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**Working Paper**

## Does environment and health awareness matter for household fuel choice? Empirical evidence from Central Asia

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## **ADBI Working Paper Series**

### **DOES ENVIRONMENT AND HEALTH AWARENESS MATTER FOR HOUSEHOLD FUEL CHOICE? EMPIRICAL EVIDENCE FROM CENTRAL ASIA**

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Dina Azhgaliyeva, Wataru Kodama,  
and Hans Holzhacker

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December 2023

**Asian Development Bank Institute**

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**Abstract**

Household consumption of coal and other dirty fuels for heating and cooking greatly contributes to air pollution both outdoors and indoors. This paper contributes to the literature on the determinants of household heating choice (dirty versus modern energy source). Energy transition in countries where a large proportion of the population is energy-poor could be challenging. To investigate the energy choice of the energy-poor population we conducted a survey with 1,522 households from three countries in Central Asia: eastern Uzbekistan, the southern Kyrgyz Republic, and northern Tajikistan (also called Fergana Valley). Half of the households (50%) use coal for heating. We find that the energy-poor (who comprise 66% of the population) are more likely to use dirty fuel for heating. The determinants of heating choice (dirty fuel versus modern energy) vary for the energy-poor and energy-non-poor. For example, households that care about environmental harm are less likely to choose dirty fuel for heating, but only among those who are energy nonpoor. Awareness of health impacts has a significant effect on the heating fuel choice across all groups (energy-poor and -nonpoor). Based on the above findings, policy recommendations for promoting the transition from dirty to modern heating are provided.

**Keywords:** fossil fuel, heating, energy-poor, Central Asia, household energy consumption, energy transition

**JEL Classification:** G50, G51, G53

## Contents

1.	INTRODUCTION.....	1
2.	CONTEXT .....	2
2.1	Background .....	2
2.2	Data.....	3
3.	METHODOLOGY .....	3
3.1	Outcome Variables.....	3
3.2	Explanatory Variables .....	5
3.3	Econometric Model.....	9
4.	RESULTS AND DISCUSSION.....	10
4.1	Use of Dirty Fuel for Heating .....	10
4.2	The Willingness to Switch from Dirty to Clean Heating .....	13
5.	CONCLUSION AND POLICY IMPLICATIONS .....	13
	REFERENCES .....	15
	APPENDIX A .....	17

# 1. INTRODUCTION

Household fossil fuel combustion, especially coal, not only greatly contributes to global GHG emissions and outdoor air pollution, but also indoor air pollution. Households consume fossil fuel mainly for heating and cooking. In cold countries, fossil fuel combustion for heating has substantial impacts on health. During heating seasons many people, babies in particular, lose their lives due to indoor air poisoning from fossil fuel combustion.<sup>1</sup> Indoor air pollution also has a negative and long-lasting impact on health, disproportionally affecting women and small children, who spend more time indoors during the heating season (cf., UNICEF 2023). Clean and modern fuel for heating is essential for safeguarding good health for women and children and enhancing the well-being of people in developing countries with cold winters such as in Central Asia. The aim of this paper is to investigate how to promote fuel switching (Karimu, Mensah, and Adu 2016; Lenzen et al. 2006; Martey 2019) and how to overcome “fuel stacking”<sup>2</sup> (Choumert-Nkolo, Combes Motel, and Le Roux. 2019; Lay, Ondraczek, and Stoeber 2013; Masera, Saatkamp, and Kammen 2000; Quinn et al. 2018; Shankar et al. 2020).

While sectors such as power plants, industry, construction, and transportation are of critical importance for the energy transition, households also matter. Household fossil fuel combustion accounts for 24% of energy consumption in the Europe and Central Asia region, of which about 72% is used by the residential sector, and about 22% of CO<sub>2</sub> emissions, with the residential sector responsible for roughly 75% of these (World Bank 2023). In Central Asia, where winter is extremely cold, clean heating forms an essential part of the energy transition (Zhang et al. 2021). However, a large portion of the population (not only rural but also urban) in the region still uses coal, fuelwood, and other solid fuels, which is harmful to the environment and human health. Furthermore, energy poverty is becoming a critical issue in the region, making energy transition challenging.

Literature studying the determinants of households’ fuel choice in developing countries is extensive, but there remain some research gaps to be filled. First, such literature highlights access to electricity as a way to transit households from coal and wood. However, despite 100% electricity access (which is related to target 7.1 in UN SDG 7 Affordable and clean energy: By 2030, ensure universal access to affordable, reliable and modern energy services), households in Central Asia continue to use coal and other dirty fuels. Second, most literature studying the determinants of fuel choice notes that education has a significant impact as probably more educated household heads are more aware of the negative health impacts of dirty fuels and have enhanced knowledge about the efficiency and convenience of modern fuels. However, the positive impact of education on clean fuel choice could be due to the effect of income and time opportunity cost. Separating these distinct channels of education and identifying the effects of awareness on negative health and environmental impacts is

---

<sup>1</sup> Although data on death from indoor fuel combustion poisoning are extremely limited, 41 people died during the 2022/23 heating season in Kazakhstan (Urnaliyev 2023).

<sup>2</sup> “Fuel stacking” theory explains that “households choose a combination of fuels from both lower and upper levels of the ladder. Indeed, modern fuels may serve only as partial, rather than perfect substitutes for traditional fuels (van der Kroon et al. 2013, 2014). Multiple fuel use arises from several reasons, such as, occasional shortages of modern fuels (Hosier and Kipondya 1993; Kowsari and Zerriffi 2011), high cost of appliances associated with using exclusively modern fuels (Davis 1998), fluctuations of commercial fuel prices (Leach 1992) and preferences inducing households not to fully adopt modern fuels (Masera, Saatkamp, and Kammen 2000)” (Muller and Yan 2018: 4).

one of the challenges in the literature and is of great importance for policies (Muller and Yan 2018).

