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The Role of Energy Poverty on the Gender-Health

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Keywords: Gender, Energy-poverty, Health Gap, Developing countries

JEL Classification: J16, I12

The Role of Energy Poverty on the Gender-Health Gap in Ghana

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Abstract

This study explores the impact that energy poverty has on health and the gender-health differences in Ghana. The novelty of the study lies in the use of Two-Stage Least Square Instrumental Variable (2SLS-IV) estimation as our identification strategy, and the suggested evidence that energy poverty potentially may explain part of the gender health gap. Using micro-level data from the Ghana Living Standards Survey (GLSS), the study finds significant gender health differences, with females reporting worse health than their male counterparts. Additionally, energy poverty appears to impact health, because those who use cleaner forms of cooking fuel, such as gas and charcoal, are found to be healthier than those who use firewood. Although the results indicate no significant gender differences in the effect on health of the use of charcoal over firewood, part of our estimates suggest that women enjoy greater health benefits from using gas than men.

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1. Introduction

Health equality has long been of interest to policymakers and academics in developing countries. Despite years of policy interventions, there is still a lack of gender equality in various aspects of life, particularly health, where many outcomes are less favourable for women. Studies have shown that women report more illnesses, have worse health outcomes, and exhibit higher health care utilisation than men, despite their higher life expectancy (Chun, Khang, Kim, and Cho 2008; Zhang, d'Uva, and Doorslaer 2015; Takahashi, Jang, Kino, and Kawachi 2020). Many attempts have been made to explain this phenomenon.

The existing literature predominantly cites "illness behavior," comprising biological risk factors, acquired risk factors and psychosocial aspects of symptoms and care, as well as health reporting behavior and prior health care as the causal factors of gender-health inequality (Molarius and Janson 2002; Case and Paxson 2005; Mestl, Aunan, and Seip 2006; Malmusi et al 2012; Verbrugge 1989). Another, less-developed, strand of the literature has explored the role that energy poverty may play on gender health inequalities. Energy poverty is defined as the inability to realize essential capabilities as a result of insufficient access to affordable, reliable, and safe energy services, taking into account the alternative means of realizing these capabilities in a reasonable manner (Day, Walker, and Simcock 2016). This definition is particularly relevant for developing countries.

The World Health Organization (WHO) reported in 2014 that about half of the world's population, including 700 million Africans, rely on biomass fuels for cooking (e.g., animal dung, crop residues, wood, and charcoal). Although a billion people in Sub-Saharan Africa are projected to gain access to electricity by 2040, 530 million will remain dependent on biomass fuels (International Energy Agency 2014). Biomass fuel is typically burned in open fires, often indoors, leading to high levels of household air pollution from smoke. Women experience high exposure to fumes and air pollution in and around the home due to gender-based domestic roles, and this exposure have been linked to a range of adverse health outcomes, including chronic obstructive pulmonary disease, lung cancer, ischemic heart disease, asthma, and pneumonia (Gordon et al 2014; WHO 2014). Also, in rural settings, the majority of the population carries word manually for domestic use. Even though there is no global data on the health effects of carrying heavy loads in domestic settings, studies show that wood carriers can carry an average of 28 to 36 kilograms, and as much as 70 kilograms, depending on age, season, purpose for the wood and other factors, several times a week (Matinga 2010).

Female exposure to polluted air, coupled with their participation in carrying wood for domestic use, may account for part of the health gap. Advocacy for improved access to cleaner energy is thus seen as a potential means of improving welfare and closing the gender health gap. Yet, compelling empirical evidence on the effects of energy poverty on health outcomes remains weak. This is because empirical studies that explicitly evaluate the impact of energy poverty and inequality in gender health outcomes are scarce and primarily conducted in developed countries

(Couture, Garcia, and Reynaud 2012; Stabile, Fuoco, Marini, and Buonanno 2015; Stabridis and van Gameren 2018). Energy poverty in the context of a developing country is not a random phenomenon, and thus requires a robust identification strategy to examine its impact. Does energy poverty play a role in the gender health gap in developing countries? We investigate this question using large representative data from a developing country (Ghana), where energy poverty is predominant.

Employing micro-level data from the Ghana Living Standard Survey (GLSS), this paper contributes to the literature by analyzing the gender health gap in Ghana, focusing on the role that energy poverty plays. First, we investigate the health gap across gender. As largely argued in the literature, it is important to confirm female health deprivation before any recommended solutions are proffered. Second, we use information on the main cooking fuel used in households (gas, charcoal or firewood) to proxy energy poverty, and examine the effect of using cleaner forms of cooking fuel on individual health outcomes. From a health policy perspective, it is important to ascertain the health effects of energy poverty so that action can be taken to reduce the energy-related deterioration of health. Finally, we examine the gender health gap in the light of energy poverty. The results confirm the health gap across gender in Ghana, with male individuals being more likely to be healthy than females. The results also show that, energy poverty plays a role in the gender-health gap. In particular, while the results indicate no significant health difference across gender for households that use charcoal as their main cooking fuel, compared to their counterparts that use firewood, the health benefits of using a cleaner form of cooking fuel such as gas are potentially greater for females than males.

The rest of the paper is organised as follows: Section 2 presents a literature review on energy poverty, including arguments on household energy poverty and reviews of the related existing literature. Section 3 presents a discussion of the data used and the model and estimation strategy employed to achieve our stated objectives. Section 4 contains the results and analysis. Finally, in Section 5, we conclude.

