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The causal relationship between energy supply deficiency and energy poverty: A case study of Kyrgyzstan

The causal relationship between energy supply deficiency and energy poverty: a case study of Kyrgyzstan

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Abstract
The aim of this study is to evaluate the impact of central energy supply deficiency on energy poverty in Kyrgyz republic, by analyzing 1900 households in 2013. The cross-household analysis conducted by World Bank- GIZ Survey, called CALISS 2013 were used. The relationship between traditional fuel consumption and energy poverty was investigated, mainly by using Energy Poverty Ratio (EPR). EPR is the ratio representing the portion of energy and fuel expenditure over income of household, by the use of '10% indicator' approach. Households, with the share of income above 10% coverage of expenses associated with fuel and energy services, are acknowledged to be energy poor households. Obtained results represent statistically significant energy and fuel consumption affect on energy poverty index. The results specify extensive traditional biomass and fuel dependence of houses and increase in the number of energy poor households; a substantial decline in supplied energy consumption, indicating a shortage of central energy supply. Results, conclusion and some recommendations were suggested in terms of policy to be implemented, focusing on decreasing the level of energy poverty.

Keywords: energy poverty; energy poverty ratio; energy supply; energy poor households.

Introduction

Based on the results of a recent poverty analysis in Kyrgyzstan, 25.6% of the population subsists below the national poverty line and the problem is more critical in rural country areas (ADB, 2017). For the majority of those rural residents, there is not only an energy access lackage, but also a scarcity of resources so that satisfy their basic needs of energy. Noticeably, the link between poverty and energy is understandable and it is two-way relationship. From the one angle, household energy usage is affected by high level of energy poverty through the lackage of access to commercialized clean energy providers, thus decreasing the level of energy consumption and boosting dramatically traditional fuel addiction. Commonly, these fuels are burned via furnaces in domestic conditions inefficiently, due to the absence of specialized equipment in rural households, consequently polluting indoor environment (IEA, 2002). From the other angle, there is a perceptible tendency on increasing the significance of clean and consistent energy supply for poverty mitigation. The well-being of nation could be improved with the help of accessibility to renewed sources of energy (World Bank, 2000).

Predominantly, by taking into account substantial two-way relationship between energy and poverty, the main three objectives are to be revealed in this study. Primarily, the paper is focused on providing various methods of energy poverty measurement and how factors of traditional biomass consumption and energy access could represent the measures of energy poverty and characteristics of human welfare level. Additionally, the research also examines theoretical view on the concern, by introducing a 2-dimensional indicator of measuring the energy poverty and allocation, which is anticipated to be a significant supplement to a commonly used the wage/cost based measures of poverty. This measure reflects both dimensions of the availability and consumption of energy, namely its' social and environmental parts. Moreover, assuming a pervasive influence of the energy in modern life, it's valuation of its different measurements can reflect significant points of the real situation of poor by showing it in precise and dynamical way. The foremost research question and objectives of the study is as follow: Does the level of traditional fuel consumption of household validly represent the lackage of central heating supply in the country? How does central energy supply deficiency give a rise to energy poverty in the country? And as a final point, how to differentiate between energy poor and energy non-poor households? How about the role of income in this scenario? The following research is attempt to investigate those questions and emphasize policy implication and recommendation with an aim of searching avenues for energy poverty reduction.

