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291 Energy Poverty and Health: Transitioning to a Bioeconomy in Romania and the EU

John M. Polimeni[1], Mihaela Simionescu[2], Raluca I. Iorgulescu[3]

[1]Albany College of Pharmacy and Health Sciences, 106 New Scotland Ave, Albany, NY USA, jm.polimeni@verizon.net

[2]Institute for Economic Forecasting-NIER, Romanian Academy, Bucharest, Romania, mihaela_mb1@yahoo.com

[3]Institute for Economic Forecasting-NIER, Romanian Academy, Bucharest, Romania, raluca.iorgulescu@gmail.com

Abstract

Reducing the energy poverty, while also improving the economic development and health of a country is a priority for institutions such as the World Bank and the European Union. Defining residential energy as a condition where households cannot afford energy to a necessary level, is a good start but does not include other important energy measures such as caloric intake. Eastern Europe is not often considered in this context. However, since the end of socialist dictatorships there have been many energy, housing, economic, and social reforms that have had implications for energy poverty. This study examines the interaction between energy poverty, socioeconomic indicators, health, and economic development for Romania and the European Union. A comparative analysis of Romania with their European counterparts. A panel analysis is used to show the relationship energy poverty and health interaction for the EU-27 countries. A time series ARDL model is used to examine the relationship for Romania. This comparative analysis enables Romania's standing to the rest of Europe, illustrating any disparities that exist between energy poor and non-energy poor societies in Europe, to be shown. The results of the panel analysis show a long-run relationship between self-perceived health, arrears on utility bills, and population unable to keep home adequately warm. There are also short-run connection for the population unable to keep home adequately warm to self-perceived health as bad or very bad for females and current health expenditure with self-perceived health as bad or very bad. The results for Romania suggest that being arrears on utility bills and population unable to keep home adequately warm enhance self-perceived health as bad or very bad for overall population and for females. The results are used to show the bigger political and economic context in which energy policy should be discussed. To effectively introduce bioeconomic policies on a large-scale efforts the energy system in Romania and other energy poor countries in Europe must be improved and modernized.

Keywords: Energy Poverty, Bioeconomy, Health

Introduction

Energy poverty is one of the biggest issues facing the world today and a priority for institutions such as the World Bank and the United Nations. “Eradicating poverty is the greatest global challenge facing the world today and an indispensable requirement for sustainable development, particularly for developing countries … This would include actions at all levels to: … Assist and facilitate …the access of the poor to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services” (United Nations 2002, p. 9, 12). There is an expanding body of literature that energy poverty is problematic in Eastern Europe due to the specific social and physical conditions that exist there, such as cold climates, the liberalization of energy prices, and the reliance on foreign sources for their energy supplies, for example, Russia (Lampietti and Meyer, 2002; Buzar, 2007).

The former socialist countries in Eastern Europe placed an emphasis on energy security and developing new sources to supply excessive energy consumers, heavily reliant on carbon-based fuels; they also had an energy intensity problem - a low value on energy and other natural resources leading to their overconsumption (Gray, 1995). The centrally planned economies treated housing and heating as goods and services accessible for all, so housing, public transportation fees, and energy were heavily subsidized (Duke and Grime, 1997). As a result, consumers had no reality of the true cost of energy.

Making matters worse, the vast majority of urban households in the centrally planned Eastern European countries had direct heating. According to Buzar (2007) the centrally located combined heat and power or heat only boiler plants typically burn coal or fuel oil in order to produce hot water usually for space heating and direct household use. The hot water was transported through pipelines to substations where it was distributed to collective or individual buildings. The direct heating pipes and apartment buildings were vertical requiring radiators in rooms that were on top of each other to be supplied by the same pipe. Therefore, measuring energy consumption at the household level was very difficult, especially since meters are often not used. As a result, room temperatures were frequently too low or too high, causing windows to be open to cool over heated rooms leading to losses of heat.

With the end of the centrally planned system, the subsidies that existed for energy costs were put under pressure to be removed. As a result, the privatization or partial privatization of the energy industry in these countries slowly occurred. The idea was that consumers would pay the full economic cost of production, distribution and supply of electricity they consume (Stern and Davis, 1998). However, direct heating systems

remained largely because there were insufficient financial resources available to operate, maintain, rehabilitate, and modernize heating systems (European Commission, 2016).

