

Clean Energy Access and Home Production Improvement: Labor Supply and Gender Difference

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Abstract

Improvements in home production play a crucial role in shaping intensive and extensive margins of labor supply and time allocation decisions, with potential differences in impact between men and women. This study leverages nationally representative data from Nepal to examine the effect of clean energy access, which enhances home production, on labor supply and time allocation decisions. A range of econometric models, including Tobit, Heckman selection, and a selection bias model with multiple choices, are employed, with the instrumental variable incorporated into these models. I found that clean stove adoption causes an increase in men's labor participation while reducing women's. Men worked 2.5 more hours and 25 more days per year with clean stoves, whereas women's work hours did not significantly change. Although fewer women participated in the labor force, those who did work 27 more days per year by adopting clean cookstoves. In the non-farm sector, the women work 20 more days, and the men work 15 more days. Self-employed women work 19 more days per year, while self-employed men work 25 more days per year. The estimation result for five different total expenditure quintiles shows that the clean stove impact is significant for the lowest four-quintile group for men.

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1 Introduction

Clean cooking energy is a key focus within the framework of Sustainable Development Goal 7 (SDG7), established by the United Nations, which aims to ensure universal access to affordable, reliable, and modern energy services, as discussed in SDG (2021). However, many people worldwide still rely on less environmentally friendly cooking fuels and outdated stove technologies, such as traditional and three-stone/open-fire stoves. This persistent reliance on outdated methods underscores the ongoing need for concerted efforts to transition towards cleaner and more sustainable cooking practices globally.

Households have access to various types of cookstoves, including traditional, improved cookstoves (ICS), and clean cookstoves, each differing in fuel type and technology. Traditional cookstoves primarily use fuels like wood, charcoal, animal waste, coal, biomass, and sawdust, which are often classified as dirty fuels. These stoves produce high levels of carbon dioxide and are the least energy-efficient. In contrast, ICSs feature enhanced technology, resulting in lower carbon emissions and greater energy efficiency by requiring less fuel. However, ICS still relies on dirty fuels, and the efficiency and emissions vary across different brands and models. Clean cookstoves, which are the focus of my study, include biogas, LPG, and electric stoves. These stoves use clean energy sources, making them the most energy-efficient and producing the lowest carbon emissions.

In this paper, I focus on the relationship between intensive and extensive margin of labor supply and the adoption of the LPG stove, which is the clean stove. While most studies on cooking energy emphasize time-saving and health benefits, relatively few studies address the impact on labor supply. Moreover, some studies have found no evidence of a causal link between the adoption of improved stoves and labor supply. (Berkouwer and Dean, 2022a; Afridi et al., 2023; Krishnapriya et al., 2021; Kurata et al., 2020; Hanna et al., 2016; Imelda, 2020; Williams et al., 2020; Su and Azam, 2023)

Through the empirical analysis, I found that using LPG stoves causes an increase in men's world hours, days, and labor participation. However, the women's work hours chance was not statistically significant. Interestingly, women's labor participation decreased with the adoption of LPG stoves, but among those women who work, they tend to work more days. The result was robust for self-employed and non-farm employment but with a different magnitude. The regression result for each five household total expenditure quintile shows that the impact is significant for the four lowest quintile men and for the second highest quintile women.

Numerous studies have examined the demand for and impact of ICS and clean stoves, both theoretically and empirically. These advanced technologies influence several key ar-

eas, including time savings related to cooking and fuel, health, and labor supply. Among these, health has been the primary focus in the field of clean cooking energy research. Researchers have empirically analyzed the health effects of using solid versus non-solid fuels.¹ (Kurata et al., 2020)

One area of study explored the health impact of ICS, particularly on respiratory and eye conditions. However, the significance of these effects has been debated. For example, Hanna et al. (2016) conducted a Randomized Control Trial (RCT) and found that the health impacts of ICS were minimal or insignificant, with some benefits diminishing over time. In contrast, a more recent study by Berkouwer and Dean (2022b) demonstrated that the Jikokoa stove, an energy-efficient charcoal stove that produces significantly less carbon dioxide, had a positive and significant effect on household health.