Using household survey data from three Central Asian countries in Fergana Valley, this paper studies the factors that affect “fuel stacking.” Focusing on households’ fuel choice for residential heating, we investigate how households’ health and environmental awareness, as well as other important factors, affect their choice. First, we find that a large fraction of households (about 66%) spend a substantial part of their income on energy (“energy-poor households”), and these households are more likely to use dirty fuel for heating. Second, households’ awareness of the impact of health has a significant effect on fuel choice across all groups (energy-poor and -nonpoor). In addition, awareness of environmental harm has greater effects on fuel choice for those who are energy-nonpoor than those who are energy-poor. Last, environmental awareness is the main reason why households switch from dirty to clean heating; however, the actual use of clean heating is affected by environmental awareness only for the energy-nonpoor, indicating that although the energy-poor may be aware of environmental impacts, they have limited ability to switch from dirty to clean heating, which could be due to other factors such as limited access to finance to change the heating system (or moving house), access, or affordability.

The rest of this paper is structured as follows. Section 2 provides context, and Section 3 describes key variables of interest and the econometric method. Section 4 presents results and a discussion. Section 5 provides conclusions and policy recommendations.

## **2. CONTEXT**

### **2.1 Background**

Fergana Valley is a region located in Central Asia, primarily within eastern Uzbekistan but it also extends into parts of northern Tajikistan and the southern Kyrgyz Republic. The climate of Fergana Valley is the factor that makes the area interesting for studying the heating (and cooling) methods and behavior. The valley has a continental climate with distinct seasons. Summers in Fergana Valley are typically hot and dry, with temperatures often exceeding 35°C during the hottest months, extending from June to August. Winters in the valley are cold and can be quite harsh. The average winter temperature can drop to minus 20°C or lower, typically from December to February. Such extreme temperatures are due to its topography: it is surrounded by mountains that influence its climate. During the summer, the enclosed nature of the valley can trap heat, leading to high temperatures, while in the winter, cold air can become stagnant, leading to very cold conditions.

The governments of all three countries of the valley are implementing policies, incentives, and regulations to promote clean heating. These measures include subsidies for renewable energy installations, tax incentives, and energy efficiency standards. Access to electricity is also guaranteed for all the households in the valley, although there are some supply disruptions. However, a large fraction of households still use coal, fuelwood, and other solid fuels for their residential heating.

## 2.2 Data

The household energy survey was carried out in-person in the territory of Fergana valley, which is located in three countries of Central Asia: eastern Uzbekistan, the southern Kyrgyz Republic, and northern Tajikistan. The survey was designed jointly by the CAREC Institute and the ADB Institute. The survey was conducted during July–August 2023 following pilot tests. The questionnaire included information on energy consumption, energy access for heating, cooling, and cooking, the quality of energy infrastructure, energy efficiency, and environmental education. The survey also traced down households' heating methods and behavior and their willingness to switch to cleaner energy. The distribution of the sample across rural/urban and household income groups (socioeconomic class, or SEC) is shown in Table 1.

**Table 1: Sample Distribution**

Country	Total Sample Households	SEC1 (poorest)	SEC2	SEC3	SEC4 (richest)	Rural
Kyrgyz Rep.	522	0%	2%	21%	44%	75%
Tajikistan	500	4%	4%	11%	32%	73%
Uzbekistan	500	9%	17%	29%	0%	42%
Total	1,522	13%	24%	61%	76%	63%

Note: SEC = socio-economic class (see Table 2).

**Table 2: Income Groups**

	Kyrgyz Rep., KGS	Tajikistan, TJS	Uzbekistan, UZS
SEC1 (poorest)	< 6,000	< 800	< 1,200,000
SEC2	6,001–12,000	801–1,400	1,200,001–2,000,000
SEC3	12,001–20,000	1,401–2,400	2,000,001–3,200,000
SEC4 (richest)	> 20,000	> 2,400	> 3,200,000

## 3. METHODOLOGY

This section provides the present outcome and explanatory variables we include in the regression analysis, with a brief review of determinants of households' fuel choice. A detailed literature review on the determinants of households' fuel choice is provided by Muller and Yan (2018). Descriptive statistics of key variables are also presented.

### 3.1 Outcome Variables

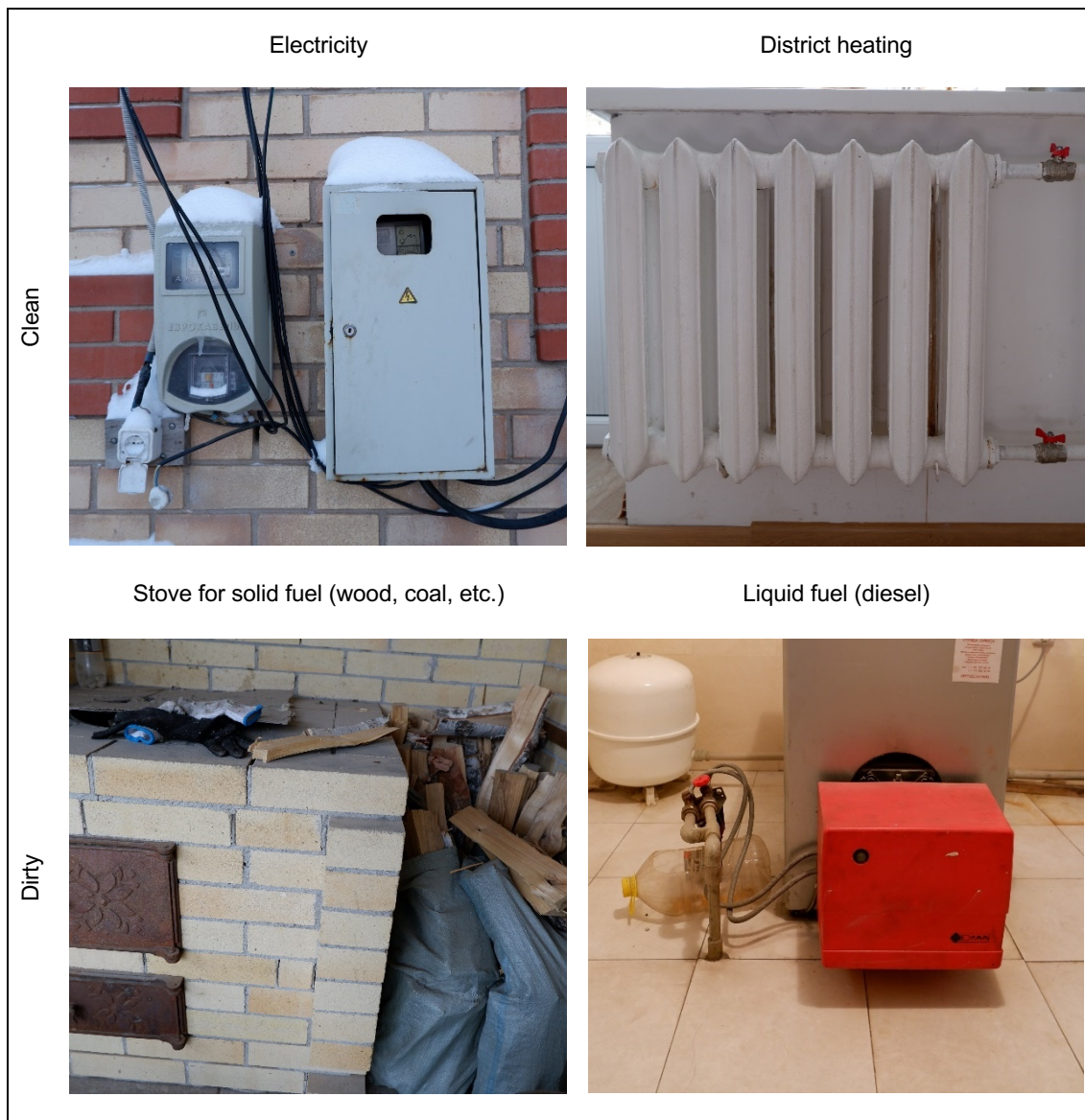
#### The Choice of Dirty Fuel for Heating