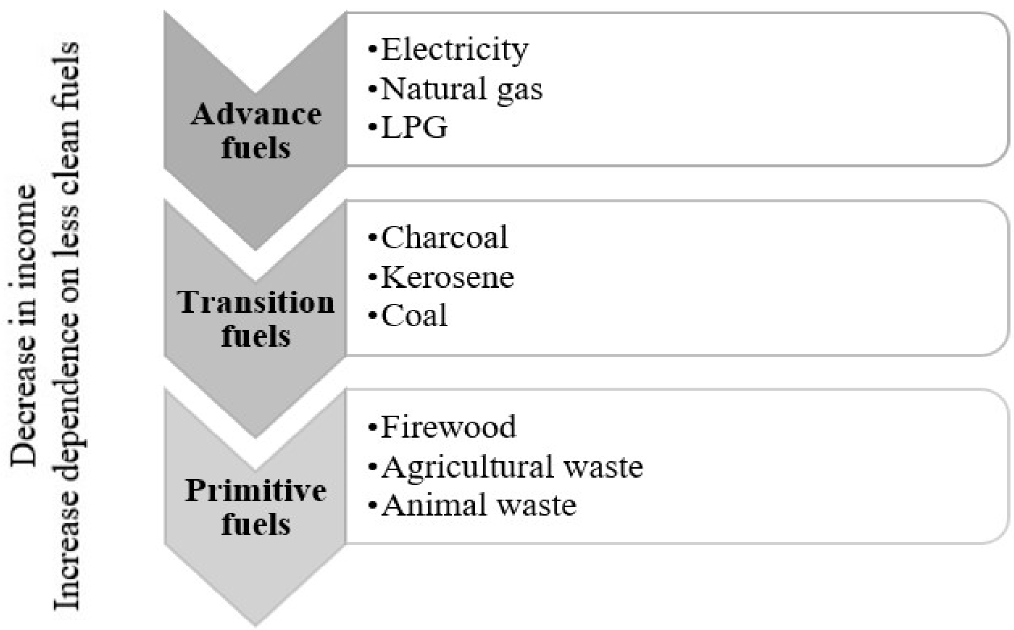
2. Literature on Energy Poverty

2.1 Household Energy Poverty

Energy poverty is one of the biggest challenges many households face. Many households still face difficulties meeting their energy needs, due to an inability to afford energy bills or limited access to energy or inadequate energy services. Conceptually, household energy poverty differs across the developed and developing world. In developed countries, energy poverty is a problem of affordability and energy efficiency. Households are regarded as energy-poor if they are unable to provide sufficient heat to their homes (Hills 2012). Measures based on expenditures and self-reported perceptions of energy difficulties are often used (Phimister, Vera-Toscano, and Roberts 2015). In developing countries, energy-poverty is primarily a problem of adequate physical access to clean and modern energy (Li et al 2014; Bonatz et al 2019). Energy-poverty is conceptualized as the lack of access to modern energy services, defined as electricity and clean fuels for cooking (Pachauri and Spreng 2011; International Energy Agency 2014). Households use more solid biomass fuels, such as charcoal, firewood, coal, dung and crop residues in rural areas than in urban areas, where the use of liquefied petroleum gas (LPG) and electricity is more common. Among the important merits of consuming LPG and electricity are their cooking efficiency and the lower levels of indoor air pollution generated. However, installation is costly and requires accessibility and infrastructure. Rural dwellers in developing countries often see the use of nearby firewood as more affordable.

Household income level and accessibility are major constraints to the use of clean cooking fuels. Households tend to change to high quality fuels as their incomes increase. This transition is known as the "energy ladder,' which is detailed in Figure 1. Movement up the ladder is associated with increasing income.

Figure 1: The energy ladder



According to the Hosier and Kipondya 1993 study, the prediction that households will move up the energy ladder as income increases is based on the economic theory of consumer behavior. However, households do not only consume more of the same fuel as incomes increase, they also shift to fuels with higher quality. Hence, the energy ladder hypothesis is underlined by the theoretical assumption that low standard of living means a greater dependence on biomass fuels as a result of income and substitution effects combined (Baland, Bardhan, Das, Mookherjee, and Sarkar 2007).

Measuring energy poverty in developing countries is consistent with the energy ladder. Households are energy-poor if they are unable to use cleaner cooking fuels in their homes. Households that use more advanced forms of fuels are said to be energy-rich, while those in the transition fuel category are energy-poor and those that use primitive fuels are the energy-poorer households. There are varied reasons for choosing a particular type of cooking fuel in households that are not limited to income alone, even though the affordability is an important factor in these choices. The literature documents that factors such as availability and accessibility, the age of the household head, the gender of the household head, the level of education of the household head and spouse, and the distance to markets all play a role (Mensah and Adu 2015; Hou, Tang, Ma, Liu, Wei, and Liao 2017; Akintan, Jewitt, and Clifford 2018). Energy poverty is also extensively argued to coincide with other forms of deprivation in the literature. In particular, a study by Sadath and Acharya in 2017 noted that the existence of energy-poverty coincides with income poverty and social backwardness. This potentially implies the presence of endogeneity bias because it may be difficult to control for some forms of deprivation, in particular social backwardness. In effect, a household's inability to afford or use clean cooking fuel is not only related to low levels of income, but also insufficient access to affordable, reliable and safe energy services and household demographics, including the head's gender.

2.2. Health Effects of Energy-Poverty

A study on energy poverty in India by Sadath and Acharya in 2017 found that inefficient use of biomass fuels cause health hazards. Cundale, et al in 2017 found a reduction in respiratory symptoms was among the reported benefits of using stoves in Malawi, though there was a perception of limited impact on health. Also, Boadi and Kuitunen in 2006 found in Ghana that households using wood and charcoal have a high prevalence of respiratory health symptoms, and that the poor are more affected by these problems due to their substantial reliance on solid fuels. Additionally, some studies focused on the health effects on children. In Guinea, Anderson in 1978 found that, overall, there is no difference in the level of obstructive lung disease in children up to 10 years of age. However, those in the highlands recorded higher loose cough rates and nasal discharge for ages above 10 years. More recently, the study of Mortimer et al in 2017 in rural Malawi did not find any evidence supporting that an intervention involving cleaner-burning, biomass-fuelled cookstoves reduced the risk of pneumonia in young children.

On the gender-specific health effects of energy poverty, Mestl and Aunan in 2005 used information on time spent in outdoor and indoor locations by different gender and age groups, with the estimates of particle concentrations (particles with a diameter of 10 micrometres or less (PM10)) in these microenvironments. They found that gender differences in time activity pattern did not significantly influence daily exposure or contribute to health differences across gender. In another study, (Mestl, Aunan, and Seip 2006) contained exposure estimations of the particle concentrations (PM10) in different micro-environments, using information on the amount of time spent in these environments. Their results suggested slight gender differences in exposure. At the country level, Sulaiman, Abdul-Rahim, Chin and Mohd-Shahwahid in 2017 analyzed the health effects of wood fuel consumption in Sub-Saharan Africa, focusing on the mortality of children under five and adults. They found the effect to be more evident in female than male adults. Further in Africa, Aliyu and Ismail in 2016 found that higher levels of CO2 and PM10 significantly increase mortality rates in infants, children under five and adults. They also found the impact of air pollution on adults to differ across gender, though it was insignificant statistically. Ezzati and Kammen in 2001 found that acute respiratory infections and acute lower respiratory infections in central Kenya are increasing concave functions of daily average exposure to PM10, but the rate of increase declines for exposures higher than about 1,000 to 2,000 ug/m3. Gender, however, failed to be a significant predictor of acute respiratory infections and acute lower respiratory infections after they included high-intensity episodes of exposure. In a study of the health effects of energy-poverty among women, Pokhrel et al in 2005 suggested that the use of solid fuel in unfluted indoor stoves increases the risk of cataracts in women doing the cooking when compared with the use of stives burning clear fuels.

