potential mediators and moderators of this link, we performed a partial least squares–path modeling (PLS–PM) analysis [75], which belongs to the family of structural equation models (SEM). The PLS–PM is an exploratory method, which already proved to be very useful in various fields, and it is based on an iterative algorithm that minimizes the variance of the actual data, as it will be discussed in the subsequent paragraphs. One of the main limitations of the method, the fact that PLS–PM provides latent variable measurement based on composites and thus does not fully account for measurement errors, was addressed in recent WarpPLS implementation [76]. The method is suitable for our purposes for it is robust even if the data is not normally distributed [77] and it has the ability to enable group comparison, a very useful feature whenever multigroup analysis is needed [78]. Its tests regarding the Simpson's Paradox, suppression statistics cases, potentially bivariate relationships, or reversed relationships are other important advantages for accurate analysis of data [79].

The standard approach of this method is defined by a combination between an outer and an inner model [80]. Firstly, the measurement (outer) model generates the exogenous latent variables by mixing the initial manifest variables in specific proportions. The structural (or inner) model further employs these estimations to identify the relationships between the latent constructs (and supplementary manifest variables, if necessary) and the endogenous (outcome) latent variable, capturing the effects on the latter. The PLS–PM method performs an iterative algorithm, based on partial OLS (Ordinary Least Squares Regression) estimations, achieving higher explained variance of the endogenous latent variables compared to covariance-based SEM technique [81].

Whilst adopting the individual, self-reported approach on energy poverty, researchers use either the Eurostat's Statistics on Income and Living Conditions (SILC) survey [82] or the European Quality of Life survey (EQLS). As a novelty and a distinctive feature, our research draws on the Life in Transition survey (LITS), focusing on the specific circumstances in the Central and Eastern European region, assessed as being the worst affected by inadequate energy supply [26].

Our sample contains 19,598 individuals from 13 countries. Eleven of them are former communist states located in Central and Eastern Europe: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Poland, Romania, Latvia, Lithuania, Slovakia, and Slovenia. These countries share many similarities as they all have a post-communist heritage, belong to the same human development group, have transitioned to market economy and gained EU membership. For comparison, we added the only developed western European countries available in the survey, namely Germany and Italy. Given the lack of statistical significance for the energy poverty topic, with only 11 persons (from over 1500) admitting house heating deprivation, Germany was later removed from the sample.

The data were drawn from the 2016 (most recent) wave of the Life in Transition survey, jointly organized by the European Bank for Reconstruction and Development and the World Bank, covering a total of 34 countries and providing various information on a large range of factors that illustrate how transition impacted the daily life of their citizens. Among the surveys offering similar proxies for energy poverty, there are the national Household Budget surveys, European Quality of Life survey, and the EU Statistics on Income and Living Conditions (EU–SILC). As a novelty, we chose to employ Life in Transition survey as source of our data because it provides useful information on other potential explanatory variables for life satisfaction that we explored through our model. This survey focuses on transition countries, including the former communist countries from Central and Eastern Europe, the part of European Union most affected by energy poverty, and the target of our own research.

We selected the relevant variables for the research guided by our goal of exploring the impact of energy poverty on life satisfaction. In Table 1, columns 1 and 2 describe the variables, according to their role in the model.

Table 1. The variables.