In dirty fuel for heating, we include those fuels that cause not only outdoor but also indoor air pollution (e.g., particulate matter and carbon monoxide): coal, fuel oil, diesel, biofuel (dung), firewood, waste, and garbage (Figure 1). In clean (modern) fuel for heating we include district heating, electricity, and gas (following Azhgaliyeva et al. 2021 and Kapsalyamova et al. 2021). Although district heating and electricity are most likely to be produced in coal-fired plants and are a source of outdoor air pollution, such heating does not cause indoor pollution, which imposes health risks and could be life-threatening. The dependent variable, choice of dirty fuel for heating, is a binary



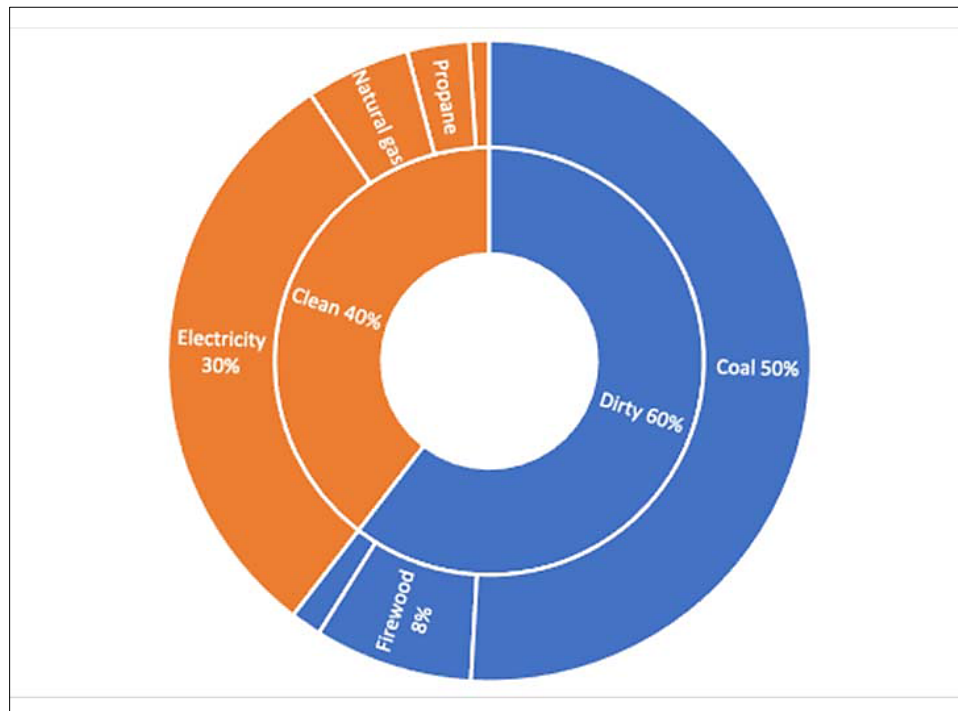
variable that equals one if a household uses dirty fuel as the main source for heating and zero if the household uses clean fuel as the main source for heating.

**Figure 1: Options for Heating**



Source: Authors' own.

Only 15 households (1%) have district heating, and most households (99%) use an autonomous heating system. Out of those who use autonomous heating, the majority (60%) use dirty fuels (Figure 2), even though the region has 100% access to electricity. Coal is the most common heating fuel, accounting for half of the households.

**Figure 2: Household Heating Choice**

### The Willingness to Switch from Dirty to Clean Heating

Those households who use dirty fuel for heating were asked if they have plans to switch to clean heating in the next five years (including moving to another house). The dependent variable, the willingness to switch from dirty to clean heating, is a binary variable that equals one if the household is planning to switch from dirty to clean heating in the next five years and zero if not. Some 22% of households with dirty heating are willing to switch from dirty to clean heating, nearly half of which are willing to switch to electricity heating (Figure 3).<sup>3</sup>