Although there is a considerable body of evidence on the health effects of energy poverty in the literature for developing countries, there are a number of gaps including whether: (i) energy poverty may play a role in closing the gender-health gap, (ii) the existing case study evidence of a small groups of people is reflected when representative national level datasets are used, and (iii) the existing evidence using objective health measures is replicated when subjective self-assessment measures are used. If properly administered, objective measures can only be more reliable and valid than patient self-reports, but such methods are often prohibitively expensive. The use of subjective measures is widely accepted and can provide accurate and efficient assessments of objective states (Cleary 1997). The current study addresses these questions. It focuses on a developing country, such as Ghana; measures the gender-health gap; examines the health effects of energy poverty; and consequently assesses the role of energy poverty in the gender-health gap using a nationally representative household survey with self-reported health outcomes.

3. Methodology

3.1 Data

This study employs micro-level data from four rounds of the GLSS, administered in 1998/1999, 2005/2006, 2012/2013 and 2016/2017. The GLSS is a nationally representative household survey, and the sampling frame for the survey is the population living in private households in Ghana. The above sample frame is divided into primary and secondary sampling units. The primary sampling unit is the census enumerated areas (EAs) that are formed within the then ten administrative regions of Ghana, based on proportional allocation using the population in each of the regions. The second sampling unit is the households living in each of the enumeration areas. We considered survey rounds four to seven due to the wider coverage of households and availability of observations. For the fourth round of the GLSS, out of the total of 6,000 households selected, 5,998 were successfully covered in the survey, representing 99.7 percent coverage. Similarly, in the fifth round of the GLSS, out of a sample of 8,700 households nationwide, 8,687 households were successfully interviewed, representing a 99.85 percent response rate. The sixth round had a total of 18,000 households. Out of this, 16,772 were successfully interviewed, representing a response rate of 93.2 percent. Finally, the seventh round of the GLSS was proposed to study about 15,000 households. At the end 14,009 households were successfully interviewed constituting 93.4 percent. These four rounds of data sets were pulled together to form a larger, cross-sectional data set. Table 1 shows the fours waves employed and the corresponding sample administered.

Table 1: Household Sample Administered for Various Waves

Wave	Year	Sample administered (response rate %)
GLSS 4	1998/1999	5,998 (99.7%)
GLSS 5	2005/2006	8,687 (99.85 %)
GLSS 6	2012/2013	16,772 (93.2%)
GLSS 7	2016/2017	14,009 (93.4%)

Source: Ghana Living Standards Survey Report.

3.2 Variable Measurement

Based on the information from the GLSS sample, we constructed the variables of interest for the empirical analysis. The health outcome variable is measured as a binary variable (healthy) that takes the value 1 for individuals who reported not suffering from any illness during the two weeks prior to the interview. Injury incidence is negligible, so excluded from the analysis. The use of self-reported measures is widely accepted and can provide accurate and efficient assessment of objective states (Cleary 1997).

The analysis is restricted to individuals who are either head or spouse in the household. In the specifications employed for the empirical analysis, we control for the gender of the individuals, whether they are heads of the household, and their interaction effects. This enables us to ascertain whether spouses, who may be more involved in household chores and thus may be more exposed to the emissions of dirty cooking fuels, are more likely to report being ill. The inclusion of the interaction effect between gender and headship also sheds light on whether women's empowerment in household decision-making matters.

Following the discussion on the energy ladder in Section 2, energy poverty is measured by three cooking fuel binary variables: gas (advanced fuel), charcoal (transitional fuel) and firewood (primitive fuel). Firewood is used as the reference group in this study. These variables are derived from a question on the main cooking fuel in the household. Responses also included electricity, kerosene, crop residue, dung cake, sawdust and others; however, these are excluded from the analysis due to insignificant numbers in the reporting.

Also, to control for other factors that may influence a households' health outcome and energy poverty, we include as covariates: (i) the log of equivalized household income , (ii) the household size, with a minimum of one and a maximum of fifteen members (iii) the age of the individual in years, with a minimum age of sixteen and a maximum of seventy-five (iv) controls for marital status (never married, married, cohabitating, divorced or widowed), (v) indicators for educational level of the individual (no education, primary, middle, secondary and tertiary), and finally, (vi) whether the household is in an urban or rural area.

3.3 Model and Estimation Strategy

The empirical framework follows the work of Gangadharan and Valenzuela in 2001, where health outcomes are assumed to be determined by the environment and income. They pointed out the environment as one of the factors that is believed to have an impact on health outcomes. Also, health outcomes of a population improve as the standard of living improves. Access to health care services and education are some of the indications of an increase in living standards.

The relationship between these variables and health outcomes is expressed as:

$$H = f(I, E, W) \quad (1)$$

where H represents health outcome of the population, I is the level of income, E represents the environment, and W refers to other factors that could influence health outcomes of the population.

Transforming the functional relationship into an econometric model and representing it in a repeated cross-sectional framework, we gradually build the model as follows:

We first investigate the gender-health gap and the role of the individual in the household as in equation (2) below,

$$healthy_{i,t} = \beta_1 + \beta_2 female_i + \beta_3 head_{i,t} + \sum_{j=4}^{k} \beta_j X_{ij} + \mu_t + \varepsilon_{it} \quad (2)$$

Secondly, the model incorporates the health effects of energy poverty by including the cooking fuel variables (gas and charcoal, with firewood as the reference group) as in equation (3) below,

$$healthy_{i,t} = \beta_1 + \beta_2 female_i + \beta_3 head_{i,t} + \beta_4 charcoal_{i,t} + \beta_5 gas_{i,t} + \sum_{j=6}^{k} \beta_j X_{ij} + \mu_t + \varepsilon_{it} \quad (3)$$

Consequently, the full model is outlined in an equation (4) as follows,

$$healthy_{i,t} = \beta_1 + \beta_2 female_i + \beta_3 head_{i,t} + \beta_4 (female_i * head_{i,t}) + \beta_5 charcoal_{i,t} + \beta_6 gas_{i,t} + \beta_7 (female_i * charcoal_{i,t}) + \beta_8 (female_i * gas_{i,t}) + \sum_{j=9}^{k} \beta_j X_{ij} + \mu_t + \varepsilon_{it} \quad (4)$$

Where $healthy_{i,t}$ is the health status of the individual, i in survey round t; $female_i$ is the gender of the individual i; $head_{i,t}$ is the head of household, i in survey round t; $(female_i * head_{i,t})$ is the corresponding interaction; $charcoal_{i,t}$ and $gas_{i,t}$ are binary variables denoting the main cooking fuel in the household, i in survey round t; and $(female_i * charcoal_{i,t})$ and $(female_i * gas_{i,t})$ are the respective interaction terms between gender and cooking fuel. X_{ij} is a vector of k variables controlling for individual and household characteristics that affect health outcome, such as age, education, marital status, household income, household size and location of the household. $\beta's$ are the parameter vectors; μ_t represents time-fixed effects, which control for unobserved survey round characteristics; and ε_{it} is the random error term of the equation.