In terms of time savings, research shows that adopting more advanced stoves can reduce cooking time, although the extent varies by country. Krishnapriya et al. (2021) conducted a multi-country study using propensity score matching and found clear evidence that ICS reduces cooking time, though the magnitude of this benefit differs across regions.

The impact of ICS on labor supply, however, remains less clear. Some studies indicate no significant increase in labor supply following ICS adoption. (Berkouwer and Dean, 2022b; Hanna et al., 2016) However, Su and Azam (2023) found that the use of LPG stoves led to an increase in female labor supply at the intensive margin.

To understand the relationship between the adoption of clean or improved stoves and household labor supply, it is essential to explore how stove adoption influences household members' labor supply decisions. Though various studies suggest that access to clean cooking energy may impact labor supply, the link between clean energy access and labor supply remains unclear. One potential channel is health improvement: adopting clean stoves reduces indoor air pollution, lowering the health risks for the primary cook—typically the woman. As a result, households can save time and money otherwise spent on health care issues caused by indoor air pollution (Verma and Imelda, 2022; Stabridis and van Gameren, 2018).

This study explores how adopting LPG stoves influences household members' labor supply decisions, emphasizing the role of home production improvements. Enhancing home production is particularly important for women's labor supply decisions. While improvements in home production have been shown to increase women's labor supply in developed countries, the effects in developing countries remain inconclusive Afridi

¹Since 2014, the WHO has classified kerosene, a non-solid fuel, as harmful and recommends against its use.

et al. (2018).

As a case study, I focus on Nepal. Nepal is a country where many households continue to rely on traditional three-stone or open-fire stoves and non-clean fuels for cooking. Although there has been a gradual increase in the use of clean-fuel stoves, the adoption rate remains low. ICS has been adopted by only a small fraction of households, with the majority still primarily using traditional and open-fire stoves. According to a study by Pinto et al. (2019), 26.3% of households use liquefied petroleum gas (LPG) stoves, and 2% use biogas stoves. The situation is even more concerning in rural areas, where only 20% of households use LPG stoves, while 67% continue to rely on traditional and open-fire stoves. In contrast, 47% of urban households have adopted LPG stoves.

I selected Nepal as a case study for several reasons. First, Nepal's diverse geographical features, including its terrain, hills, and mountains, make it particularly well-suited for the application of Instrumental Variable (IV) analysis compared to other countries. Additionally, LPG stoves are the primary clean cooking technology in Nepal, and given the distribution of cooking energy sources, most households rely on either wood or LPG. Therefore, I anticipate that the statistical results will accurately capture the impact of LPG stove adoption compared to traditional wood-burning stoves.

This study makes a significant contribution by using an instrumental variable (IV), land slope, and various econometric models, each suitable for its specific case. The adoption of LPG stoves is self-selection, so without controlling the endogeneity, the estimation results can be biased. Therefore, I employ the IV to control the endogeneity of the LPG stove adoption variable. To understand the rationale behind this IV, it is crucial to be familiar with Nepal's geography and the LPG (liquefied petroleum gas). Nepal's geographical features are diverse, with the Himalayas located in the northern part and three ecological zones: mountain, hill, and Terai (Pinto et al., 2019). Previous studies have highlighted the ecological zone indicator as a significant factor influencing households' cooking fuel choices (Giri and Goswami, 2018; Aryal et al., 2022; Koirala and Acharya, 2022; Joshi and Bohara, 2017). In addition to geographical factors, accessing LPG stoves can be challenging. Distributing and using LPG in areas with difficult terrain, such as high elevations and steep slopes in mountainous regions, presents logistical challenges and increases the cost of using LPG stoves (Pinto et al., 2019). Given this context, it is assumed that land slope is associated with the adoption of LPG stoves but is not directly linked to labor supply and time allocation decisions.