## 3.2 Explanatory Variables

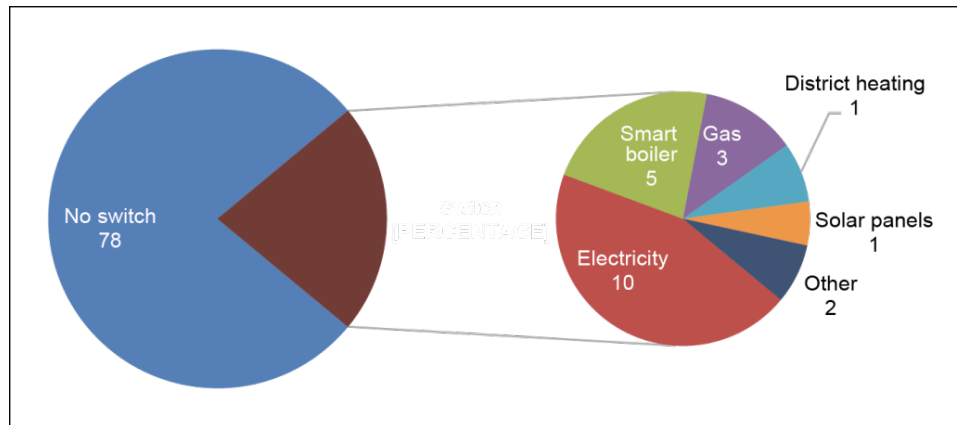
### Energy Poverty

The choice of heating fuel could be different for energy-poor households than for energy-nonpoor ones (Xie et al. 2022; Burguillo, Barisone, and Juez-Martel 2022). Energy-poor households are more likely to use dirty fuel than energy-nonpoor ones (Burguillo, Barisone, and Juez-Martel 2022). For measuring energy-poor households we use a simple and the most commonly used measure of energy poverty – 10% of expenditure, following Boardman (1991). In other words, energy-poor households are those that spend more than 10% of their income on energy expenditure. In our sample, the majority (68%) of households are energy-poor. The distribution of energy expenditure shares to total expenditure (%) by country is shown in Figure 4. There are a considerable number of households, particularly in the Kyrgyz Republic, whose

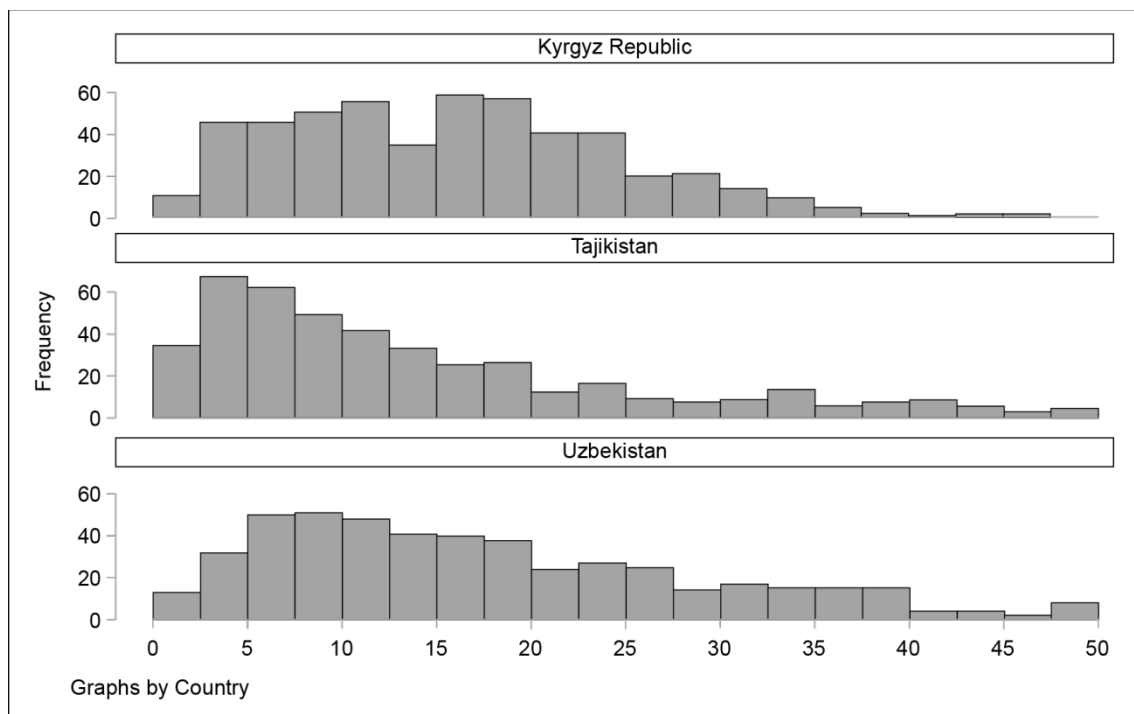
<sup>3</sup> It would be helpful to study not only plans for fuel switching but also actual switching in the past. The questionnaire included a question asking whether households had experience of switching from dirty to clean heating in the past five years. However, we could not use this question for econometrics due to the very small sample of households with such experience (N = 66, which is 4% of the sample, mainly from coal to electricity).

energy expenditure accounts for more than 20% of their total expenditure. This high level of energy poverty is associated with increases in energy prices in recent years. In our sample, almost all of the households indicated that their energy bills (e.g., electricity) had increased in the last few years (results not shown).