A key methodological issue of concern is the potential endogeneity that may bias the estimated effect of energy poverty on health in equations (2) through (4). For this reason, our identification strategy relies on the use of instrumental variables. In non-linear models, it is difficult to account for endogeneity when the endogenous regressors are binary (as in our case). Estimation routines such as instrumental variable probit (IV-Probit) are only appropriate when the endogenous regressors are continuous variables. Thus, our preferred method is the 2SLS-IV estimation. Furthermore, Ordinary Least Squares (OLS), as a natural approach to estimation, makes explicit use of the structure of the model as laid out in the equations above. In addition, least squares, even for linear probability models, enjoy a robustness compared to other estimators, in the sense that even if the true model is not a linear regression, the regression line fit by least squares is an optimal linear predictor for the dependent variable. Finally, under the very specific assumptions of the classical model, by one reasonable criterion, least squares will be the most efficient use of the data (Greene 2003).

Following arguments in the literature, and in particular that of Sadath and Acharya in 2017, which indicated that the existence of energy poverty coincides with other forms of deprivations such as income poverty and social backwardness (as argued in Section 2 above), the estimation of equations (3) and (4) may suffer from endogeneity caused by omitted variable bias. This is because social backwardness can deny people a great deal of comfort, including access to a cleaner source of cooking fuel such as electricity and gas. Therefore, its omission in the model is likely to produce bias estimates. Furthermore, there may be other reasons to suspect that energy poverty may be endogenous. Mekonnen and Köhlin in 2009 argued that as household incomes increase, their demand for fuel is influenced by the type of appliances they use, and that fuel choice depends on the purpose for which energy is required. This boils down to preferences. In rural parts of developing countries, for example, electrical appliances are not common, and there is less education on how to operate electric and gas cooking equipment. Owing to the lack of operational knowledge of advanced fuels such as those used in electric and gas cookers, rural dwellers may still prefer traditional over advanced fuels as incomes increase, even when there is improved access to advanced fuels. The time pattern can also influence the type of cooking fuel households use. In the short run, households may depend on less clean fuel while planning for the installation of appliances using more advanced fuels. In addition, women are generally more risk-averse than men, and may choose less risky cooking fuels. For instance, the use of LPG is much riskier because it can explode, and may not be preferred by women or risk-averse individuals.

In an attempt to solve the access problem (take account of any potential endogeneity) and to improve the empirical analysis, we estimate a two-stage, least squares (2SLS)- Instrumental Variable (IV) regression. In doing so, we acknowledge the fact that being “energy-poor” is not random and may depend on parameters such as income or access to cleaner cooking fuel.

Household income is expected to have a direct impact on health, thus not satisfying the exogeneity assumption. Our identification strategy relies on using instrumental variables related to access to a cleaner cooking fuel. In particular, the study uses four instrumental variables that capture regional accessibility to cleaner forms of energy: (i) two binary variables that take the value 1 if at least one person in the district uses charcoal or gas respectively and 0 otherwise, to measure access to gas and charcoal in the district, (ii) the percentage of households in the region that uses charcoal and gas respectively to measure the extent of access, and (iii) interaction terms between the female and each of the above instruments. The empirical discussion primarily relies on the 2SLS-IV results, as this is our preferred estimator.

4. Empirical Results

4.1 Summary and Descriptive Statistics

Table 2 presents summary statistics for the key variables used in this study. Around 51 percent of the sample were female, with 78 percent of the survey participants reporting being healthy. The percentage of household heads in the full sample is about 68 percent, with about 38 percent and 98 percent in the female and male sub-samples, respectively. In terms of the households' main cooking fuel, about 36 percent use charcoal, with about 19 percent and 46 percent using gas and firewood, respectively. The average household income was GHC2,041.956. The average age of the respondents was forty. Regarding marital status, about 7 percent were never married; about 64 percent were married; those co-habitating (living together) were about 15 percent; about 4 percent were divorced; and about 5 percent were widowed.

Table 2: Summary Statistics

Variable	Observations	Mean
Female	25,982	0.508
Healthy		0.784
Illness	25,571	0.261
Head	25,982	0. 677
Head (female subgroup)	13,191	0.383
Head (male subgroup)	12,791	0. 979
Charcoal	25,982	0. 355
Gas	25,982	0.190
Wood	25,982	0.455
Household income	25,982	2041.956
Age	25,982	39.99
Never married		0.067
Married		0.639
Cohabitation	25,982	0.152
Divorce		0.043
Widowed		0.052

No education		0.122
Primary		0.232
Middle school	25,982	0.423
Secondary		0.112
Tertiary		0.111
Household size	25,982	4.376
Rural	25,982	0.520

Source: Authors' computation using STATA.

Similarly, about 12 percent had no formal education; about 23 percent had primary education; those with an education level up to middle school were about 42 percent; and those with secondary and tertiary education were 11.2 percent and 11.1 percent, respectively. An average household size of about four was recorded. Finally, about 52 percent of the sample were from the rural areas of Ghana.

4.2 Empirical Estimations and Discussion

This sub-section analyses the empirical results with the aim of examining the gender-health gap, the health effects of energy poverty and the role that energy poverty plays in the gender-health gap in Ghana. Table 3 presents the results of the OLS regressions that use micro level data from four rounds of the GLSS, accounting for household income level, size, and location, as well as the individuals' age, education level and marital status. To gradually build the health model, we begin by assessing the gender-health and head-spouse health gaps. The first column (column 1) is estimated using only key individual and household characteristics as specified in equation (2). In column 2, we further assess the health effects of energy poverty by adding the energy poverty variables, equation (3). Finally, in column 4, we incorporate the role energy poverty may play in the gender-health gap and female headship by estimating the full model with the respective interaction terms, equation (4). All regressions are corrected for robust standard errors and controlled for year effects of various data rounds. While our OLS estimates are statistically significant and economically meaningful, the issue of potential endogeneity bias remains.