In addition to the endogeneity of the LPG stove adoption variable, which is the key variable for this study, there are some more econometric issues. First, the time variable, which is one of the dependent variables, is censored below zero, so the IV-Tobit model

was used for the time allocation study. For work days analysis, the dependent variable, work days per year, exists for those household members who worked during the past year. Hence, the study utilized the Heckman selection model with IV. Lastly, I conducted a deeper analysis for the work days per year study by using the two constructed categorical variables based on the job types: non-farm employment and self-employed. This study requires a more advanced selection model than the Heckman selection model since individuals have three options for each constructed variable. For example, the non-farm employment categorical variable has three choices: non-farm employment, farm employment, and no work. Therefore, a model introduced by Dahl (2002) was employed to address the selection bias with the multiple choice model.

One of the contributions of this study is to provide empirical evidence of gender disparity in labor supply decisions, which is attributed to the home production improvement channel. The adoption of clean stoves can be considered as a home production improvement (Afridi et al., 2023). Recent studies have shown that home production improvement is a significant factor in increasing women's labor supply (Albanesi and Prados, 2022; Greenwood et al., 2005; Fukui et al., 2023). Additionally, empirical evidence shows that adopting LPG stoves increases female employment (Verma and Imelda, 2022; Su and Azam, 2023). However, using the developing countries' data, some studies have found the opposite result, indicating that home production improvement either has no impact on or decreases female labor supply, which is known as a puzzle of low female labor participation in developing countries (Afridi et al., 2018; Berkouwer and Dean, 2022a; Afridi et al., 2023; Hanna et al., 2016).

The primary focus of this study is the impact of LPG stoves on men's and women's labor supply and time allocation decisions. The study utilized Multi-Tier Framework Survey (MTF) data in Nepal, which includes various variables related to energy access, cooking solutions, and health. Of particular interest, the MTF-Nepal contains numerous cooking energy and stove-related variables that are associated with households' socio-economic characteristics.

The research revealed that the use of LPG stoves led to an increase in men's labor supply, including work time, employment, and the number of work days per year. Men spent an additional 150 minutes per typical day on outdoor work and worked 25 more days each year. However, the findings were more complex for women. Women's work time did not significantly increase, and fewer women were employed after adopting LPG stoves. However, among those women who did choose to work, they worked 27 more days.

2 Data

2.1 Multi-Tier Framework Data

I utilize data from the Multi-Tier Framework Survey (MTF) - Nepal, a nationally representative dataset that provides detailed information on household cooking fuels and stove types, along with other relevant cooking-related variables. In addition to energy data, MTF-Nepal includes household characteristics and asset ownership, with particular emphasis on transportation ownership.

The MTF survey, developed by the Energy Sector Management Assistance Program (ESMAP), is a crucial tool in supporting the Sustainable Development Goals (SDGs). It sets a global standard for assessing energy access and cooking solutions. Unlike a simple binary assessment of electricity access, the MTF survey adopts a more nuanced approach, evaluating multiple dimensions of energy access, including availability, reliability, convenience, affordability, and safety. This multifaceted framework recognizes the complexity of energy access and its broader impacts on households and communities. Using a tiered system ranging from 0 to 5, the survey provides a more comprehensive understanding of energy access than traditional measures. This detailed information enables policymakers, researchers, and development practitioners to gain deeper insights into the energy landscape of a given region or country. (Bhatia and Angelou, 2015)

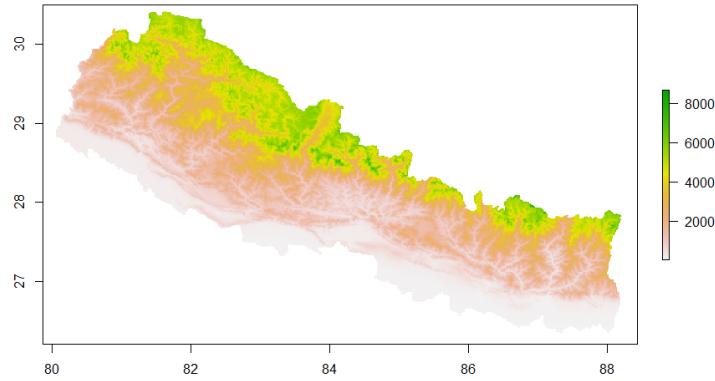
I chose to use the MTF data because it provides detailed information about the types of fuel used by each household stove. For instance, Nepalese households use a wide range of fuels, including animal waste, biomass, charcoal, coal, plant biomass, garbage, peat, pellets, sawdust, wood, biogas, electricity, kerosene, LPG, natural gas, and solar energy as primary cooking fuels. This data allows me to clearly identify households using clean fuels, such as LPG, biogas, electricity, or solar energy.