**Figure 3: Willingness to Switch from Dirty to Clean Heating (%)**



**Figure 4: Distribution of Energy Expenditure Share over Total Expenditure (%) by Country**

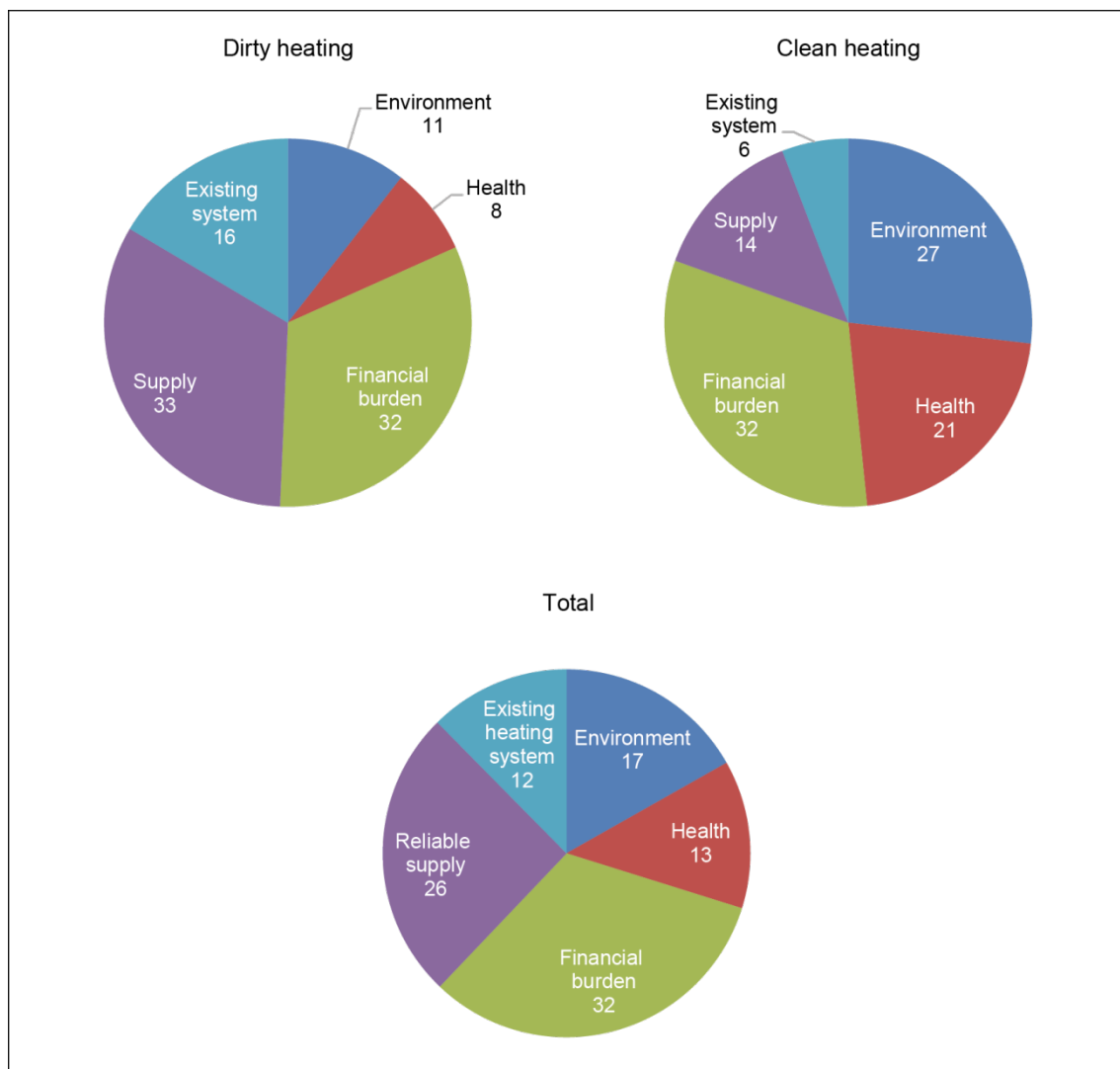


### Awareness/Perception

Household heads who are more aware of the negative impact of pollution caused by traditional fuel combustion are more likely to opt out of the use of dirty fuel (Azhgaliyeva et al. 2021; Kapsalyamova et al. 2021). The existing literature uses education level as a proxy for environmental awareness, believing that more educated

household heads are more aware of the negative impact of traditional fuel combustion (Alem, Hassen, and Kohlin 2016). However, this might not be the case; it could be due to other factors such as higher income level or higher opportunity cost for taking care of the time-consuming stove for traditional fuel of more educated household heads. To overcome this limitation, in our survey the households were asked what guides them when choosing their main source of heating. One third (32%) of households selected heating fuel based on the least financial burden, a quarter (26%) based on continuity (uninterrupted) of supply, 12% according to the existing heating system (it is costly to change a heating system), and 30% based on the least environmental and health impact (Figure 5). Interestingly, one third of households choose dirty fuel and clean heating due to the least financial burden. More households (33%) choose solid fuel due to a reliable energy supply than those that choose clean heating (14%). More households (48%) choose clean heating due to the least environmental and health impact than those that choose solid fuel (19%).

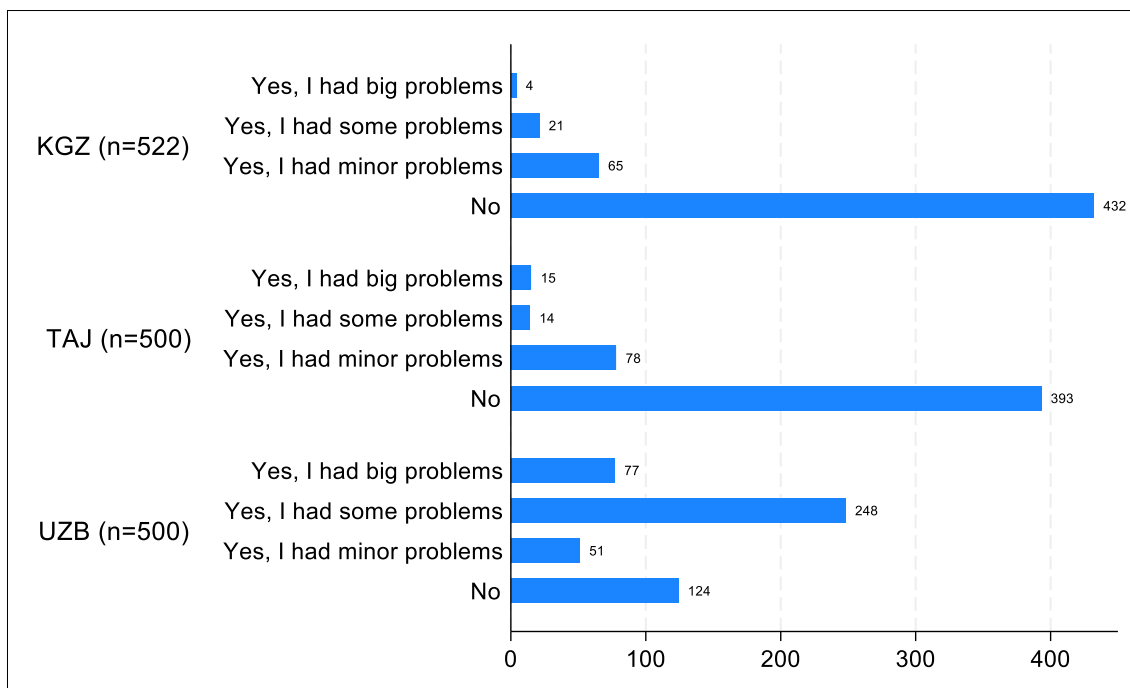
**Figure 5: Awareness/Perception of Heating Choice**  
(%)



## Financial Difficulties

Households were asked if they experienced financial difficulties with paying electricity bills in 2022 and 2023. Most households (62%) did not experience such difficulties. Nearly a quarter of households experienced financial difficulties in Uzbekistan (Figure 6). Financial difficulties with paying utility bills might affect the choice of heating, with households opting for dirty heating that does not require utility bills, such as coal, wood, etc., or serve as a barrier to investing in changing the heating system from dirty to clean. Financial difficulty is one of the barriers to choosing clean fuel (Sana et al. 2020; Heltberg 2005; Brunner, Spitzer, and Christanell 2012).