Table 3: Estimates of Equation (2) through (4) Using OLS and 2SLS Instrumental Variables (IV)

Dependent Variable: Health Status (Healthy=1, Illness=0)					
Independent Variables	**OLS**	**OLS**	**IV**	**OLS**	**IV**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Female	-0.070***	-0.071***	-0.076***	-0.121***	-0.136***
	(0.008)	(0.008)	(0.008)	(0.022)	(0.027)
Head	-0.023***	-0.022**	-0.018**	-0.076***	-0.077***
	(0.009)	(0.009)	(0.009)	(0.022)	(0.022)
Female*Head				0.061***	0.068***
				(0.023)	(0.024)
Charcoal		0.023***	0.138***	0.028***	0.154***
		(0.007)	(0.038)	(0.009)	(0.042)
Gas		0.036***	0.220***	0.039***	0.196***
		(0.009)	(0.029)	(0.011)	(0.031)
Female*Charcoal				-0.011	-0.036
				(0.012)	(0.049)
Female*Gas				-0.007	0.053*
				(0.013)	(0.031)
Year Effects	Yes	Yes	Yes	Yes	Yes
Observations	25,571	25,571	25,571	25,571	25,571
R-squared	0.038	0.038	0.022	0.039	0.021
Weak identification test			161.171		122.739
Under identification test			778.036		590.727
			(0.000)		(0.000)
Overidentification test			9.263		6.074
			(0.159)		(0.194)
Endogeneity test			48.132		52.130
			(0.000)		(0.000)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The coefficient of the control variables and year dummies is not reported for brevity. For the under-identification, Hansen J. (overidentification) and endogeneity tests, we report the test values with p-values in parentheses. Full estimates are provided in Appendix I (OLS) and Appendix II (IV).

To improve the estimates and account for any potential endogeneity, the 2SLS-IV regression is presented in columns 3 and 5 of Table 3. The choice of instruments is supported by the corresponding tests. The F-statistics on the test for weak identification of the endogenous regressors (charcoal, gas, female*charcoal and female*gas) are reported as 161.171 and 122.739, for equations (3) and (4), respectively. These values exceed the critical values reported by Stock-Yogo (2005), indicating that the endogenous regressors are strongly identified. Furthermore, the test statistics for under-identification and over-identification (Hansen J.), reported at the bottom of Table 3, suggest that the instruments are relevant and the overidentifying restrictions are exogenous, respectively. Thus, the chosen instruments are well identified. Finally, the endogeneity test rejects the null hypothesis of exogeneity, thus supporting the use of instrumental variables. As a result, the 2SLS-IV method is our preferred estimator as the results account for potential endogeneity and allow us to identify the causal effect of energy poverty on health.

The results from Tables 3 confirmed the health difference across gender. In line with the findings and arguments in the literature (Verbrugge 1989; Malmusi et al 2012; and Zhang, d'Uva, and

Doorslaer 2015, in America, Spain and China, respectively), the coefficient of the gender dummy (female) is negative and statistically significant at a 1 percent level across all regressions in Tables 4, with the magnitude of this coefficient increasing as the number of regressors increase. In each case, it indicates that females on average aremore likely to report having been ill compared to their male counterparts. To the authors' knowledge, this is a novel finding in the literature for the case of Africa. Referring to the OLS estimates of the full model in column 4, the results suggest that females are 12.1 percent less likely to be healthy by not reporting any form of illness, than males. The probable health difference became more pronounced after accounting for endogeneity in column 5, indicating corrections made to the bias of the OLS estimator. Based on the IV-estimates of the full specification model, females are found to be 13.6 percent less likely to report being healthy than their male counterparts, with all other factors being equal. This finding is in line with our expectation and consistent with the existing literature.

Next, the health effects of energy poverty is analysed. In line with the existing literature (for example Boadi and Kuitunen 2006), the results show (at 1 percent significance level) that people in households where gas or charcoal is the main cooking fuel are healthier than their counterparts who use firewood, across regressions. According to the 2SLS-IV estimates of the full specification model in column 5, people in households where charcoal is used as a main cooking fuel are about 15 percent more likely to be healthy than their counterparts who use firewood, all else equal. Simlarly, people in households that use gas as a main cooking fuel are about 20 percent more likely to be healthy than their counterparts who use firewood. This is a logical finding, since the emissions and hazards associated with the use of firewood is more than the hazards of either charcoal or gas. In any of the two cases (charcoal and gas), the hypothesis that energy-poorer households (households that use unclean cooking fuels) are less healthy compared to their counterparts that use relatively clean cooking fuels is supported. The magnitude of the estimated coefficients using 2SLS-IV analysis is larger than the OLS results, which may indicate correction made to the anticipated bias of the OLS.

The analysis also suggests that heads of household are less likely to report being healthy than their counterpart spouses. This finding may seem counterintuitive, because spouses may be more exposed to the health hazards associated with unclean cooking fuels and thus expected to report poorer health. Indeed, the analysis reveals gender differences on the effect of household headship. The interaction terms between female and household head suggests that the health cost of household headship is lower for women than men, as shown in Table 3 columns 4 and 5.

Finally, the results provide an indication that energy-poverty may play a role in the gender-health gap, in the sense that using cleaner cooking fuel has the potential of reducing the health gap across gender. Specifically, in the 2SLS-IV estimates (column 5), the coefficient of the interaction term 'Female*charcoal' is negative but statistically insignificant, indicating that there is no significant health difference across gender for households that use charcoal as their main cooking fuel compared to those that use firewood. However, the coefficient of the interaction term 'Female*gas' is positive with weak statistical significance (at the 10 percent level), suggesting that the associated health benefits of using gas may be larger for women than men.

Specifically, the results suggest that, all else equal, the associated health benefits of using gas are about 5 percentage points more for women than men.

To further investigate the health effects of energy poverty, we provided both the estimates of OLS and 2SLS-IV for a split sub-sample (female and male sub-samples) in Table 4. Relying on the 2SLS-IV estimates, these sub-sample estimates provided results that are consistent with that of Table 3. The coefficients of 'charcoal' and 'gas' remain positive and significant suggesting that, in both sub-samples, people in households that use gas or charcoal as their main cooking fuel are more likely to be healthy than those who use firewood. For the female sub-sample, those who use charcoal or gas are about 12.4 percent and 23.2 percent more likely to be healthy, respectively, while the male sub-sample that used charcoal or gas was about 15.1 percent and 21.7 percent more likely to be healthy, respectively. It should be noted, though, that a comparison of the coefficients across the two samples does not suggest that there are statistically significant gender differences in the magnitude of the estimated effects. The z values[1] provided in Table 4 for charcoal and gas coefficients were all below 1.96, thus failing to reject the null hypothesis that $\beta_{Female} = \beta_{Male}$, and one cannot conclude that energy poverty affects females differently than males. This suggests that the health benefits of using gas (which tends to be greater for women) will offer very little contribution in bridging the gender health gap. Finally, household heads are less likely to be healthy than spouses, though this is insignificant for the female sub-sample.