Manifest Variables	Item			Mean	Standard Variation
1	2			3	4
Energy poverty	Can you afford adequate heating of your dwelling? Yes = 1 No = 2			93.5% 6.5%	-
Health status	How would you assess your health? 5-point Likert scale, from Very good = 1, to Very bad = 5			2.51	0.92
Work status	Did you work during the past 12 months? Yes = 1 No = 2			61.4% 38.6%	-
Age	Respondent's age (years)			51.88	17.74
Gender	Male = 1 Female = 2			44.1% 55.9%	-
Intolerance	Percentage of affirmative responses to the question: "Could you please mention any that you would not like to have as neighbors? Families with children/Pedophiles/Drug addicts/People of a different race/People who have AIDS/Elderly people/Immigrants/Foreign workers/Homosexuals/Gypsies/People of a different religion/Poor people/Heavy drinkers/Unmarried couples living together/Jewish people/People who speak a different language"			4.29	2.888
Exogenous Latent Variables	**Items Rated on 5-Point Likert Scale, From 1 = Strongly Disagree to 5 = Strongly Agree**	**Factor Loadings**	**D.G. rho**	**AVE**	**Cronbach's Alpha**
Economic environment improvement	The economic situation in our country is better today than around 4 years ago	0.889	0.888	0.726	0.811
	The political situation in our country is better today than around 4 years ago	0.860			
	On the whole, I am satisfied with the present state of the economy	0.805			
Satisfaction with socioeconomic status	My household lives better nowadays than around 4 years ago	0.750	0.831	0.621	0.693
	All things considered, I am satisfied with my job as a whole	0.760			
	All things considered, I am satisfied with my financial situation as a whole	0.850			
Endogenous (Outcome) Variable	**Item Rated on 5-Point Likert Scale, From 1 = Strongly Disagree to 5 = Strongly Agree**			**Mean**	**Standard Variation**
Life satisfaction	All things considered, I am satisfied with my life now			3.5	1.06

We provide the mean and standard variation for manifest variables and the standard statistical information (to be discussed in the next section) for the latent variables (Table 1).

4. Results

The dependent latent variable in our study is self-assessed satisfaction with life, predicted by a mix of manifest and latent variables. The preliminary investigation of the explanatory variables was

carried out with two R packages: "plspm" and "plsdepot", while for the subsequent PLS–PM analysis we used WarpPLS 6.0.

The 11 post-communist countries in our sample have common characteristics, most likely due to geographical proximity and their communist heritage, including poor energy efficiency of the housing stock. In addition to previously documented similarities, we found significant impact of energy poverty on life satisfaction for the citizens of the countries in our sample. Nevertheless, there might still be important differences from one country to another and we should statistically test the life satisfaction gap between energy poverty and non-energy poverty groups, for each individual country.

Based on the indications of Welch two-sample t-tests (Table 2), we are confident that the mean differences in life satisfaction, for the energy poverty versus the non-energy poverty groups, are indeed statistically significant for every country in our sample, including the more developed ones.

Table 2. Welch two-sample t-tests for mean differences by country.

Country	Mean Life Satisfaction for Non-Energy Poverty Group	Mean Life Satisfaction for Energy Poverty Group	Difference in Mean Life Satisfaction	t-Statistic	*p*-Value
Bulgaria	3.000	2.135	0.87	11.03	$<2.2 \times 10^{-16}$
Croatia	3.490	2.186	1.30	7.6346	1.806×10^{-10}
Czech Rep.	3.537	2.946	0.59	3.6643	0.0007592
Estonia	3.611	3.000	0.61	6.1917	4.927×10^{-9}
Germany	3.909	3.818	0.09	0.345	0.7373
Hungary	2.909	2.211	0.70	5.295	6.42×10^{-7}
Italy	3.189	2.341	0.85	5.364	2.621×10^{-6}
Latvia	3.496	2.897	0.60	4.9781	2.521×10^{-6}
Lithuania	3.432	2.733	0.70	8.95	$<2.2 \times 10^{-16}$
Poland	3.479	2.588	0.89	7.151	2.116×10^{-10}
Romania	3.129	2.525	0.60	5.146	1.143×10^{-6}
Slovak Rep.	3.327	2.909	0.42	2.7793	0.007898
Slovenia	3.622	3.085	0.54	3.9022	0.0002071

Note: Alternative hypotheses: mean difference is not zero.

The heating-related differential in life satisfaction is extremely large in Croatia, Bulgaria, Italy, and Hungary, while reaching a minimum in the richest country in the sample, namely Germany, characterized by a very low incidence of poorly heated households (Figure 1). From the EU member countries, Bulgaria is the most affected by energy poverty, despite long efforts directed towards energy subsidies and direct household financing. Energy inefficiency of the old building stock, combined with income poverty and steadily increasing costs, perpetuate heating deprivation in many Bulgarian houses.