2.2 Geography Data

I use the average land slope for each region, calculated at the smallest available administrative boundary level—GADM level 4, equivalent to municipalities.² The slope is measured in degrees, with values ranging from 0 to 90 degrees (Hijmans et al., 2015, 2022; Ribeiro and Diggle, 2003). This fine distinction provides the most detailed administrative division available in Nepal. Figure 2 illustrates the regional boundaries at each level, while Figure 1 presents an elevation map based on my data. For each administrative unit, I calculate the mean slope and elevation.

²<https://gadm.org/>

Figure 1: Elevation-Nepal



The MTF data includes location details at the province, district, and municipality levels, with the municipality being the finest and most detailed administrative division in Nepal. Therefore, I merged the average slope of each municipality with the MTF data for a more granular analysis.

2.3 Outcome and Control Variables

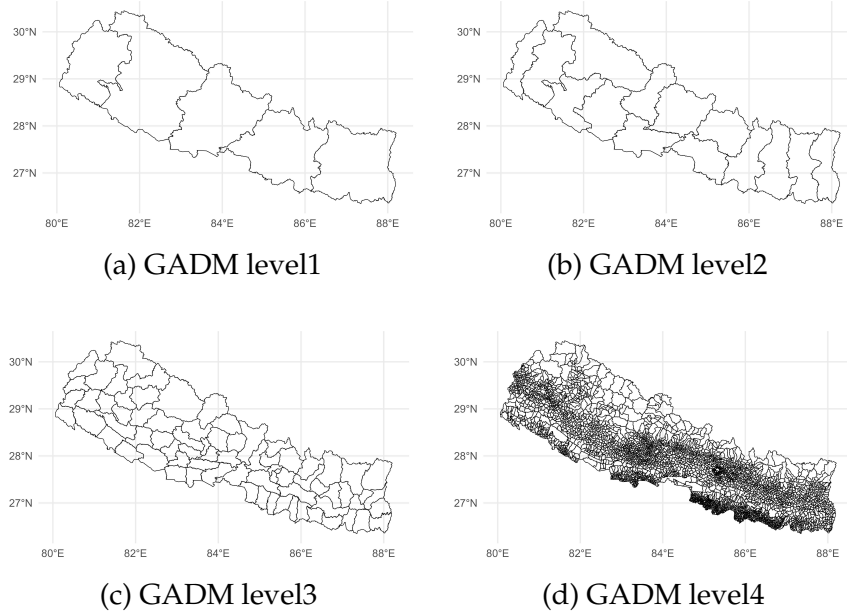
The work days per year outcome variables are constructed by the author by combining multiple variables in MTF. MTF has questionnaires, "How many months did you work?" and "How many days did you work for the typical month?" By combining two variables, I construct the days of work per year.

The MTF includes a questionnaire about the main job types, from which I created the work dummy variable, nonfarm, and self-employed categorical variables. Figure 3 displays the distribution of job types for both women and men.

To create the work dummy variable indicating whether an individual worked or not, I recategorized the main job type variable. I excluded "student," "retired/pensioner," "too old to work," and "disabled" because their inclination to work is low, or it is not in their best interest to have a job for welfare optimization. For instance, students prioritize higher future wages after graduation, making the opportunity cost of working too high to give up education for a job. To prevent potential distortion from these individuals, I removed them from the dataset. Subsequently, I created the work dummy variable, which is equal to 1 if the individual is not a "job seeker," "unemployed," or "housewife/husband."