Table 4: Estimates of Gender sub-sample Using OLS and 2SLS Instrumental Variables (IV)

Independent Variables	Female sub-sample		Male sub-sample		$\beta_{Female} = \beta_{Male}$	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**
	(2)	**(3)**	**(4)**	**(5)**	**Z values**	
Head	-0.017	-0.010	-0.077***	-0.079***	---	---
	(0.012)	(0.012)	(0.022)	(0.022)		
Charcoal	0.012	0.124**	0.034***	0.151***	1.539	0.349
	(0.010)	(0.058)	(0.010)	(0.051)		
Gas	0.022	0.232***	0.050***	0.217***	1.574	0.265
	(0.013)	(0.042)	(0.012)	(0.038)		
Year Effects	Yes	Yes	Yes	Yes		
Observations	13,054	13,054	12,517	12,517		
R-squared	0.036	0.017	0.038	0.022		
Weak identification test		138.005		169.626		
Under identification test		345.182 (0.000)		415.248 (0.000)		

[1] Following the works of (Clogg et al, 1995; Paternoster et al, 1998), the formula $z = \frac{\beta_1 - \beta_2}{\sqrt{(SE\beta_1)^2 + (SE\beta_2)^2}}$ is argued to be appropriate for testing for the difference between two regression coefficients.

Overidentificat	3.487	1.999		
ion test	(0.1749)	(0.368)		
Endogeneity	28.656	22.527		
test	(0.000)	(0.000)		

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The coefficient of the control variables and year dummies is not reported for brevity. For the under-identification, Hansen J. (overidentification) and endogeneity tests, we report the test values with p-values in parentheses. Full estimates are provided in Appendix III.

In sum, our analysis provided three key findings: (i) there is a gender-health gap in Ghana, where females are less likely to report being healthy than their male counterparts, (ii) energy poverty has adverse effects on health, as people in households that rely on less clean forms of cooking fuel report lower health, and finally (iii) part of our estimates suggest that energy poverty may contribute to widening the gender-health gap, a finding that potentially may have significant policy implications.

5. Summary, Conclusion and Policy Implications

Energy poverty is one of the biggest challenges that households face. Many households still face difficulties meeting their energy needs due to their inability to afford energy bills, limited access to energy, or inadequate energy services. Depending on the type of cooking technology adopted in a household, the health of household members can be negatively affected. Adoption of LPG and electricity is less hazardous to a households' health because of their cooking efficiency and the lower levels of indoor air pollution. Unlike electricity and LPG, biomass fuels, which are typically burned in open indoor fires, can lead to high levels of household air pollution from smoke and have been linked to a range of adverse health outcomes. Females are likely to experience high exposures in and around the home due to their domestic roles, and subsequently may be less healthy than males. This study provides novel contribution to the literature by providing empirical evidence on the gender-health gap and energy poverty in Ghana. In particular, using micro-level data from four rounds of the GLSS and employing least squares and instrumental variable regressions, the study first analysed the gender-health gap in Ghana and then assessed the health effects of energy poverty and the role that energy poverty plays in the gender-health gap.

The results confirmed the health difference across gender in Ghana. In particular, the results suggest that females are less likely to be healthy than their male counterparts, confirming the health imbalance that is argued to be bias against females in extant literature. On the effects of energy poverty on health outcomes, the results showed that those who use gas or charcoal as their main cooking fuel are more likely to be healthy than their counterparts who use firewood. Finally, there is some evidence suggesting that using cleaner cooking fuel may contribute to reducing the health gap across genders. In particular, part of our estimates suggested that the health benefits of using gas as a main cooking fuel in the household, compared with firewood, are greater for females than for males.

According to our study, there is a gender health gap that tends to be less favourable to women in Ghana. The use of unclean cooking fuel has adverse health effects that may contribute to the gender-health gap. Thus, promoting and expanding the use of clean cooking fuel in households may help address the gender-health gap in a developing country such as Ghana. This is possible through improved access to clean cooking fuels and the establishment of funding schemes. Domestic policymakers in developing countries should encourage policies that eliminate energy-poverty in their countries. The importance of eliminating energy-poverty was recognized and included in the United Nation's Sustainable Development Goals for the 2030 Agenda as the seventh goal, focusing on universal access to affordable, reliable, and modern energy services. Governments in developing countries should work hand-in-hand with the UN to ensure the elimination of energy poverty.

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Appendix I: Estimates of Equation (2) through (4) Using OLS

Dependent Variable: Health Status (healthy=1, illness=0)			
Independent Variables	(1)	(2)	(3)
Female	-0.070***	-0.071***	-0.121***
	(0.008)	(0.008)	(0.022)
head	-0.023***	-0.022**	-0.076***
	(0.009)	(0.009)	(0.022)
Female*head			0.061***
			(0.023)
Charcoal		0.023***	0.028***
		(0.007)	(0.009)
Gas		0.036***	0.039***
		(0.009)	(0.011)
Female*charcoal			-0.011
			(0.012)
Female*gas			-0.007
			(0.013)
Log of income	0.015***	0.014***	0.014***
	(0.004)	(0.004)	(0.004)
Age	0.002*	0.002	0.002
	(0.001)	(0.001)	(0.001)
Age squared	-0.59e-4***	-0.55e-4***	-0.55e-4***
	(0.16e-4)	(0.16e-4)	(0.16e-4)
(Never married)			
Married	0.027**	0.029**	0.031***
	(0.012)	(0.012)	(0.012)
Cohabitating	0.021*	0.023*	0.024*
	(0.012)	(0.012)	(0.013)
Divorce	0.003	0.005	0.004
	(0.015)	(0.015)	(0.015)
Widowed	-0.13e-3	0.002	0.001
	(0.017)	(0.017)	(0.017)
(No education)			
Primary	0.033***	0.032***	0.032***
	(0.010)	(0.010)	(0.010)
Middle	0.040***	0.036***	0.036***
	(0.011)	(0.011)	(0.011)
Secondary	0.040***	0.032**	0.033***
	(0.012)	(0.013)	(0.013)
Tertiary	0.064***	0.052***	0.052***
	(0.012)	(0.013)	(0.013)
Household size	0.004***	0.005***	0.006***
	(0.001)	(0.002)	(0.002)
(urban)			
Rural	-0.047***	-0.032***	-0.032***
	(0.005)	(0.007)	(0.007)
Year Effects	Yes	Yes	Yes
Observations	25,571	25,571	25,571
R-squared	0.038	0.038	0.039

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The coefficient of the year dummies is not reported for brevity.