Geographical variations in the energy poverty landscape are largely grounded in differences in primary energy sources and their efficiency, and also depend on specific energy-related policies, including national regulations regarding energy supply, prices, and taxation. The post-communist countries in our sample have similar energy efficiency problems, ensuing from the old and poorly maintained building stock, dependence on external sources of energy, and increased vulnerability of their large low-income population [82,83]. On an individual level, alongside objective personal income inequalities and disparities in building infrastructure (such as quality of thermal insulation and efficiency of heating appliances), subjective emotional factors also play their part, conditioning the perceived heating deprivation and the strengths of its effect on general wellbeing, as revealed by our model.

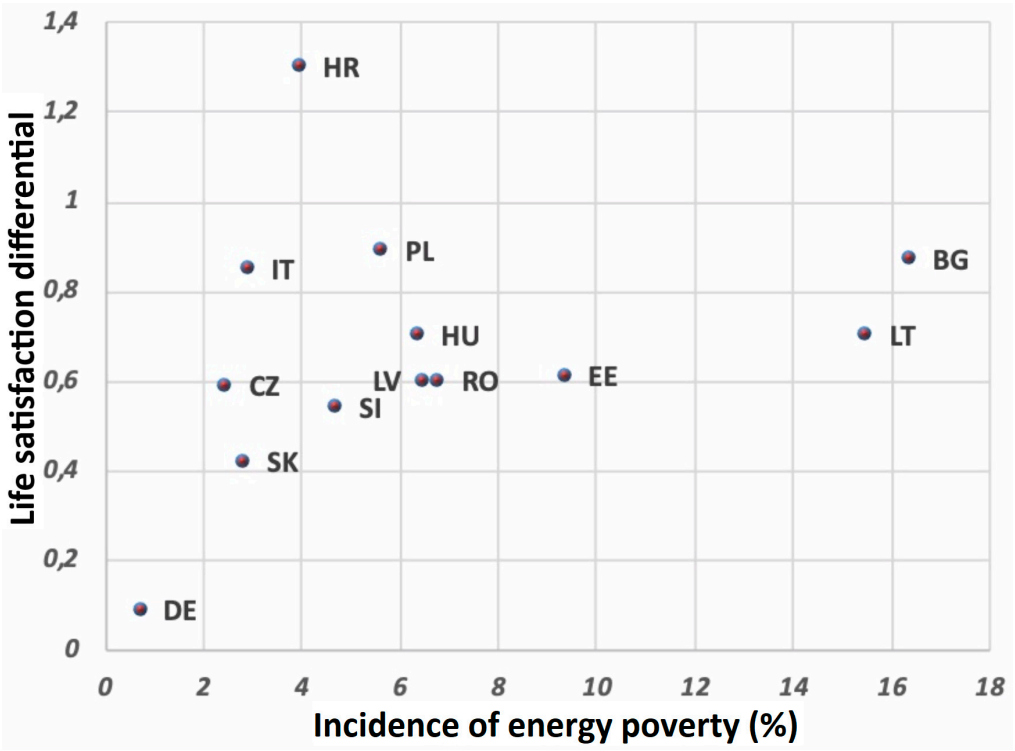

Figure 1. Life satisfaction differential between non-energy poverty and energy poverty groups in relation to energy poverty incidence. Note: BG—Bulgaria, HR—Croatia, CZ—Czech Rep., EE—Estonia, DE—Germany, HU—Hungary, IT—Italy, LV—Latvia, LT—Lithuania, PL—Poland, RO—Romania, SK—Slovak Rep., SI—Slovenia.