For the self-employed variable, I recategorized the main occupation variable into three job types: self-employed, non-self-employed, and did not work. Self-employed

Figure 2: GADM level



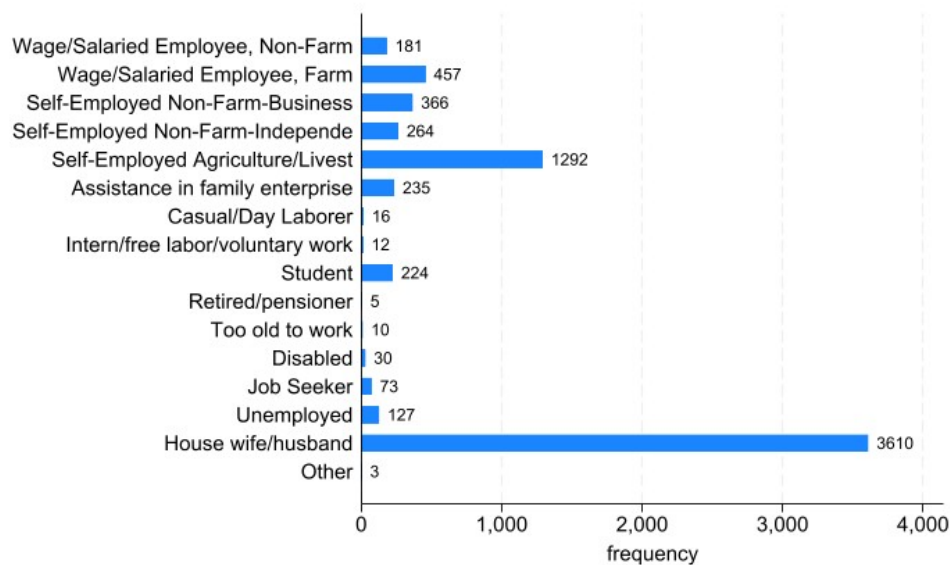
individuals include "self-employed nonfarm business enterprise," "self-employed non-farm independent contract," "self-employed agriculture/livestock," and "assistance in the family enterprise." Non-self-employed individuals comprise "wage/salaried employee, nonfarm," "wage/salaried employee, farm," "casual/day labor," and "intern/free labor/voluntary work." The "did not work" category includes "job seeker," "unemployed," and "housewife/husband."

To create the nonfarm employed variable, I formulated a categorical variable: non-farm employed, farm-employed, and did not work. Nonfarm employed includes "wage/salaried, nonfarm," "self-employed nonfarm business enterprise," and "self-employed non-farm-independent contract." Farm employed includes "wage/salaried employee, farm," "self-employed agriculture/livestock," "assistance in family enterprise," "casual/day labor," and "intern/free labor/voluntary work." The "did not work" category includes "job seeker," "unemployed," and "housewife/husband."