Literature Review

Energy Poverty Study

The presence of societal disproportionateness in living conditions tends to be emphasized by the lack of commercial supply of energy to households, particularly electricity. Subsequently, these could result in improved form of poverty, lackage of opportunity improvement, large migration to urban cities and uncertainty of society concerning its future's prospect. There is an evidence that those societies could have sustainable economic stability and enhanced life quality, with the advent of electricity supply (Pereira, 2010). The accessibility to consistent electrical energy supply is considered as one of the approaches concerning economic substantiality of the household. Particularly, in terms of economy's expansion of rural area as well as the poverty reduction, access to energy plays a crucial role. Though, according to Pachauri (2004), due to the high expenses related to the expansion of energy systems and the development of reorganized systems through which power is supplied, expanding access to electrical energy has progressed slowly worldwide. As stated by Freitas and Pereira (2009), contained by a number of specific government strategies aimed not only at alleviating, but also at eradicating, poverty should be the focus of attention. Particularly, in rural areas, where opportunities are limited, lackage of admission to modern energy sources exacerbates poverty. In order to eradicate poverty, the government policy focused on poverty reduction should be implemented, including expanded access to energy resources, particularly to electricity, by bearing in mind mostly social interactions. On the word of Pachauri (2004), there are various energy consumption measures, such as energy supply chain stages: primary and final energy. The primary energy consists of natural resources embodied energy, that processed through mining, collecting or extracting but not experiencing any anthropogenic transformation or conversion; they are commonly fuel, crude oil, coal, wood and uranium. On the other hand, final energy, mainly represented by supplied energy, is transformed into the form of energy for consumer's end-use, such as electricity; beneficial energy that is considered as energy for actual use, for instance heating systems or powered energy for air circulation. Therefore, in order to distinguish energy facilities from other services and energy products, there are no tangible ways. Thus, the measurement of consumption level in a form of useful energy is the most capable approximation, owing to the impracticality of any other methods of direct energy service evaluation (Kaygusuz, 2011). Okushima (2016) investigated the association between energy poverty with energy and fuel consumption in the households and the scope of study represented statistically significant results of household research, conducted in Japan from 2004 to 2014. The foremost question to answer have been to distinguish between energy poor and energy non-poor subdivisions of population. From the perception of DECC (2010), whenever the households are not capable to consume appropriate amount of energy supplied by contributing 10% of the total income, they are considered as energy poor households. The vivid illustration of '10% indicator' measurement approach has been implemented by government of UK, defining households within energy poverty segment; by means of quantifying the number of households, experiencing expenses on fuel and energy costed more than 10% of overall income (DECC, 2010). The energy costs intended to be different types of expenses, such as heating, hot water supply, electricity and gas supplies, but excludes the cost of energy spent on driving cars. From the point of view of "aggregation," the 10% indicator is a kind of coefficient, representing the personnel number that defines the poverty degree in a society, by usage of population's share of "poor" (DECC, 2010; Okushima, 2016). The relationship between energy supply throughout the rural households and reduction of poverty was studied by Pereira (2010), however for the use of experimental projects, the analysis' scope is restricted or limited. In addition, as stated by Gunther and Harttgen (2009), the poverty ignores time dynamics, by measuring the current household poverty status only. Besides, energy poverty should be expressed in terms of many other extended spheres, rather than only the income poverty perspective. Although it is persistently distributed, derived from income lackage, observation of poverty actually should be done as a 'multidimensional phenomenon', which includes, among other things: sub nourishment as physical weakness, strength lackage, precarious health, disability, higher rates of non-independent active adults; urban or rural inhabited, lack of education, absence of access to knowledge or information; influence of income, energy supply and vulnerability, expressed by increased natural disaster exposure. The researches associated with lessening energy poverty typically perceive the expression of poor with regard to income (Pereira, 2010). One of the alternatives used refers to consumption of energy as a way of distinguishing the poor from the non-poor households. The degree of material deprivation increase is usually associated with countries with a greater degree of income inequality, which includes an inclusive variety of measurements that determine social contribution - starting from the access inability to simple goods and services (containing energy resources), and ending with the lack of basic technology, transportation and household facilities (Whelan & Mater, 2012). The post-soviet background of energy demand and supply was also reinforced by the prevalent existence of district fossil fuel heating networks in urban areas (Bouzarovski, Sýkora, & Matoušek, 2016), along with the prevalence of coal in the structure of energy consumption. Particular attention was paid to expanding the supply infrastructure - increased gasification and electrification levels were typical - although the quality of end services was intermittent and low. All at once, prices of energy services for households remained low through the system of indirectly subsidized gas and electricity bills particularly. Especially, in the occasion of region heating, the assessing strategies were practically lacking. The heavy industry focus combined with low-priced energy charges for generating unusual high energy intensity within the economy, and a principle throughout which energy was comprehended as an easily obtainable commodity instead of a unit price service (Bouzarovski, 2009, 2010). In relation to Schäfer et al. (2011), poor quality of energy services is caused mainly by a low level of energy technology compliance to the particular desires of people and circumstances. The abovementioned incidence arises along with bias associated with urban providers of energy service, resulting in inordinate expenses. The individuals, who are acknowledged to be restrained by the energy poverty difficulty, tend to be disadvantaged from the quality of energy services supplied (e.g. lackage of grid access), face larger expenses associated with energy rather than those, who experience higher quality of energy services and pay more in absolute relations while monitoring income (Groh, 2014). What is more, academic studies on energy poverty have been emphasized its connection with low income levels (Milne and Boardman, 2000), insufficiency of house constructions (Nevin, 2010), heating systems (Walker, 2008) as well as sociodemographic positions, like class, gender, literacy rate and dwelling size (Wright, 2004). Moreover, there is an evidence of underlined higher expenditure and increasing energy poverty associated with the health condition of household members, such as families with disabilities, illnesses and elderly people (Cheshire, 2009). Correspondingly, they connect energy poverty and illnesses resulted from it, with such factors as adequate home heating, sufficient energy services, open access to gasification and electrification as well as hot water supply and thermal comfort of the households (Petrova, 2013).