Measurement (outer) model. Firstly, the outer model had to be validated through a series of standard statistical tests. The assessment of the outer model addresses its internal consistency (composite reliability), the reliability of the variables, as well as the convergent and discriminant validity of variable constructs. As Table 1 clearly illustrates, the measurement model performs well, all test values being situated well above their specific minimum thresholds, as follows: 0.70 for composite reliability D.G. rho [84], 0.50 for average variance extracted (AVE) and 0.7 for Cronbach's alpha coefficients. There is one minor nonconformity, as the latent variable personal improvement scores only 0.693 at Cronbach's alpha. This is nevertheless quite acceptable given that it has few manifest variables in its composition [85].

Table 1 also shows the discriminant validity (inter correlations) of variable constructs, based on the loadings (contributions) of the manifest variables to the two exogenous latent variables—personal improvement and economic environment improvement. All factor loadings are relatively large (above 0.75) and highly significant ($p < 0.001$).

The discriminant validity of the measurement scales is substantiated in Table 3: the square roots of the AVEs displayed on the main diagonal largely surpass the off-diagonal values. Moreover, all off-diagonal correlations are below the 0.8 required threshold [86]. To conclude, all verifications confirm that the two latent variables—personal improvement and environmental improvement—are adequate for our analysis.

Table 3. Discriminant validity of variable constructs.

Latent Variable	Satisfaction with Socioeconomic Status	Environmental Improvement
Satisfaction with socioeconomic status	0.788	0.506
Economic environment improvement	0.506	0.852

Note: The diagonal elements in italic are square root of average variance extracted (AVEs).

Structural (inner) model. We further applied the Wrap 3 procedure to estimate the structural model. Since a direct test of the path coefficients is not available in the PLS–PM analysis, model testing had to be carried out through a bootstrap procedure [81], with 999 resampling.

The resulting structural model is free from multicollinearity (as the maximum variance inflation factor of 1.9 is well below the 5 threshold) and there is no Simpson's Paradox or bivariate causality direction. The model also performs well in terms of goodness of fit: large Tenenhaus GoF (0.514) and small SRMR (0.065), which is inferior to the 0.08 threshold in Hu and Bentler [87].

The final results from estimating the inner model are displayed in the form of direct effects and direct effect sizes (Table 4), and indirect and total effects on life satisfaction.

Table 4. Direct effects and direct effect sizes.

Header Variables	Direct Effects			Direct Effect Sizes (f^2)		
-	Health Status	Satisfaction with Socioeconomic Status	Life Satisfaction	Health Status	Satisfaction with Socioeconomic Status	Life Satisfaction
Health status	-	-	−0.112 *** (0.007)	-	-	0.030
Satisfaction with socioeconomic status	-	-	0.592 *** (0.007)	-	-	0.394
Energy poverty *No: reference Yes*	Reference 0.085 *** (0.007)	Reference −0.173 *** (0.007)	Reference −0.050 *** (0.007)	0.011	0.033	0.009
Work status *Yes: reference (employment) No*	Reference 0.149 *** (0.007)	Reference −0.209 *** (0.007)	Reference −0.060 *** (0.007)	0.060	0.047	0.007
Age	0.424 *** (0.007)	-	−0.002 (0.007)	0.219	-	0.000
Economic environment improvement	-	-	0.087 *** (0.007)	-	-	0.035
Intolerance	-	-	−0.006 (0.007)	-	-	0.000
Health status * Gender	-	-	−0.017 * (0.007)	-	-	0.002
R^2/ Adjusted R^2	28.9%/28%	8%/7.8%	47.9%/47%	-	-	-

*** p-value < 0.001; * p-value < 0.05.

Table 5 displays total effect sizes, similar to Cohen's f^2. These effects will be discussed in the last section, in terms of their implications for practical interventions.

Table 5. Indirect and total effects on life satisfaction and total effect sizes.