**Figure 6: Financial Difficulties with Paying Electricity Bills**



Note: KGZ = Kyrgyz Republic, TAJ = Tajikistan, UZB = Uzbekistan.

## Other Household Head and Household Characteristics

We also include household head characteristics that are usually included in the literature as determinants of household fuel choice: gender, marriage status, education, and age, as well as household characteristics including household income, size, and location (rural/urban) as control variables. Below, the motivation for including them and the expected impact are explained.

A large body of literature predicts that households headed by females are less likely to use dirty fuel (Karimu, Mensah, and Adu 2016; Rahut, Behera, and Ali 2016), which could be due to the fact that it is usually females who take care of the inconvenient and time-consuming solid fuel for stoves. However, few papers show the opposite effect (Adjakloe et al. 2021; Kapsalyamova et al. 2021). This could be when a household is headed by a female not from choosing to be a decision-maker but because she has no choice (such as when a female is single, widow, or divorced), thus it is important to control for income level and marriage status. More educated household heads have a greater opportunity cost for taking care of the time-consuming stove for dirty fuel, thus we expect that they are less likely to use dirty heating (unless other family members can take care of the stove). Older household heads are expected to be more likely to use dirty fuel due to factors such as habits, established preferences, or cultural beliefs (Van der Kroon, Brouwer, and Van Beukering 2014).

According to the energy ladder hypothesis (Leach 1992), as income increases, households use more reliable, cleaner, modern, and efficient fuel. Larger households with more children and more females have a lower opportunity cost of collecting biomass and taking care of the time-consuming stove for dirty fuel (Alem, Hassen, and Kohlin 2016; Heltberg 2005). Thus, we expect that larger households are more likely to use dirty heating. The literature suggests that households living in rural areas are more likely to use dirty fuel due to easy access to free fuel such as biomass and also less accessible modern energy due to a lack of infrastructure such as natural gas and district heating in developing countries (Azhgaliyeva et al. 2021; Kapsalyamova et al. 2021).

### 3.3 Econometric Model

Based on the above discussion, we use the following logit model to study the determinants of heating choice:

$$\Pr(\text{dirty}) = \alpha + \beta \text{Poor}_i + \sum_{j=2}^6 \gamma_j A_i + \sum_{l=2}^4 \eta_l F_i + \sum \theta_n \text{SEC}_i + \varepsilon_i,$$

where *dirty* is a binary variable that equals one if a heating system uses dirty fuel and zero if it uses clean heating (district heating, electricity, or gas); *poor* is a binary variable that equals one if the household spends more than 10% of expenditure on energy and zero otherwise; *rural* is a binary variable that equals one if the household lives in a rural area and zero if it lives in an urban area. The following variables are categorical: *A* is awareness, *F* is financial difficulties, *SE* is a vector of other socioeconomic household and household head characteristics, including the head's gender, age, education, and marriage status and the household's size, income, and location (rural). Summary statistics of outcome and explanatory variables are provided in Table 3.

**Table 1: Summary Statistics**

Variable	Mean	Std. Dev.	Min	Max
Dirty heating	0.588	0.492	0	1
Switch to clean	0.143	0.351	0	1
Energy-poor	0.661	0.474	0	1
Awareness				
• Environment	0.164	0.370	0	1
• Health of my family	0.127	0.333	0	1
• Financial burden	0.314	0.464	0	1
• Energy supplies	0.248	0.432	0	1
• Existing heating system	0.121	0.326	0	1
Financial problem				
• Big problems	0.063	0.243	0	1
• Some problems	0.186	0.389	0	1
• Minor problems	0.127	0.334	0	1
• No problem	0.624	0.485	0	1
Income				
• SEC1	0.160	0.366	0	1
• SEC2	0.143	0.478	0	1
• SEC3	0.353	0.478	0	1
• SEC4	0.345	0.476	0	1
Female	0.499	0.250	0	1
Age	40.9	15.0	18	85
Education				
• Incomplete secondary (9 classes)	0.068	0.254	0	1
• Secondary (11 classes)	0.395	0.489	0	1
• Secondary specialized and vocational	0.274	0.446	0	1
• Higher education	0.262	0.440	0	1
Married	0.773	0.419	0	1
Household size	5.40	2.23	1	19
Rural	0.634	0.482	0	1

Note: N = 1,522.

## 4. RESULTS AND DISCUSSION

### 4.1 Use of Dirty Fuel for Heating

The results on the determinants of choosing dirty fuel are presented in Table 4. The likelihood ratio test indicates that our explanatory variables have statistically significant explanatory power for the outcome. Overall model fitness is reported in pseudo-R-squared, suggesting that the model explains about 35% of the observed outcome (column 1).

The energy-poor are more likely to use dirty fuel for heating, thus energy-poor households are more prone to “fuel stacking.” The energy-poor group are 1.19<sup>4</sup> times more likely than the energy-nonpoor group to use dirty heating (or a 19% greater chance). Moreover, as was expected, the determinants of heating choice (clean versus dirty) vary for the energy-poor and energy-nonpoor. For example, households that care about environmental harm are less likely to choose dirty heating, but only among those who are energy nonpoor. The group of households that are not prioritizing environmental harm are 1.12 times more likely than the group prioritizing environmental harm to use dirty heating (or a 12% greater chance). The awareness of environmental harm is not significant for the choice of heating fuel among the energy-poor. Awareness of health impacts has a significant effect on the choice of heating fuel across all groups (energy-poor and -nonpoor), however the impact is greater on the energy-nonpoor than on the energy-poor. The group of households that are not prioritizing health damage are 1.18 times more likely (1.21 for the energy-poor and 1.23 for the energy-nonpoor) than the group prioritizing health damage to use dirty heating (or an 18% greater chance (21% for the energy-poor and 23% for the energy-nonpoor)).