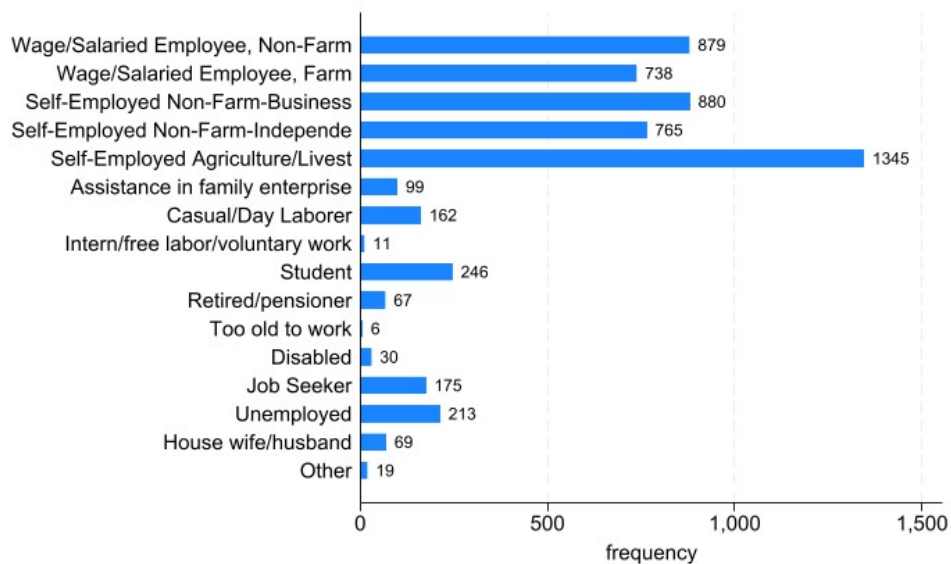
In order to control household income, I use total household expenditure as a proxy. I also create a variable to represent household wealth, assuming that wealthier households tend to have better house structures and are more likely to use advanced technology stoves. The house structure variable is based on wall and roof materials from the MTF data. It's common to use household material as a proxy for household wealth (Bergeron et al., 2021).

I also take into account regional characteristics like urban or rural location and aver-

Figure 3: Main Job Type



(a) Main Job Type - Women



(b) Main Job Type - Men

age land elevation to address differences between urban and rural areas. To account for cooking-related factors, I consider fuel availability, cooking frequency, and the number of stove burners. Additionally, I control for an individual's socioeconomic characteristics such as marital status, age, education level, household size, number of children, and household head status.

3 Theory Background

In this study, we're looking into the impact of adopting LPG stoves, which are known for being clean and efficient. We're particularly interested in how these stoves affect household members' time allocation and labor supply. We'll be exploring the various channels through which the adoption of better technology can bring about these changes. We'll delve into the home production channel and utilize the intrahousehold model to better understand how this impacts household members' labor supply decisions. This model is based on the work of Chiappori (1997), Donni (2008), and Apps and Rees (1997) and gives us a theoretical framework for studying how the development of home production influences household labor supply.

Suppose there are two members in a household. Assume the utility function for member i is $u^i(x_i, y_i, L_i)$, where x_i is private consumption for member i , y_i is the domestic good, and L_i is leisure.

Home production is described by the following maximization problem:

$$\max_{t_1, t_2} pAh(t_1, t_2) - w_1t_1 - w_2t_2 \quad (1)$$

where A is the home production technology.

Each member i maximizes their utility:

$$\max_{x_i, y_i, L_i} u^i(x_i, y_i, L_i)$$

subject to the budget constraint:

$$x_i + py_i + w_iL_i = s_i$$

where s_i stands for member i 's potential income. The total potential income is given by:

$$s = s_1 + s_2 = (w_1 + w_2)T + m_1 + m_2 + pAh(t_1, t_2) - w_1t_1 - w_2t_2$$

To derive the equations for leisure L_i and home production time t_i , I analyze the optimization problems:

1. Home Production Optimization

The household maximizes the net value of home production:

$$\max_{t_1, t_2} pAh(t_1, t_2) - w_1t_1 - w_2t_2$$

The first-order conditions are:

$$pA \frac{\partial h(t_1, t_2)}{\partial t_1} = w_1$$

$$pA \frac{\partial h(t_1, t_2)}{\partial t_2} = w_2$$

These equations determine the optimal time allocation t_1 and t_2 for home production.

2. Individual Utility Maximization

Each member i maximizes their utility subject to the budget constraint:

$$x_i + py_i + w_iL_i = s_i$$

Using the Lagrangian:

$$\mathcal{L} = u^i(x_i, y_i, L_i) + \lambda (s_i - x_i - py_i - w_iL_i)$$

The first-order conditions are:

$$\frac{\partial \mathcal{L}}{\partial x_i} = \frac{\partial u^i}{\partial x_i} - \lambda = 0 \quad \Rightarrow \quad \lambda = \frac{\partial u^i}{\partial x_i}$$

$$\frac{\partial \mathcal{L}}{\partial y_i} = \frac{\partial u^i}{\partial y_i} - \lambda p = 0 \quad \Rightarrow \quad \lambda = \frac{\partial u^i}{\partial y_i} \cdot \frac{1}{p}$$

$$\frac{\partial \mathcal{L}}{\partial L_i} = \frac{\partial u^i}{\partial L_i} - \lambda w_i = 0 \quad \Rightarrow \quad \lambda = \frac{\partial u^i}{\partial L_i} \cdot \frac{1}{w_i}$$