Header Variables	Sum of Indirect Effects	Total Effects (Direct Effect + Sum of Indirect Effects Via Mediators)	Effect Sizes for Total Effects
Health status	-	−0.112 *** (0.007)	0.030
Satisfaction with Socioeconomic Status	-	0.592 *** (0.007)	0.394
Energy poverty *No: reference* *Yes*	Reference −0.112 *** (0.007)	Reference −0.162 *** (0.007)	0.030
Work status *Yes: reference (employment)* *No*	Reference −0.140 *** (0.007)	Reference −0.200 *** (0.007)	0.025
Age	−0.047 *** (0.005)	−0.049 *** (0.007)	0.005
Economic environment improvement	-	0.087 *** (0.007)	0.035
Intolerance	-	−0.006 (0.007)	0.000
Health status * Gender	-	−0.017 * (0.007)	-

*** p-value < 0.001; * p-value < 0.05.

The direct, mediated, and moderated relationships between all variables in the PLS–PM model are pictured more clearly in Figure 2.

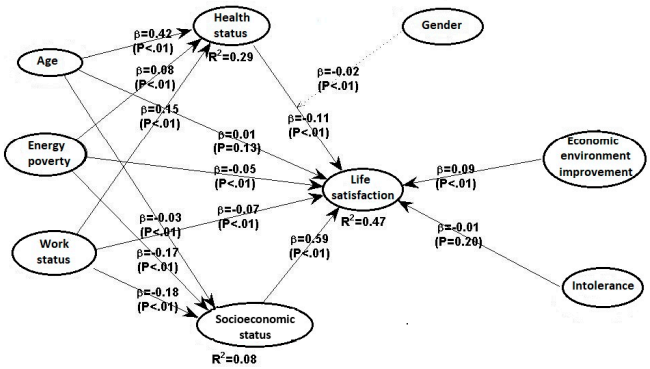

Figure 2. The estimated structural model.

The mediation models

Health status. The first mediator, health status, is predicted by energy poverty, work, and age, having an explanatory power of 29%. All three predictors are relevant in explaining the variations in the outcome, as follows: age is negatively correlated with health status, which is not only intuitive, but confirms previous findings obtained by the National Institute on Aging in 2011. Those who experience energy poverty score higher for health status, thus indicating poorer health, as revealed likewise by studies based on data from the European Quality of Life survey [26]. Insufficient heating increases not only the probability of colds, but also the risk of more dangerous diseases, such as cardiac and respiratory ones [88,89].

In a similar vein, working correlates positively with better health. The persons that did not work during the past 12 months declared higher scores (meaning worse physical shape) for health status. As expected, health status is statistically significant in predicting life satisfaction, since good health is an essential ingredient of well-being [90].

Satisfaction with socioeconomic status. The second mediation model, although with a far lower explanatory power of only 8%, reveals that work status and energy poverty are significant predictors for the respondents' satisfaction with their socioeconomic status. As expected, those who experience energy poverty declare that these aspects of their lives did not improve, while those who do not experience energy poverty are more likely to score higher in their levels of contentedness. A similar result holds for the other predictor, work status, the unemployed having significantly lower levels of satisfaction with socioeconomic status and overall life satisfaction. Overall, the perceived level of the mediator is a statistically significant predictor of life satisfaction.

Table 5 shows that the sum of the indirect effects of energy poverty on life satisfaction via these two mediators is sizeable and statistically significant. Also, the overall model explains 49% of the variation in life satisfaction.

The moderation effect. Our results reveal that poor health predicts lower levels of life satisfaction. Since previous research indicated that most common diseases develop differently for women and men, leading on average to dissimilar levels of health and wellbeing [91,92], we added the moderating role of gender in this equation. Caring for the physical and emotional well-being of their families, women usually acquire relevant health information [93,94] and are more likely to apply better health choices than men [95]. Our results indicate that indeed gender moderates the relation between health status and life satisfaction, as the women in our sample achieve higher contentedness via good health.