Thus, raising environmental awareness for promoting switching to clean heating is expected to have a smaller impact. The impact of environmental harm awareness is smaller than that of health damage (12% < 23%) and mainly affects the energy-nonpoor (limited or no impact on the energy-poor), while raising awareness of health impacts will have a greater effect across all groups (energy-poor and -nonpoor).

As expected, female-headed households are less likely to use dirty heating, which is consistent with the majority of existing literature (Azhgaliyeva et al. 2021; Kapsalyamova et al. 2021; Karimu, Mensah, and Adu 2016; Rahut, Behera, and Ali 2016). The group of households headed by males are 1.09 times more likely than the group of households headed by females to use dirty heating (or a 9% greater chance). However, the role of gender is only significant for energy-nonpoor households, as gender is not significant in energy-poor households. This explains why in some studies the impact of gender was not significant or not as expected. Thus, women empowerment policies will have a limited impact (affecting mainly energy-nonpoor households and having no impact on energy-poor households). Thus, energy-poor households will need more policy support than energy-nonpoor ones for incentivizing the switch from dirty to clean heating. In addition, household income and financial conditions are also the key determinants of heating fuel (dirty versus clean). Households with lower income, big financial difficulties (not significant for the energy-poor) and those living in rural areas are more likely to use dirty heating.

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<sup>4</sup>  $e^{\beta} = e^{0.176} = 1.19$ , the odds ratio that associates energy-poor with the use of dirty heating.



**Table 4: Use of Dirty Fuel for Heating, Marginal Effects of Logit Model**

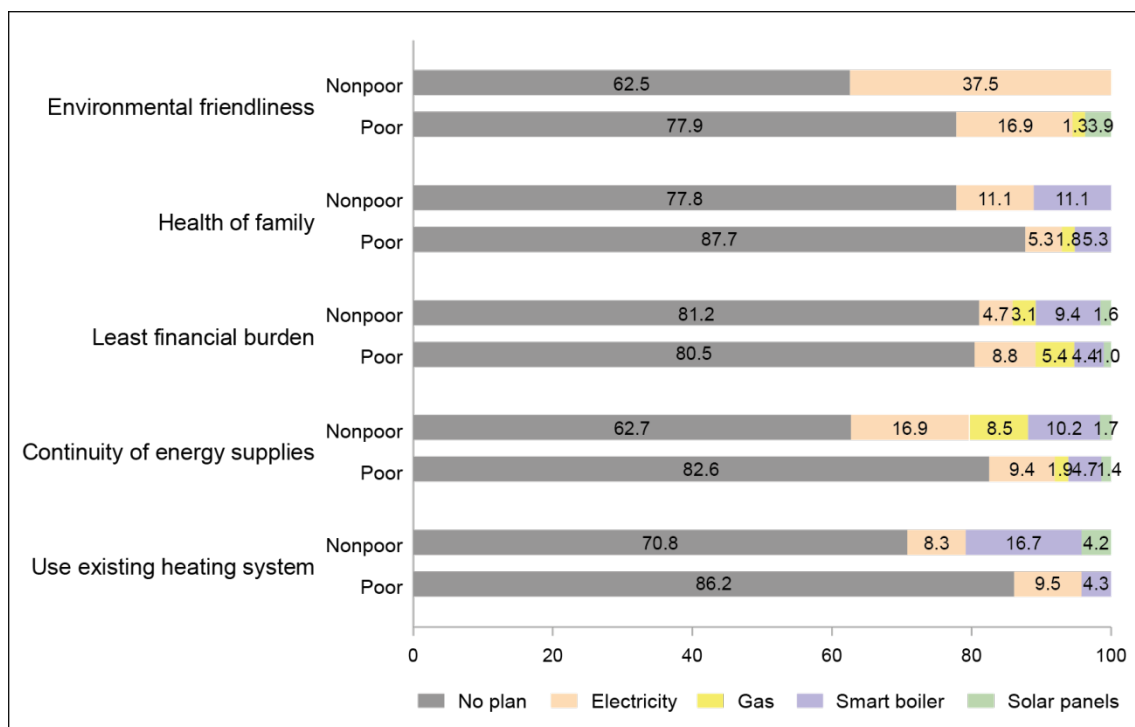
	(1) All	(2) Energy-poor	(3) Energy-nonpoor
Energy-poor	0.174*** (0.020)		
Awareness/selection criteria (reference: others)			
Environmental friendliness	−0.051 (0.061)	−0.056 (0.066)	−0.112* (0.067)
Health of my family	−0.165** (0.065)	−0.193*** (0.072)	−0.208** (0.082)
Least financial burden	0.007 (0.060)	−0.056 (0.065)	0.041 (0.069)
Continuity of energy supplies	0.042 (0.064)	−0.014 (0.069)	0.063 (0.076)
Use existing heating system	0.081 (0.069)	0.048 (0.074)	—
Financial condition (reference: no problem)			
Yes, I had big problems	0.084** (0.039)	0.059 (0.047)	0.144* (0.075)
Yes, I had some problems	0.051 (0.031)	0.050 (0.037)	0.044 (0.053)
Yes, I had minor problems	−0.013 (0.033)	−0.026 (0.042)	−0.014 (0.053)
Household income (reference: SEC1 – poorest)			
SEC2	−0.060* (0.033)	−0.052 (0.038)	−0.091 (0.062)
SEC3	−0.040 (0.029)	−0.054 (0.034)	−0.026 (0.050)
SEC4	−0.078** (0.032)	−0.073* (0.040)	−0.100* (0.051)
Household characteristics			
Female	−0.029 (0.020)	−0.003 (0.025)	−0.085** (0.034)
Age	0.001 (0.001)	0.000 (0.001)	0.003** (0.001)
Secondary (11 classes)	0.009 (0.042)	0.023 (0.050)	−0.037 (0.079)
Vocational education	−0.035 (0.043)	0.004 (0.051)	−0.131* (0.079)
Higher education	−0.046 (0.043)	−0.017 (0.052)	−0.110 (0.079)
Married	0.032 (0.024)	0.057* (0.030)	−0.049 (0.040)
Household size	0.004 (0.005)	−0.001 (0.006)	0.015* (0.008)
Rural area	0.178*** (0.022)	0.156*** (0.028)	0.193*** (0.034)
Region fixed effect	Yes	Yes	Yes
Likelihood ratio $\chi^2$	686.34***	314.61***	280.84***
Pseudo-R-squared	0.350	0.263	0.455
Observations	1,466	997	457

Notes: Asterisks (\*, \*\*, and \*\*\*) denote significance at 10, 5, and 1% levels, respectively. Standard errors are reported in parenthesis.