In contrast, Western European countries largely rely on decentralized heating systems. These countries created more stringent building and efficiency standards in the late 1960s and early 1970s to counter high energy prices (Berkland, 2014). As a result, many countries in Western Europe, such as the United Kingdom, Spain, Germany, Italy, and France, have residential natural gas and oil boilers or direct electric heating systems as their main unit. In Nordic countries, such as Finland, biomass stoves and furnaces are typical for residential purposes (European Commission, 2016). Additionally, Western European nations have progressed more in shifting to renewable energy, such as solar thermal energy.

Regardless of the two vastly different approaches that Eastern and Western European countries take for their heating needs, energy poverty persists impacting those most vulnerable. The vulnerable populations include those with little marketable skills and less mobility, such as children, the elderly, women, the disabled, some minority groups, and single parents (Torrey et al., 1999; Cornia et al., 1996). However, there are other groups that are just as much at risk. For example, young adults who may have just graduated and are looking for employment, the long-term unemployed, and those that live pay check to pay check. This last group, considered the working poor, do not necessarily fit the definition of the economic poor. These people could have well-paying jobs but may not have the ability to pay for their energy needs.

Unlike income poverty, which can be defined as having a lack of financial resources, energy poverty is much more intricate. Energy poverty can be related to poverty, but does not have to be. Energy poverty can be related to domestic energy efficiency but does not have to be. Energy poverty can be related to political circumstances but does not have to be. As a result, energy poverty is very difficult to define due to its complexity. In developing countries, the search for energy is a continuous battle (Sovacool, 2014). However, those in developed countries are not immune to the problem of energy poverty either.

This paper examines the issue of energy poverty in Europe, providing a comparative analysis of the European Union and Romania. Energy poverty persists in both the EU and Romania and these reasons will be investigated. The rest of the paper is structured as follows. The next section provides a description of the data and research methodology used to analyse the data, followed by a section which provides a discussion of the results. The last section concludes the paper.

Methods

Two different analytical methods are used in this paper: panel data models for the EU-27 countries (2003-2020) and time series models for Romania (2007-2020). Missing data forces us to consider a shorter period for Romania. Under the hypotheses of heterogeneity, cross-dependence and non-integration, panel Autoregressive Distributed Lag models (panel ARDL) will be considered. Given the low volume sample, a Bayesian nonparametric approach is proposed to estimate ridge regression for Romania. The dependent variable is represented by self-perceived health as bad or very bad (total and for females). The explanatory variables are: current health expenditure (% of GDP), arrears on utility bills for (total and females) (arrears), population unable to keep home adequately warm (population).

The basic ARDL model:

$$\log(self\ perceived\ health_{it}) = \alpha_i + \sum_{l=1}^{p} \beta_0 (self\ perceived\ health_{it-l}) + \sum_{l=0}^{q} \beta_1 \log(arrears)_{it-l} + \sum_{l=0}^{q} \beta_2 \log(population)_{it-l} + e_{it} \quad (1)$$

Where i is the index for country and t is the index for time.

After parameterization, equation (1) becomes:

$$\Delta\log(self\ perceived\ health_{it}) = \alpha_i + \Phi_i\big(self\ perceived\ health_{it-l} - \theta_1 \log\_arrears_{it-l} - \theta_2 \log(population_{it-l})\big) + \sum_{l=1}^{p-1} \lambda_{il}\, \Delta\log(self\ perceived\ health_{it-l}) + \sum_{l=0}^{q-1} \lambda'_{il} \Delta\log(\text{arrears}_{it-l}) + \sum_{l=0}^{q-1} \lambda''_{il} \Delta\log(population)_{it-l} + e_{it} \quad (2)$$

where λ, λ′, λ″ are short-run coefficients corresponding to lagged endogenous variable, arrears on utility bills and population unable to keep home adequately warm respectively. θ_1 and θ_2 are the long-run parameters for arrears on utility bills and population unable to keep home adequately warm. The speed of adjustment is denoted by Φ_i.

The pooled mean group (PMG) estimator is based on the homogenous long-run equilibrium across countries and heterogeneous short-run connection. The heterogeneity specific to countries is caused by different responses to external shocks. The main advantage of the PMG estimator is the ability to reduce endogeneity.