In terms of effect size, Table 4 shows that energy poverty has a low contribution to health status (0.011) but a larger contribution to satisfaction with socioeconomic status (0.033), thus indicating that interventions on energy poverty may not greatly improve the level of health, which can be better explained by many other genetic, situational, and lifestyle factors, but can have an influence on how people feel about their life. The effect in this second case, although small, is high enough to have practical significance [96]. Not only satisfaction with socioeconomic status, but also the perception of a better economic and political situation in the country (economic environment improvement) can increase the satisfaction of the individuals in our sample, even if in a lower degree (0.035). Aging also has a direct diminishing effect on well-being, a long-established fact in the literature, although this correlation is sometimes disputed [97] as it needs to be analyzed in more specific contexts, in connection with other explicative factors.

Even if the corresponding predictor is statistically significant, we will not discuss the effects placed below the 0.02 threshold, since they are usually deemed irrelevant for the dependent variable [78].

In depth country comparison. Since we finally dropped Germany from the analysis due to its very low number of energy poor cases, Italy (the only remaining developed country in the LIT survey) is further used for inter-country comparisons. In Table 6, Italy is compared with each of the other countries in the sample in terms of absolute differences in path coefficients, for all independent variables (listed on the columns) of the model. It is noteworthy that the comparison between pairs of countries was expressed in absolute values, and the results do not show which estimated country coefficient is higher.

Table 6. Differences across countries in the estimated path coefficients.

Variable	Economic Environment Improvement	Intolerance	Health Status	Socioeconomic Status	Age	Energy Poverty	Work Status	Gender * Health
Bulgaria Versus Italy								
Life satisfaction	0.020 (0.290)	0.025 (0.249)	0.053 (0.071)	0.057 (0.051)	0.016 (0.331)	0.040 (0.135)	0.028 (0.224)	0.034 (0.174)
Health status	-	-	-	-	0.066 * (0.031)	0.066 * (0.034)	0.201 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.041 (0.128)	0.099 ** (0.003)	0.079 * (0.014)	-
Croatia Versus Italy								
Life satisfaction	0.030 (0.205)	0.010 (0.389)	0.030 (0.205)	0.085 (0.008)	0.009 (0.401)	0.015 (0.340)	0.052 (0.077)	0.038 (0.146)
Health status	-	-	-	-	0.059 * (0.048)	0.021 (0.283)	0.089 ** (0.007)	-
Socioeconomic status	-	-	-	-	0.065 * (0.038)	0.101 ** (0.002)	0.051 (0.080)	-
Czech Republic Versus Italy								
Life satisfaction	0.111 *** (<0.001)	0.022 (0.270)	0.017 (0.320)	0.105 ** (0.001)	0.116 *** (<0.001)	0.030 (0.202)	0.056 (0.062)	0.001 (0.487)
Health status	-	-	-	-	0.079 * (0.012)	0.014 (0.350)	0.084 * (0.010)	-
Socioeconomic status	-	-	-	-	0.047 (0.099)	0.016 (0.330)	0.051 (0.080)	-
Estonia Versus Italy								
Life satisfaction	0.065 * (0.036)	0.028 (0.217)	0.033 (0.184)	0.128 *** (<0.001)	0.086 * (0.009)	0.004 (0.460)	0.036 (0.164)	0.028 (0.220)
Health status	-	-	-	-	0.054 (0.062)	0.031 (0.196)	0.147 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.171 *** (<0.001)	0.053 (0.073)	0.077 * (0.017)	-
Hungary Versus Italy								
Life satisfaction	0.071 * (0.025)	0.027 (0.231)	0.025 (0.242)	0.014 (0.343)	0.098 ** (0.004)	0.006 (0.433)	0.052 (0.075)	0.036 (0.159)
Health status	-	-	-	-	0.119 *** (<0.001)	0.026 (0.238)	0.169 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.072 * (0.024)	0.007 (0.428)	0.107 ** (0.002)	-
Latvia Versus Italy								
Life satisfaction	0.050 (0.085)	0.008 (0.414)	0.047 (0.097)	0.151 *** (<0.001)	0.044 (0.114)	0.019 (0.304)	0.085 ** (0.009)	0.011 (0.377)
Health status	-	-	-	-	0.088 ** (0.006)	0.024 (0.250)	0.136 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.042 (0.124)	0.015 (0.343)	0.064 * (0.038)	-
Lithuania Versus Italy								
Life satisfaction	0.092 ** (0.006)	0.009 (0.399)	0.003 (0.470)	0.151 *** (<0.001)	0.082 * (0.012)	0.035 (0.165)	0.069 * (0.029)	0.112 ** (0.001)
Health status	-	-	-	-	0.033 (0.172)	0.017 (0.316)	0.118 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.138 *** (<0.001)	0.102 ** (0.002)	0.049 (0.089)	-
Poland Versus Italy								
Life satisfaction	0.066 * (0.034)	0.097 ** (0.004)	0.046 (0.100)	0.032 (0.179)	0.024 (0.251)	0.027 (0.230)	0.069 * (0.028)	0.006 (0.440)
Health status	-	-	-	-	0.041 (0.124)	0.042 (0.122)	0.107 ** (0.002)	-
Socioeconomic status	-	-	-	-	0.077 * (0.017)	0.049 (0.085)	0.049 (0.085)	-