Concept of 10% indicator

In relation to 10% indicator, once the households have to devote greater than 10% share of its total income to acquire sufficient energy services, a household is identified as energy deprived. The abovementioned definition of energy poor household was generated firstly by Boardman (1991) and turned out to be approved indicator of energy poverty used by UK authorities, Further, Hills (2012) has revised the strategy on measuring fuel poverty, which was selected by LIHC as the new measurement of energy poverty. It is worth noting, that a 10% value has some important advantages, such as easy calculation, free communication and the versatility function from the point of view of pragmatics. However, this indicator also suffers from noticeable limitations highlighted by Schuessler (2014) and Heindl (2015). This kind of limitation can be explained by many factors. But, the main reasons are:

1) Underestimation of the importance of the problem associated with sensitivity to energy prices

2) To the arbitrary choice of a 10% threshold, which was justified by the economic situation of Great Britain 30 years ago, but is not directly related to other spaces and time

3) Lack of reference to household profits.

The data show that inefficient homes owned by high-income households or excessive energy consumption in other ways that are not poor were also included in the 10% threshold calculated for many countries. Heindl (2015) states that energy poverty rates above 25% are much different than other indicators and indicate that the 10% indicator is an outlier. For a detailed analysis of the criticism put forward by the expert, the initial rationale should be analyzed, which ended with the election of a 10% threshold for the United Kingdom. After researching the 1988 data, Boardman (1991) concluded that a 10% indicator represents not only the energy costs of 30% of all households in the country, but also about half the average of all energy costs. Nevertheless, Schuessler (2014) believes that the facts indicated are not relevant, but only serve to consolidate the obtained values. However, the allocation of the considered possibility of a 10% indicator in order to approximate the average cost of the established ratio of the poorest households, the indicator takes on a new dimension with some distortions. In addition, it must be clarified that the first definition expresses the absolute limit of poor households, while the second level defines the relative level of consumption. Thus, Schuessler declares that enough arguments can be made about the ease of use of relative or absolute indicators in the process of resolving energy insolvency issues. Therefore, it is worth considering the situation with energy poverty not as a problem of well-being, but for the sake of achieving social justice, since it is a problem of absolute limits. Improvement or worsening of society’s behavior on the issue of energy poverty should not affect the situation individually. This means that the relative poverty indicator does not express poverty itself, but inequality. In this situation, absolute measures are most appropriate and Romero believes that the analysis of energy inequality will be enriched by such measures (2018).