Appendix II: Estimates of Equation (2) Using 2SLS Instrumental Variables (IV)

Dependent Variable: Health Status (healthy=1, illness=0)								
Independent	stage 1		**stage 2***	stage 1				**stage 2****
Variables	Gas	Charcoal		Female*Gas	Female*Charcoal	Gas	Charcoal	
Charcoal			**0.138*** **					**0.154*** **
			(0.038)					**(0.042)**
Gas			**0.220*** **					**0.196*** **
			(0.029)					**(0.031)**
Female*Charcoal								**-0.036**
								(0.049)
Female*Gas								**0.053***
								(0.031)
Female	-0.037**	0.039**	**-0.076*** **	-0.017	-0.207***	-0.013	0.024	**-0.136*** **
	(0.018)	(0.019)	**(0.008)**	(0.014)	(0.013)	(0.025)	(0.032)	**(0.027)**
Head	-0.036***	0.030***	**-0.018****	-0.009*	0.001	-0.008	0.014	**-0.077*** **
	(0.007)	(0.009)	**(0.009)**	(0.005)	(0.005)	(0.019)	(0.027)	**(0.022)**
Female*Head				-0.012	0.058***	-0.030	0.019	**0.068*** **
				(0.009)	(0.010)	(0.020)	(0.029)	**(0.024)**
Log of income	-0.008**	0.014***	**0.005**	-0.006**	0.008**	-0.007**	0.014***	**0.005**
	(0.003)	(0.005)	**(0.004)**	(0.003)	(0.003)	(0.003)	(0.004)	**(0.004)**
Age	0.013***	-0.009***	**-0.15e-3**	0.005***	-0.005***	0.013***	-0.009***	**-0.29e-4**
	(0.001)	(0.001)	**(0.002)**	(0.001)	(0.001)	(0.001)	(0.001)	**(0.002)**
Age squared	-0.15e-3***	-0.83e-4***	**-0.32e-4*** **	-0.000***	0.000***	-0.000***	0.000***	**-0.31e-4***
	(0.11e-4)	(0.16e-4)	**(0.17e-4)**	(0.000)	(0.000)	(0.000)	(0.000)	**(0.17e-4)**
(Never married)								
Married	-0.025**	0.026*	**0.036*** **	0.013	0.002	-0.027**	0.027**	**0.036*** **
	(0.012)	(0.014)	**(0.012)**	(0.008)	(0.009)	(0.011)	(0.014)	**(0.012)**
Cohabitating	-0.083***	0.046***	**0.035*** **	-0.026***	0.015	-0.084***	0.049***	**0.035*** **
	(0.012)	(0.014)	**(0.013)**	(0.008)	(0.010)	(0.012)	(0.014)	**(0.013)**
Divorce	-0.087***	0.071***	**0.016**	-0.038***	0.024**	-0.087***	0.071***	**0.014**
	(0.013)	(0.016)	**(0.015)**	(0.010)	(0.012)	(0.013)	(0.016)	**(0.015)**
Widowed	-0.100***	0.094***	**0.012**	-0.053***	0.026*	-0.101***	0.095***	**0.009**
	(0.014)	(0.018)	**(0.017)**	(0.011)	(0.014)	(0.014)	(0.018)	**(0.017)**
(No education)								
Primary	-0.001	0.044***	**0.024****	0.015***	0.026***	-0.001	0.046***	**0.023****
	(0.006)	(0.010)	**(0.011)**	(0.005)	(0.008)	(0.006)	(0.010)	**(0.011)**
Middle	0.058***	0.048***	**0.014**	0.060***	0.026***	0.056***	0.050***	**0.012**
	(0.006)	(0.010)	**(0.011)**	(0.005)	(0.008)	(0.006)	(0.010)	**(0.011)**
Secondary	0.214***	-0.031**	**-0.010**	0.151***	-0.025**	0.212***	-0.029**	**-0.013**

	(0.010)	(0.013)	**(0.014)**	(0.007)	(0.010)	(0.010)	(0.013)	**(0.014)**
Tertiary	0.367***	-0.118***	**-0.008**	0.193***	-0.077***	0.365***	-0.113***	**-0.011**
	(0.010)	(0.013)	**(0.016)**	(0.007)	(0.009)	(0.010)	(0.013)	**(0.016)**
Household size	-0.011***	-0.012***	**0.011*****	-0.005***	-0.005***	-0.011***	-0.012***	**0.012*****
	(0.001)	(0.002)	**(0.002)**	(0.001)	(0.001)	(0.001)	(0.002)	**(0.002)**
(Urban)								
Rural	-0.143***	-0.329***	**0.045*****	-0.069***	-0.168***	-0.143***	-0.329***	**0.045*****
	(0.005)	(0.007)	**(0.017)**	(0.003)	(0.005)	(0.005)	(0.007)	**(0.017)**
Gas access	0.035***	0.115***		-0.033***	-0.029***	0.035***	0.115***	
	(0.005)	(0.010)		(0.002)	(0.003)	(0.005)	(0.010)	
Charcoal access	-0.056***	0.187***		-0.019***	-0.008**	-0.058***	0.185***	
	(0.009)	(0.010)		(0.004)	(0.004)	(0.009)	(0.010)	
Gas access%	0.009***	-0.005***		-0.001***	-0.001***	0.009***	-0.005***	
	(0.000)	(0.001)		(0.000)	(0.000)	(0.000)	(0.000)	
Charcoal access%	-0.002***	0.005***		-0.000**	-0.002***	-0.002***	0.005***	
	(0.000)	(0.001)		(0.000)	(0.000)	(0.000)	(0.000)	
(Female*gas access)	0.012*	0.001		0.112***	0.178***	0.011	0.003	
	(0.007)	(0.014)		(0.005)	(0.010)	(0.007)	(0.014)	
(Female*char access)	0.014	0.002		-0.013	0.208***	0.017	0.001	
	(0.013)	(0.015)		(0.010)	(0.010)	(0.013)	(0.015)	
(Female*gas access%)	-0.001**	0.001		0.010***	-0.003***	-0.001**	0.000	
	(0.001)	(0.001)		(0.000)	(0.000)	(0.000)	(0.001)	
(Female*char access%)	0.002***	-0.001**		0.000	0.007***	0.002***	-0.001**	
	(0.001)	(0.001)		(0.000)	(0.000)	(0.000)	(0.001)	
Underid test			778.036(0.000)					590.727 (0.000)
Hansen J (overid)			9.263(0.159)					6.074 (0.194)
Endogeneity test			48.132(0.000)					52.130 (0.000)
F-stat (Weak ident. test)	158.93	215.39	161.171	484.90	392.26	158.58	214.83	122.739
Year Effects			Yes					Yes
Observations			25,571					25,571
R-squared			0.022					0.021

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The coefficients of the year dummies are not stated for brevity. For the underidentification, Hansen J. (overidentification) and endogeneity tests, we report the test values with p-values in parenthesis.