Table 1 provides the descriptive statistics of the variables used in the analysis in this paper.

Unlike the least squares estimator in the linear regression model, the linear ridge regression model constructs estimates by a reduction being used to explain self-perceived health in Romania. Estimates and the posterior probability are calculated for the standardized parameter to fall within a standard deviation of 0. Beta represents the standardized coefficients (a posterior mean), based on the centred mean and the normalized explanatory variables of mean 0 and variance 1. The coefficients are

between - 1 and 1 when all explanatory variables are uncorrelated (there is no multicollinearity). PP1SD represents the posterior probability that a standardized coefficient is at maximum a standard deviation of zero. An explanatory variable significantly influences the dependent variable if PP1SD is less than 0.5.

Table 1. Descriptive statistics

Variable	Mean	Standard deviation	Minimum value	Maximum value
Arrears on utility bills; total population (%)	10.44	8.36	1.1	42.2
Arrears on utility bills for single; females (%)	7.65	7.49	0.3	38.8
% Population unable to keep home adequately warm	11.39	11.98	0.3	69.5
Self-perceived health as bad or very bad; total population (%)	10.58	4.75	2.5	26.8
Self-perceived health as bad or very bad; females (%)	11.85	5.39	2.7	27.5
Current health expenditure (% of GDP)	8.13	1.72	4.70	11.58

Source: own calculations in Stata 15

Results and Discussion

The assumption of heterogeneity is checked since the sample is composed by developed and developing countries in the EU with different patterns of economic and social development.

Table 2. The results of CD Pesaran's test.

Variable	Calculated statistics*
Arrears on utility bills; total population (%)	21.76
Arrears on utility bills; females (%)	8.41
% Population unable to keep home adequately warm	10.73
Self-perceived health as bad or very bad; total population (%)	4.55
Self-perceived health as bad or very bad; females (%)	9.33
Current health expenditure (% of GDP)	20.63

*Note: * shows that all the p-values are less than 0.05*

Source: own calculations in Stata 15

CD Pesaran's test is applied to check for cross-sectional dependence for the basic variables. Since p-values are lower than 0.05, the hypothesis of cross-section independence is rejected at 5% level of significance (see Table 2). The cross-sectional dependence is explained by the fact that all the EU countries are the subject of common regulations.

The logarithmic forms for all the data series are considered to allow the interpretation in terms of elasticities. The Im-Pesaran-Shin test is used to check for a unit root since it assumes non-balanced panels and heterogeneity. The null hypothesis states that all panels contain unit roots. The results after the test application are presented in Table 3.

Table 3. The results of Im-Pesaran-Shin test for unit roots in panel data

Variable (in logarithm)	Calculated statistics	p-values
Arrears on utility bills; total population (%)	-0.2600	0.3974
Arrears on utility bills; females (%)	-4.4385	0.0000
% Population unable to keep home adequately warm	-0.0732	0.4708
Self-perceived health as bad or very bad; total population (%)	0.1196	0.5476
Self-perceived health as bad or very bad; females (%)	0.4496	0.6735
Current health expenditure (% of GDP)	-1.1948	0.1161

Source: own calculations in Stata 15

The data series are stationary (integrated of order 0: I(0)) for the arrears on utility bills for females (see Table 3). The rest of the variables are non-stationary. The data in the first difference were stationary. Therefore, we can state that the panel data for the rest of the variables are integrated of order 1 (I(1)). The Westerlund test for cointegration was applied, but the results suggest no cointegration between arrears on utility bills, population unable to keep home adequately warm and the rest of the dependent variables. Starting from these results, for non-stationary and non-cointegrated panel data series, the long-run and short-run relationships might be represented using a panel autoregressive distributed lag model (panel ARDL model). A particular case of panel ARDL model is used, PMG. This estimator assumes homogenous long-run equilibrium across countries and heterogeneous short-run connection and it reduces the endogeneity.

Self-perceived health is explained using PMG estimators (Table 4). The results of estimations indicate a significant overall long-run relationship between self-perceived health, arrears on utility bills, and population unable to keep home adequately warm. Only in the short-run, population unable to keep home adequately warm is the cause

for self-perceived health as bad or very bad. In the long-run, arrears on utility bills explains the self-perceived health as bad or very bad. There is a short-run connection for the population unable to keep home adequately warm to self-perceived health as bad or very bad for females. As expected, there is a positive correlation between arrears on utility bills and population unable to keep home adequately warm.