Data, methodological aspects and fieldwork

The fieldwork was undertaken via the application of structured questionnaires, named ‘Jobs, skills, migration, consumption survey’ or ‘CALISS 2013’, the dataset has been collected from July to August within the year of 2013 in Kyrgyz Republic. All the empirical analysis represented in this paper are grounded on the abovementioned dataset. The primary variables used in the empirical model were mined from individual survey dataset as well as household dataset of CALISS. For the model construction, represented further, the household data as well as individual data, both were merged in one dataset in order to get regression analysis results.

Calculation of EPR (10% indicator)

In order to calculate Energy Poverty Ratio, the following equation was constructed by Boardman (1991, 2010) and further modified by Okushima (2016) and used in this study.

$$\text{EPR} = \frac{Q}{N} = \frac{1}{N}\sum_{i=1}^{N} c\left(\frac{E_i}{Y_i} > 0.1\right),$$

Where $Q = \sum_{i=1}^{N} c\left(\frac{E_i}{Y_i} > 0.1\right)$, representing number of energy poor households and N is households number in total. The EPR represents the extent of energy poverty in the society, as a ratio between number of poor Q over total number of households N; c(·) is the indicator, taking one value of conditions in brackets, if it's true and zero if not. Y_i is total household income; $E_i = \left(\sum_r cE_{ri}\right)$ is energy expenditure, including traditional fuel expenditure.

Empirical model specification

With the intention of getting the qualitative effect of traditional fuel expenditure, household size, dwelling type, average income and urban/rural area on existence of energy poverty; the empirical model was specified as follows:

$$\begin{aligned} \textit{Energy Poverty Ratio}_i = \beta_0 &+ \beta_1 * \ln(\textit{Traditional Fuel Expenditure})_i \\ &+ \beta_2 * (\textit{Household Size})_i \\ &+ \beta_3 * (\textit{Dwelling Type})_i \\ &+ \beta_4 * (\textit{Average Income})_i \\ &+ \beta_5 * (\textit{Urban/Rural Area})_i \\ &+ \beta_x * CV_i \\ &+ \mu_i \end{aligned}$$

Where the dependent variable is Energy Poverty Ratio (EPR), which was calculated by above method mentioned in the last section; independent variables are traditional fuel expenditure, household size, dwelling type, average income and a dummy variable of urban or rural area of accommodation and CV, representing the vector of control variables.

Data

Dependent variable

Designed for the measurement of energy poverty, there are various explanatory indicators, the vivid illustration of which could be LIHC generated by Hills (2012). Though, the main motive of choosing '10% indicator' measurement generated by Boardman (1991, 2010) is the nature of data, represented by available dataset. The energy poverty indicator of 10% income was used as the key measurement of energy poverty index primarily due to its usability among all other techniques. Though, the only limitation of dataset is denoted by the lackage of information regarding total income of household, meaning all the monthly earnings of each member of family, rather than the income of the family head only, as represented in current dataset. Therefore, the total expenditure of household members was calculated as the summation, including education, food, non-food, clothing, health, utility and fuel expenditures as denominator figure of the EPR, in a pattern of Saunders et al. (2002) approach. As the numerator of EPR, the sum of energy and fuel expenditure of household was taken, but excluding fuel spending on vehicle purposes. Finally, to indicate the energy poor families, there have been taken a logarithmic form of EPR, in order to get values in percentage term. Thus, all the families with level of EPR being above 10% were considered as energy poor.

Interest variables

Predominantly, the variables of research's major interest are traditional fuel expenses and household size. Traditional fuel expenses include kerosene, firewood, black coal, liquefied gas in vessels, mazut, diesel, peat, dung, corn leaves, brushwood and petrol consumption expenditure of households, by excluding petrol, used for car maintenance. Household size variable comprises the number of family members within the household. The next assortment of interest variables includes dwelling type, average income and urban or rural living area. Dwelling type variable includes variation of occupation types, such as separate apartment in a multistory building, apartment or room in multiple occupation, separate house, part of a house, hostel, temporary premise, other nonresidential premise used for habitation, other living space and barracks. The variable of dwelling type is a dummy variable, consisting of set of numbers representing each type of accommodation respectively. Moreover, the income variable, representing last four weeks earning of the household head was added into the model. Lastly, the important variable of respondent's address of occupation, being more precise, the area of that occupation. This variable is dummy, question of choice between urban or rural area of household location.