Table 6. *Cont.*

Variable	Economic Environment Improvement	Intolerance	Health Status	Socioeconomic Status	Age	Energy Poverty	Work Status	Gender * Health
Romania Versus Italy								
Life satisfaction	0.026 (0.237)	0.018 (0.314)	0.012 (0.366)	0.019 (0.289)	0.037 (0.156)	0.012 (0.366)	0.053 (0.071)	0.050 (0.086)
Health status	-	-	-	-	0.063 * (0.038)	0.055 (0.063)	0.159 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.124 *** (<0.001)	0.049 (0.087)	0.012 (0.368)	-
Slovak Rep. Versus Italy								
Life satisfaction	0.115 *** (<0.001)	0.023 (0.264)	0.001 (0.487)	0.108 *** (<0.001)	0.049 (0.088)	0.048 (0.094)	0.032 (0.185)	0.001 (0.487)
Health status	-	-	-	-	0.050 (0.076)	0.042 (0.123)	0.144 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.031 (0.198)	0.016 (0.324)	0.010 (0.387)	-
Slovenia Versus Italy								
Life satisfaction	0.021 (0.285)	0.026 (0.238)	0.062 * (0.043)	0.204 *** (<0.001)	0.091 ** (0.006)	0.002 (0.476)	0.034 (0.176)	0.033 (0.181)
Health status	-	-	-	-	0.111 *** (<0.001)	0.028 (0.220)	0.121 *** (<0.001)	-
Socioeconomic status	-	-	-	-	0.024 (0.254)	0.003 (0.467)	0.018 (0.305)	-

*** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05.

The one-on-one comparisons between Italy and the rest of the countries point to statistically insignificant inter-country differences in the relationship between energy poverty and life satisfaction, as mediated by health status and socioeconomic status. The only exceptions are Bulgaria, at the level of both energy poverty–health status and socioeconomic status–energy poverty links, and respectively Croatia and Lithuania, only for the segment socioeconomic status–energy poverty. Even in these few instances, the differences in path coefficients against Italy are quite low.

We believe that this outcome is at least partially derived from the subjective measurements of all three variables involved in the discussion. Thus, it does not objectively show that all countries are at the same level, as one may be easily tempted to speculate, but rather it suggests that we are looking at the same adaptation mechanism to a certain national reference point (albeit, a different one in each country).

5. Discussion, Conclusions, and Research Limitations

Current work on energy poverty is more focused on traditional, objective, and infrastructure-related variables than on self-perceived energy poverty as determinants and implications. Our research brings an unconventional perspective to some neglected facets of the impact subjective energy poverty has upon life satisfaction, in more precise terms than the negative relationship already unveiled in previous studies [26,98–100]. Strengthening and expanding this literature niche may be a crucial aspect in increasing the awareness about the major role played by energy policies for the wellbeing of a society, in connection to health and social measures. The paper also contributes to the extant literature by narrowing its focus to Central and Eastern European countries, marked by sizeable rates of energy poverty due to structural and institutional difficulties, such as poor housing stock quality, high income inequalities, low purchasing power, different unsynchronized measures for economy deregulation, and liberalization of energy markets [18,53].