Considering the deviation from the long-run, the speed of adjustment to the equilibrium is measured by the error correction term in absolute value. The rate of correction in the bivariate model explaining self-perceived health as bad or very bad (total) is 31.05% according to the PMG approach. In the case of self-perceived health as bad or very bad for females, the speed of adjustment is lower (28.3%).

Table 4. PMG estimators to explain the self-perceived health in the EU-27 countries (2003-2020)

	Variables (in log)	Dependent variable	Variables (in log)	Dependent variable
		self-perceived health as bad or very bad (total)		self-perceived health as bad or very bad for females
Long-run relationship	arrears on utility bills	0.125 (0.000)	arrears on utility bills for females	0.011 (0.728)
	population unable to keep home adequately warm	0.006 (0.713)	population unable to keep home adequately warm	0.026 (0.144)
Error correction term		-0.3105 (0.000)		-0.283 (0.000)
Short-run relationship	arrears on utility bills	0.037 (0.264)	arrears on utility bills for females	0.015 (0.511)
	population unable to keep home adequately warm	0.071 (0.007)	population unable to keep home adequately warm	0.093 (0.02)
	Constant	0.571 (0.000)	Constant	0.580 (0.000)
Residuals	I(0)	I(0)	Residuals	I(0)

Note: p-values in brackets

Robustness check- additional variable (current health expenditure (% of GDP))

Table 5 shows current health expenditure is a short-run cause for self-perceived health as bad or very bad (total).

Table 5. PMG estimators to explain the self-perceived health in the EU-27 countries (2003-2020)

	Variables (in log)	Dependent variable	Variables (in log)	Dependent variable
		self-perceived health as bad or very bad (total)		self-perceived health as bad or very bad for females
Long-run relationship	arrears on utility bills	0.149 (0.000)	arrears on utility bills for females	-0.433 (0.000)
	population unable to keep home adequately warm	0.121 (0.000)	population unable to keep home adequately warm	0.196 (0.000)
	current health expenditure	1.729 (0.000)		-117.303 (0.000)
Error correction term		-0.219 (0.000)		-0.046 (0.046)
Short-run relationship	arrears on utility bills	0.021 (0.625)	arrears on utility bills for females	0.022 (0.421)
	population unable to keep home adequately warm	0.043 (0.150)	population unable to keep home adequately warm	0.018 (0.585)
	current health expenditure	-0.315 (0.023)		50.749 (0.000)
	Constant	-0.469 (0.000)	Constant	0.998 (0.007)
Residuals	I(0)	I(0)	Residuals	I(0)

Note: p-values in brackets

In the short-run, the increase in health expenditure reduces the negative perception on health, but in the long-run the pessimistic perception on health increases when health expenditure grows. This result indicates that health expenditure in the EU-27 countries is not sustainable and further policies should focus more on individual needs of these individuals with arrears on utility bills and unable to keep their home warm.

When health expenditure is considered, there is a long-run relationship between all the self-perceived health as bad or very bad (total) explanatory variables and self-perceived health as bad or very bad (total). The rate of correction is lower for overall case (21.9%) and for females (4.6%).

A separate case is represented by Romania for which the models are run in a Bayesian framework. The results of Elliott-Rothenberg-Stock point-optimal test (Table 6) indicate that only the series for current health expenditure is stationary in the first difference, while for the rest of the variables the data series are stationary in level. The critical values for equation with intercept, respectively for equation with intercept and trend are 2.97, respectively 5.72 at 5% level of significance.

Table 6. The results of Elliott-Rothenberg-Stock point-optimal test for Romania

Variable (in logarithmic values)	Include in the equation:	p-statistic
arrears on utility bills	Intercept	13.37501
	intercept and trend	137.9013
arrears on utility bills for females	Intercept	18.24017
	intercept and trend	264.3925
population unable to keep home adequately warm	Intercept	382.0152
	intercept and trend	53.87204
current health expenditure	Intercept	1.592448
	intercept and trend	3.282076
self-perceived health as bad or very bad (total)	Intercept	15.94518
	intercept and trend	6.083708
self-perceived health as bad or very bad for females	Intercept	12.13633
	intercept and trend	16.13844

Source: own calculations in EViews 9

A covariate is a "significant" predictor when the posterior probability that the standardized coefficient is within 1 standard deviation of 0 is less than 0.5.