In accordance with literature review, the positive relationship, between consumption of traditional biomass and fuel and EPR, was hypothesized. The additional fuel usage in the households was used as a proxy of inaccessibility to centrally supplied energy services, because when the energy services stop supplying energy means to households, they need to find alternative methods of heating, cooking and lighting such as black coal, kerosene and vessel of liquid gas. It is hypothesized, that this problem occurs mainly due to the area of accommodation and household income; according to the theory, the more vulnerable to energy poverty are the income-poor households, living in rural areas of the countries. Owing to the literature, the larger is the consumption of additional fuel, the higher is the level of energy poverty.

Control variables

According to relevant literature and justification of theory of energy poverty, there are numerous factors influencing and resulting in energy poverty prevalence. The model specified in previous section should be reviewed and modified, by adding more control variables into the empirical model. The additional variables added in abovementioned model are dummy variables from household perspective, such as presence or absence of individual heating system, central (district) heating, water supply, hot water supply, central gas supply, power supply and dwelling size; and set of variables, containing individual information: gender, age, marital status, highest diploma obtained (literacy rate), respondent's activity status in labor market, enrollment in educational institutions, temporality and seasonality of employment and last medication receipts from doctor (health condition of respondent).

Empirical results

Table I shows the regression results of energy poverty analysis by using standard OLS method. Although, energy poverty is associated with the income, it is important to mention, that energy and fuel consumption expenditure significantly upsurges a likelihood of energy-poor household prevalence. With 99% confidence interval, regression of Traditional Fuel Expenditure on EPR demonstrates a statistically significant and positive estimation coefficient. In the restricted econometric model, the variance in traditional fuel expenditure explains 18.9% of the variance in energy poverty ratio. Thus, one percent increase in energy consumption expenditure, on average, increases the occurrence of energy poverty by forty-three percent, by keeping all other factors constant. All abovementioned factors suggest, that any policy implemented in order to reduce energy poverty should have to take into consideration not only the income instability but also the traditional biomass usage of the household. The addiction and dependence on fuel consumption is the key signal on energy poverty prevalence in the households. The lack of central energy supplies force household to become addicted to traditional types of fuel, thus increasing the expenditure spent on traditional energy and fuel, and results in household considered to be energy poor.

From statistical point of view, the addition of the household size and average income variables into the model, seems correspondingly important in explanation of variation in energy poverty, meaning that as the increase in the household size occurs the likelihood of household to be energy poor. Although, household location area variable should be statistically important, in accordance with theory, but it turns coefficient to be insignificant. Nonetheless, as this variable is relevant from theoretical point of view, it is needed to possess the latter to further study and specification of model.

Table I. OLS (1) and robust OSL (2) regression results.