Appendix III: Estimates of Gender sub-sample Using OLS and 2SLS Instrumental Variables (IV)

Dependent Variable: Health Status (Healthy=1, llness=0)								
Independent Variables	Female sub-sample				Male sub-sample			
	OLS	2SLS-IV			**OLS**	2SLS-IV		
		Stage 1		**Stage 2**		Stage 1		**Stage 2***
		Gas	Charcoal			Gas	Charcoal	
Charcoal	**0.012**			**0.124****	**0.034*****			**0.151*****
	(0.010)			**(0.058)**	**(0.010)**			**(0.051)**
Gas	**0.022**			**0.232*****	**0.050*****			**0.217*****
	(0.013)			**(0.042)**	**(0.012)**			**(0.038)**
Head	**-0.017**	-0.038***	0.022*	**-0.010**	**-0.077*****	-0.005	0.015	**-0.079*****
	(0.012)	(0.009)	(0.012)	**(0.012)**	**(0.022)**	(0.019)	(0.027)	**(0.022)**
Log of income	**0.020*****	-0.009*	0.012*	**0.011***	**0.006**	-0.005	0.014**	**-0.002**
	(0.005)	(0.005)	(0.006)	**(0.006)**	**(0.005)**	(0.005)	(0.006)	**(0.006)**
Age	**-0.001**	0.012***	-0.007***	**-0.004***	**0.007*****	0.014***	-0.011***	**0.006****
	(0.002)	(0.001)	(0.002)	**(0.002)**	**(0.002)**	(0.002)	(0.002)	**(0.002)**
Age squared	**-0.19e-4**	-0.14e-3***	0.60e-3***	**0.10e-4**	**-0.11e-3*****	-0.16e-4***	0.11e-3***	**-0.89e-4*****
	(0.24e-4)	(0.17e-4)	(0.24e-4)	**(0.25e-4)**	**(0.23e-4)**	(0.16e-4)	(0.23e-4)	**(0.24e-4)**
(Never married)								
Married	**0.023**	-0.008	-0.033	**0.033**	**0.024**	-0.045***	0.068***	**0.029***
	(0.020)	(0.019)	(0.023)	**(0.021)**	**(0.015)**	(0.015)	(0.017)	**(0.015)**
Cohabitating	**0.027**	-0.071***	-0.010	**0.044****	**0.006**	-0.092***	0.087***	**0.014**
	(0.021)	(0.019)	(0.023)	**(0.021)**	**(0.016)**	(0.015)	(0.019)	**(0.017)**
Divorce	**0.003**	-0.066***	0.022	**0.017**	**-0.008**	-0.105***	0.105***	**0.001**
	(0.021)	(0.019)	(0.023)	**(0.021)**	**(0.022)**	(0.018)	(0.024)	**(0.023)**
Widowed	**-0.012**	-0.068***	0.039	**0.001**	**0.015**	-0.137***	0.140***	**0.020**
	(0.024)	(0.020)	(0.026)	**(0.024)**	**(0.025)**	(0.018)	(0.026)	**(0.027)**
(No education)								
Primary	**0.026***	0.020**	0.039***	**0.014**	**0.042*****	-0.024***	0.058***	**0.036****
	(0.014)	(0.009)	(0.014)	**(0.015)**	**(0.016)**	(0.008)	(0.014)	**(0.016)**
Middle	**0.031****	0.087***	0.032**	**0.003**	**0.044*****	0.015*	0.077***	**0.027**
	(0.014)	(0.009)	(0.014)	**(0.015)**	**(0.016)**	(0.008)	(0.015)	**(0.017)**
Secondary	**0.031***	0.289***	-0.071***	**-0.029**	**0.037****	0.136***	0.017	**0.007**
	(0.018)	(0.015)	(0.019)	**(0.023)**	**(0.018)**	(0.012)	(0.018)	**(0.019)**

tertiary	**0.065*** **	0.493***	-0.216***	**-0.022**	**0.048*** **	0.273***	-0.043**	**0.001**
	(0.019)	(0.016)	(0.020)	**(0.029)**	**(0.017)**	(0.012)	(0.018)	**(0.020)**
Household size	**0.003**	-0.009***	-0.012***	**0.009*** **	**0.008*** **	-0.012***	-0.012***	**0.014*** **
	(0.002)	(0.002)	(0.002)	**(0.003)**	**(0.002)**	(0.002)	(0.002)	**(0.002)**
(urban)								
Rural	**-0.035*** **	-0.136***	-0.327***	**0.044* **	**-0.028*** **	-0.150***	-0.331***	**0.048** **
	(0.010)	(0.006)	(0.009)	**(0.025)**	**(0.009)**	(0.007)	(0.009)	**(0.023)**
Gas access		0.042***	0.120***			0.039***	0.111***	
		(0.005)	(0.011)			(0.005)	(0.010)	
Charcoal access		-0.042***	0.186***			-0.053***	0.183***	
		(0.010)	(0.011)			(0.009)	(0.010)	
Gas access%		0.008***	-0.004***			0.009***	-0.005***	
		(0.000)	(0.001)			(0.000)	(0.001)	
Charcoal access%		-0.000	0.004***			-0.002***	0.005***	
		(0.000)	(0.001)			(0.000)	(0.001)	
Underid test				345.182 (0.000)				415.248 (0.000)
Hansen J (overid)				3.487 (0.1749)				1.999 (0.368)
Endogeneity test				28.656 (0.00)				22.527 (0.000)
F-stat		154.02	187.93	138.005		157.70	229.24	169.626
Year Effects	Yes			Yes	Yes			Yes
Observations	13,054			13,054	12,517			12,517
R-squared	0.036			0.017	0.038			0.022
Gas=Charcoal	0.82 (0.3651)			2.96 (0.0851)	2.70 (0.1005)			1.58 (0.2094)

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The coefficients of the year dummies are not stated for brevity. For the under-identification, Hansen J. (overidentification) and endogeneity tests, we report the test values with p-values in parenthesis. For the coefficient equality test, we presented chi square/F values with p-values in parenthesis.

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