The results for Romania in Table 7 suggest that arrears on utility bills and population unable to keep home adequately warm increase the percentage of people with self-perceived health as bad or very bad for overall population and for females.

More current health expenditure reduces the bad or very bad perception on health only for total population.

More public expenditure for health does not have a significant impact of females perception on their health.

Table 7. The results of ridge regression for Romania

Variables (in log)	Dependent variable: self-perceived health as bad or very bad (total)		Variables (in log)	Dependent variable: self-perceived health as bad or very bad for females	
	Unstandardized Coefficients	Posterior probability that the standardized coefficient is within 1 standard deviation of 0		Unstandardized Coefficients	Posterior probability that the standardized coefficient is within 1 standard deviation of 0
arrears on utility bills	0.123	0.183	arrears on utility bills for females	0.077	0.471
population unable to keep home adequately warm	0.201	0.021	population unable to keep home adequately warm	0.176	0.063
current health expenditure in the first difference	-0.355	0.455	current health expenditure	-0.243	0.568
constant	1.827	1	constant	2.030	1

Source: own calculations in MatLab

Conclusions

There is little literature that explores the relationship between energy poverty and health. However, this relationship is important, one that requires much further research and discussion. Those individuals experiencing energy poverty are more susceptible to poorer health because they will not have adequate heat during the winter months, sufficient cooling in the summer months, or other necessities that require energy. On the other hand, individuals with poor health will have higher out-of-pocket medical expenses that may preclude them from having the ability to purchase the amount of energy services necessary to maintain a good health. Therefore, energy poverty/health is a dual causal relationship that has not been sufficiently examined. The objective of this paper is to fill the gap in the literature by analysing EU-27 countries and Romania. The results show a relationship between energy poverty and poor health.

The results for the EU-27 show a long-run relationship between self-perceived health, arrears on utility bills, and population unable to keep home adequately warm. In the short-run, population unable to keep home adequately warm is the cause for self-perceived health as bad or very bad, while in the long-run, arrears on utility bills explains the self-perceived health as bad or very bad. There is a short-run connection for the population unable to keep home adequately warm to self-perceived health as bad or very bad for females. Furthermore, there is a positive correlation between arrears on utility bills and population unable to keep home adequately warm.

Current health expenditure is a short-run cause for self-perceived health as bad or very bad. In the short-run, increases in health expenditure reduces the negative perception on health, but in the long-run a negative perception on health increases when health expenditure grows, indicating that health expenditure in EU-27 countries is not sustainable. Additionally, there is a long-run relationship between self-perceived health as bad or very bad for the total population with health expenditure.

The results for Romania suggest that being arrears on utility bills and population unable to keep home adequately warm enhance self-perceived health as bad or very bad for overall population and for females. An increase in current health expenditure reduces the bad or very bad perception on health only for total population. More public expenditure for health does not have a significant impact of females perception on their health.

Further research will investigate the complex relationship between energy poverty and health. Exploring the EU-27 is necessary to determine the magnitude of the problem within Europe. This analysis of Europe is particularly important given the reliance on energy imports until an adequate level of sustainable, renewable energy can be developed. An analysis of Romania is necessary to determine if there are public policies that one or the either uses to address the interconnected issues. Given the number of pensioners and the relatively low-income, in comparison to the rest of

Europe, the energy poverty/health dynamic is especially crucial as those individuals are among the most vulnerable.

This particular study is important because the results indicate both long-run and short-run causal relationships between energy poverty and health. Energy poverty is a multifaceted issue that both impacts health and can be caused by bad personal health. As a result, public policies must be examined at the European, national, and local levels. However, only with rigorous analysis will policy-makers take this dynamic seriously enough to address the issue. Not developing public policy that will help alleviate the energy poverty/health relationship will likely cost countries more, in terms of additional healthcare costs, lost productivity, and reduced GDP, than if they were to properly correct the issue. Therefore, the results of this study provide meaningful insight that could be used to support governmental action against energy poverty.

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