	(1)		(2)
Variables	**EPR**	**Variables**	**EPR**
Traditional Fuel Expenditure	0.4353***	Traditional Fuel Expenditure	0.4353***
	(0.0553)		(0.0548)
Household Size	0.2216***	Household Size	0.2216***
	(0.0246)		(0.0254)
Dwelling Type	-0.1506**	Dwelling Type	-0.1506**
	(0.0701)		(0.0694)
	-		-
Average Income	0.0000***	Average Income	0.0000***
	(0.0000)		(0.0000)
UrbanRural	0.1555	UrbanRural	0.1555
	(0.1183)		(0.1186)
	-		-
Individual Heating System	0.3246***	Individual Heating System	0.3246***
	(0.0979)		(0.0972)
Central (District) Heating	-0.4153	Central (District) Heating	-0.4153
	(0.5261)		(0.5871)
Water Supply	0.0421	Water Supply	0.0421
	(0.1024)		(0.1017)
Hot Water Supply	-0.5193	Hot Water Supply	-0.5193
	(0.4558)		(0.4464)
Central Gas Supply	-0.5848**	Central Gas Supply	-0.5848**
	(0.2800)		(0.2618)
Power Supply	0.0756	Power Supply	0.0756
	(0.1478)		(0.1478)
Gender	0.2439**	Gender	0.2439**
	(0.0991)		(0.0988)
Age	0.0023	Age	0.0023
	(0.0045)		(0.0042)
Marital Status	0.0040	Marital Status	0.0040
	(0.0235)		(0.0237)
Highest Diploma Obtained	0.0405	Highest Diploma Obtained	0.0405
	(0.0394)		(0.0392)
Labor Market Activity Status	0.0777***	Labor Market Activity Status	0.0777***
	(0.0181)		(0.0182)
Educational Institution Enrollment	0.0738	Educational Institution Enrollment	0.0738
	(0.2743)		(0.2592)
Temporality of Employment	-0.0823**	Temporality of Employment	-0.0823**
	(0.0401)		(0.0407)
Dwelling Size	0.0581	Dwelling Size	0.0581
	(0.0432)		(0.0458)
Last Medication Receipts	0.1679	Last Medication Receipts	0.1679
	(0.2158)		(0.1937)
Constant	0.1526	Constant	0.1526
	(1.5340)		(1.7956)
Observations	1,908	Observations	1,908
R-squared	0.1887	R-squared	0.1887
Standard errors in parentheses		Robust standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1		*** p<0.01, ** p<0.05, * p<0.1	

Furthermore, dwelling type interest variable showed statistically important results, representing the justification of the theory, that the point of view of accommodation type, apartment or separate house, those facing larger amount of energy and fuel expenses are more vulnerable to become energy poor households.

Meanwhile, addition of control variables in the model, representing the provision of energy supply services, the only individual heating system and central gas supply turned to be statistically important at 1% and 5% respectively. Both variables negatively influence the EPR, denoting that with occurrence of individual energy systems and presence of adequate central gas supply in households, the likelihood of household becoming energy poor is lessened. Other control variables, representing household information, such as central heating supply, water supply, hot water supply and power supply turned to be insignificant in regression analysis, however, the signs of variance influence on variance of energy poverty prevalence have been in line with theory, being negative. Such control variables of individual data as labor market activity status, temporality of employment and gender are showing statistically impotent variation coefficients, p-values presenting almost 0.01, 0.04 and 0.09 respectively.

For the reason of heteroscedasticity problem occurrence while conducting OLS regression analysis, the robustness check was conducted. The robust regression results illustrated in the next column of **Table I**, proved statistical importance of variance of fuel expenditure variable as well as all other interest and control variables, keeping signs constantly unchanged. Robust regression results are valid and statistically significant in term of variables of my interest and, moreover, robustness check fixed the influence of heteroscedasticity problem on model and OLS results.

Conclusion

The results of the research highlighted that the widely implemented, income-fuel indicator of the poverty estimated based on the income were used, specifically threshold equal to 10% in most of the cases depicts the number of energy poor households. Since 10% indicator is mostly used to calculate energy inequality of energy supply, it is highly advised to implement LIHC and MIS instruments which measure level of poverty, based on the objectives and absolutes. Nevertheless, present number of limitations which should be taken into consideration, such as housing expenses with appropriate and accurate definition of energy need, also gathering information regarding total income of all household members within one month. In addition, the LIHC and MIS that consist of the very basic expenses made in households should be included. Besides, considering the fact that all above mentioned indicators are only make available figures in numbers which do not allow precisely recognize households at risk which is paramount in shaping suitable policy programs, research on distinguishing specific aspects that highlight the susceptibility of energy poverty should be conducted. During the study of the Kyrgyzstan case it was found out that, families with low income, with children and unstable employments, are the part of above mentioned households. Also, it should be emphasized, that approaches which include only income criterion also comprise family groups which are not vulnerable, among them huge families and pensioners.