## 4.2 The Willingness to Switch from Dirty to Clean Heating

The households were asked whether they plan to switch from dirty to clean heating in the next five years. The environmental friendliness of clean heating is a significant determinant of planning/willingness to switch (Table A1 in Appendix A). The determinants of willingness to switch vary less among energy-poor and energy-nonpoor households compared to the results from the actual choice of heating (Section 3.1). Environmental awareness is the households' major reason for switching from dirty to clean heating (Figure 7); however, the actual use of clean heating is affected by environmental awareness only for the energy-nonpoor (Section 3.1), indicating that the energy-poor, although they could be aware of environmental impacts, have limited ability to switch from dirty to clean heating, which could be due to other factors such as limited access to finance to change the heating system (or moving house), or the access to, or affordability of, clean heating. Thus, energy-poor households will need more policy support, besides raising awareness, such as improving access to finance to change the heating system, or the access to, or affordability of, clean heating.

**Figure 7: Awareness and Plan to Switch from Dirty to Clean Heating**



## 5. CONCLUSION AND POLICY IMPLICATIONS

Using the household energy survey that was carried out in-person in the territory of Fergana Valley, which is located in three countries of Central Asia, namely eastern Uzbekistan, the southern Kyrgyz Republic, and northern Tajikistan, during July and August 2023, this study provides the following key results and evidence-based policy recommendations for promoting clean heating among households.

First, the energy-poor (which comprise 66% of the population) are more likely to use dirty fuel for heating, thus energy-poor households are more prone to “fuel stacking.” Therefore, the energy transition from dirty to clean heating will require more incentives and support for energy-poor households.

Second, households that care about environmental harm are less likely to choose dirty fuel for heating, but only among those who are energy-nonpoor. The awareness of environmental harm is not significant for the choice of heating fuel among the energy-poor, thus raising environmental awareness will have a limited impact on switching to clean heating. On the other hand, awareness of health impacts has a significant effect on the choice of heating fuel across all groups (energy-poor and -nonpoor). Thus, raising environmental awareness for promoting switching to clean heating will have a limited impact (affecting mainly the energy-nonpoor and having no impact on the energy-poor), while raising awareness of health impacts will have a greater effect across all groups (energy-poor and -nonpoor). Policies for raising awareness of the health impacts from dirty fuel are more likely to lead to a greater effect on fuel switching than raising awareness of environmental harm.

Third, environmental awareness is the main reason for households to switch from dirty to clean heating; however, the actual use of clean heating is affected by environmental awareness only for the energy-nonpoor, indicating that the energy-poor, although they could be aware of environmental impacts, have limited ability to switch from dirty to clean heating, which could be due to other factors such as limited access to finance to change the heating system (or moving house), or the access to, or affordability of, clean heating.

Overall, our results suggest that raising environmental awareness is not enough for energy-poor households to adopt modern fuels. They will also need more policy support, besides raising awareness, such as improving access to finance, access to clean heating, and its affordability.

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## APPENDIX A

**Table A1: Willingness to Switch from Dirty to Clean Heating,  
Marginal Effects of Logit Model**

	(1) All	(2) Energy-poor	(3) Energy-nonpoor
Energy-poor	−0.076** (0.031)		
Awareness/selection criteria (reference: existing heating system)			
Environmental friendliness	0.132** (0.066)	0.104 (0.066)	0.260 (0.173)
Health of my family	−0.053 (0.050)	−0.047 (0.051)	−0.008 (0.153)
Least financial burden	0.018 (0.039)	0.056 (0.042)	−0.014 (0.088)
Continuity of energy supplies	0.021 (0.041)	0.002 (0.042)	0.176* (0.103)
Financial condition (reference: no problem)			
Yes, I had big problems	0.039 (0.064)	−0.001 (0.062)	0.166 (0.167)
Yes, I had some problems	0.049 (0.048)	0.058 (0.055)	−0.008 (0.095)
Yes, I had minor problems	0.062 (0.046)	0.040 (0.049)	0.170 (0.111)
Household income (reference: < 6,000 KGS)			
6,001–12,000 KGS	−0.013 (0.056)	−0.015 (0.058)	−0.065 (0.149)
12,001–20,000 KGS	0.014 (0.048)	0.028 (0.052)	−0.032 (0.117)
> 20,000 KGS	−0.048 (0.049)	−0.068 (0.050)	0.044 (0.140)
Household characteristics			
Female	−0.027 (0.026)	−0.019 (0.028)	−0.079 (0.067)
Age	−0.002** (0.001)	−0.002** (0.001)	−0.002 (0.002)
Secondary (11 classes)	0.094** (0.044)	0.072 (0.045)	0.180 (0.130)
Vocational education	0.051 (0.046)	0.054 (0.048)	0.059 (0.139)
Higher education	0.095* (0.049)	0.124** (0.052)	0.001 (0.132)
Married	0.059* (0.035)	0.078* (0.041)	0.007 (0.075)
Household size	−0.004 (0.006)	−0.004 (0.007)	−0.011 (0.014)
Rural area	0.004 (0.035)	0.029 (0.036)	−0.114 (0.108)
Region fixed effect	Yes	Yes	Yes
Observations	895	709	179

Notes: Asterisks (\*, \*\*, and \*\*\*) denote significance at 10, 5, and 1% levels, respectively. Standard errors are reported in parenthesis.