Concretely, there are two main directions derived from our findings: (1) we continue to consolidate the existing link between energy poverty and self-reported health, and (2) we propose a theoretical

framework expansion by including totally novel factors to be analyzed in this context: satisfaction with socioeconomic status, economic environment improvement, and intolerance.

Previous research discusses the negative effects of energy poverty in terms of health issues, namely diagnosed problems and perceived health. Our first contribution is to confirm the importance of this mediator as one of the mechanisms through which energy poverty may impact life satisfaction.

The less evident mechanism is the one via satisfaction with socioeconomic status: energy poverty leads to low levels of self-esteem and consequently to diminished satisfaction with life. The perception captured in the satisfaction with socioeconomic status variable is nothing other than what is more commonly labeled as subjective meaning-making—the manner in which individuals translate into their own understanding both their personal and different social contexts. Such an understanding can act both positively or negatively upon grasping opportunities, and thus upon the feelings associated with life in general [101].

As our results reveal, unlike the effect size of energy poverty on life satisfaction via health status, too small to support effective intervention, satisfaction with socioeconomic status can be considerably improved by reducing energy poverty. This means that by ignoring this second mechanism we miss an essential tool for understanding the major consequences of energy poverty, and for addressing them correspondingly. Being dissatisfied with one's own socioeconomic status is something that neither translates into salient costs, as explicit health issues do (like for example curing a flu), nor triggers extreme interest for public decision makers. More precisely, because it is difficult to be fully aware and to account, at a personal level, for the effects of this dissatisfaction, there is a major risk to treat it marginally or to ignore it. Gradually, on the long run, this may grow into a fertile field for emotional distress and much more concrete treatment costs.

More so, as our results show, the lack of satisfaction with one's own socioeconomic status lowers life satisfaction more than poor health status does. This somewhat counterintuitive finding, at first glance, is actually another proof of how undervalued the meaning of mental state (and mental illness) is, both in the eyes of the government and the public [102]. The important, even essential, distinction here is that health status is socially valued and supported by public policy, while low levels of self-esteem as a result of dissatisfaction with one's own achievements is not on the public agenda. This is especially true in our analyzed countries, where psychological vulnerability is still a social stigma and, consequently, there are no appropriate mental health protocols and infrastructure.

A lot of effort has been paid to alleviate different facets of poverty, the main focus being on the type of needs placed at the bottom of Maslow's hierarchy. This view is consistent with the concept of absolute poverty, even if the role of relative poverty as a measurement tool is highly acknowledged. What our results reveal is that energy poverty, as with any other form of poverty, touches deeper dimensions of our humanity that are less salient and thus less addressed by policy makers. In other words, the welfare significance of energy poverty has a prominent personal dimension, probably overriding to some extent income poverty.

This is a topic to be further investigated and it actually leads to the main limitation of this research: the boundaries of our database. The quantitative measure used in this paper is relatively narrow, expressing only one facet of energy poverty, namely deficient heating. As a self-assessed indicator, energy poverty, and the other variables, likewise, might suffer from a subjectivity bias. Another important word of caution lies in the inherent limits of the PLS–PM method that we used. An alternative study involving measurements based on factors rather than composites may bring new insights on the topic. Also, hierarchical modeling, accounting for the different countries in our sample, could be a good alternative to our multi-group analysis and comparison. The country comparison results reinforce the methodological concern regarding the limits of cross-country comparison based on subjective indicators, but at the same time they also strengthen the need for locally tailored interventions.

Despite such inherent limitations, we believe that self-reported energy poverty provides a better insight into the real-life experience of individuals and is therefore a relevant and appropriate instrument

for analysis. In the end, our analysis of the energy poverty impact on life satisfaction addresses what should be the ultimate goal of any economic or social policy, namely improving population well-being.

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