Policy recommendations

On the basis of outcomes, study proposed the next policy suggestion:

It is recommended to decide on reliable energy poverty indicator used all around the world, with accurate calculation method. Referring to the results obtained in the last section, the most suitable indicator of energy poverty, calculated on the basis of income and expenses would be the one that (i) takes into consideration the earnings and expenditures of families simultaneously and (ii) might be calculated with using of absolute strategy , thus it will measure the energy poverty, not inequality of energy supply. Therefore, poverty indicators determined with application of LIHC or MIS indicators are the most appropriate ones. From another perspective, there is still demand for innovative approach or instrument to overpower recently experienced mistakes. Potential alternate has been developed for those who have unbalanced employment sphere, which are the most sensitive to the energy poverty. Line up with the results of research, support system might be the special social tariffs, which (1) covers all expenses on energy source, not only electro energy and gas supplies (2) and might be available to vulnerable users and only to the households with low income with children under their care, as well as those who experience unstable employment position. Another effective decision that can be made are the measures on increasing the energy efficiency through decreasing expenses on energy necessary in achieving the main energy services. These measures have high theoretical potential if would be implemented correctly. Still, in order to receive expected results, the main recipients of this implications should only be sensitive users. All other cases with differed policy should be based on the strict evidences. Eventually, there is great hope that analysis and evidences suggested by Imbert et al. (2016) and also readjusted for Kyrgyz case in this paper are representing strong facts on necessity of improving the energy poverty measures which were adopted by the present time. The recommendations are as follows:

In accordance to the variance raised in outcomes of investigation between energy poverty and conventional statistical indicators influenced to the overall results of the research article. The research analysis has been found quite speculative and indirect outcomes as the result of shortage of customized data collected regarding total income of household, even though the empirical research of information on inadequate energy in home services have been implemented. Based on analysis, it could be stated that certain group of demographics are deprived from domestic energy, those who are low income people, farmers, households, pensioners, people with health weakness and others. Correspondingly, the research of the aimed articles indicates that energy poverty indicators through the prism of expenditure-based indicators are less significant when it is difficult to provide adequate levels of energy services at home which is common among the general population. While the last analytic aim of the research article defined the analysis that revealed a fair income distribution of domestic energy deprivations, as a result of which broader model conditions for income inequality were found. Consequently, it could be stated that in the country of interest, Kyrgyzstan, the domestic energy deprivation has been experienced and the trend towards domestic energy is concentrated in the open and peripheral regions with limited access to affordable fuel (S. Bouzarovski and Petrova, 2016) (Kovačević, 2004; Miazga & Owczarek, 2015).

Limitation of this study and suggestions for further studies

Although model specification test results indicate of no omissions, there is a need for further analysis of the factors and variables, which could contribute to better understanding the determinants of energy poverty prevalence in transition economies.

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Appendix

```
. corr EPR lFuel m21_q1 m21_q2 urbanrural hhsize
(obs=1,909)
```

	EPR	lFuel	m21_q1	m21_q2	urbanr~l	hhsize
EPR	1.0000					
lFuel	0.2238	1.0000				
m21_q1	-0.0385	0.0161	1.0000			
m21_q2	0.0773	0.1142	-0.0366	1.0000		
urbanrural	0.0969	0.1853	0.0026	0.0590	1.0000	
hhsize	0.2214	0.1083	0.0210	0.1104	0.1043	1.0000

```
. vif
```

Variable	VIF	1/VIF
m1_q6	1.49	0.668898
m1_q4_age	1.48	0.675875
m2_q1	1.23	0.815510
m6_q5	1.17	0.852587
m3_q8	1.15	0.871825
m2_q4	1.13	0.884385
m23_qa_06	1.13	0.886588
lFuel	1.10	0.906923
m6_q9	1.10	0.909274
m23_qa_05	1.10	0.910926
m23_qa_01	1.08	0.922069
hhsize	1.08	0.922230
urbanrural	1.08	0.923205
m23_qa_03	1.07	0.932205
m23_qa_02	1.06	0.942172
m23_qa_10	1.06	0.944811
m21_q2	1.06	0.946373
m1_q3	1.06	0.946917
m11_q4	1.03	0.974087
m21_q1	1.02	0.983919
Mean VIF	1.13	

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of EPR
       Ho:  model has no omitted variables
                F(3, 1884) =     41.89
                  Prob > F =      0.0000
```

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of EPR

         chi2(1)      =     0.19
         Prob > chi2  =   0.6627
```

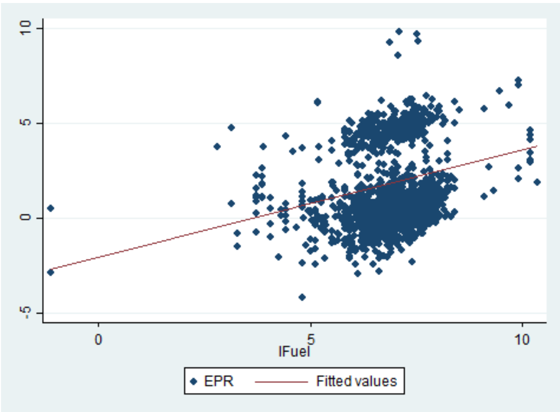

Figure A1. Fitted line for Fuel.

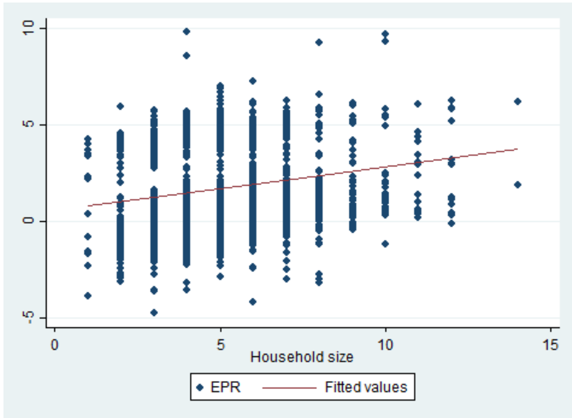

Figure A2. Fitted line for Household size

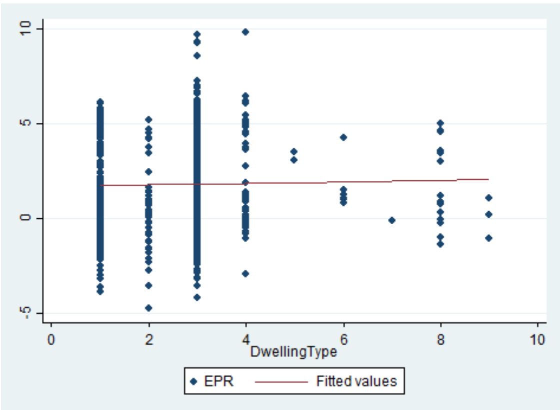

Figure A3. Fitted line for Dwelling type

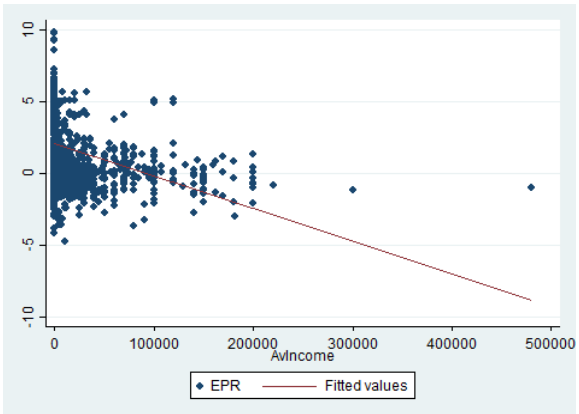

Figure A4. Fitted line for Average income

Source: authors' calculations based on CALISS 2013 dataset.