Equating the expressions for λ :

$$\frac{\partial u^i}{\partial x_i} = \frac{1}{p} \frac{\partial u^i}{\partial y_i} = \frac{1}{w_i} \frac{\partial u^i}{\partial L_i}$$

The leisure L_i can be found by substituting the derived optimal consumption levels back into the budget constraint:

$$L_i = \frac{s_i - x_i - py_i}{w_i}$$

3.1 Comparative Static Analysis: home production technology development

The main interest of this study is the impact of improved home production by adopting the LPG stove, which is an advanced and clean cooking stove, on each household member's labor supply decision.

$$l_i = T - L_i(w_i, s_i^*) - t_i(w_1, w_2, A)$$

$$\frac{\partial l_i}{\partial A} = -\frac{\partial L_i}{\partial s_i^*} \frac{\partial s_i^*}{\partial A} - \frac{\partial t_i}{\partial A}$$

where

$$\frac{\partial t_i}{\partial A} < 0 \quad \frac{\partial L_i}{\partial s_i^*} > 0 \quad \frac{\partial s_i^*}{\partial A} > 0$$

Hence, the first term < 0 and the second term > 0 . If the first term is larger, then a household member i 's labor supply will be decreased. If the second term is larger than the first term, then a household member i 's labor supply will be increased. The household decision on the labor supply is jointly determined so that each member's decision for labor supply and leisure influences each other's decisions. This theory background can support the result of empirical analysis.

4 Methodology

The issue in econometrics is that the main variable, LPG stove adoption, is endogenous. This occurs because the decision to adopt LPG stoves is a self-selection process. It's possible that the decision to adopt LPG stoves is linked to unobservable factors, such

as work preferences, which are, in turn, linked to the amount of time spent working. Additionally, households that work more may earn more income or have higher preferences for home production development, making them more likely to buy LPG stoves. To address these potential biases, I used the IV method employing the control function approach. The standard two-stage least square method can't be applied to this study due to other econometric issues. Therefore, I employed the Heckman selection with IV and a multiple choice selection bias model with IV Dahl (2002); Heckman (1979).

4.1 Instrumental Variable

The primary issue addressed in this study is the endogeneity of the key variable. Individuals in wealthier households with a strong preference for work are more likely to adopt clean stoves, making them more inclined to work. To address this, I am using land slope as an IV. The concept of land slope IV was introduced by Dinkelman (2011) in her research on the impact of electrification. She found a positive effect of grid electricity connection on women's employment. To mitigate the endogeneity issue in the choice of grid electricity connection, Dinkelman (2011) used average land slope as an IV. The rationale behind this IV is that the cost of installing grid infrastructure varies based on geography. Steeper or rugged terrain increases the installation cost, which may lead to higher grid connection fees or reluctance to install grid infrastructure in such areas. Consequently, households in these regions may be less likely to connect to the grid. Thus, there is a correlation between land slope and choice of household grid connection.

A similar approach can be applied in this study, particularly regarding LPG adoption in Nepal. I use the same IV from Dinkelman (2011) but for a different purpose - to assess LPG stove adoption in Nepal. The primary clean stove in Nepal is the LPG stove, which requires gas cylinders for refilling, usually with a typical size of 3kg or larger. However, challenging geographical conditions in some areas can make accessing LPG more expensive. Land slope serves as a suitable proxy for these difficult geographical conditions since higher slopes indicate rougher terrain. Consequently, land slope is correlated with the adoption of LPG stoves. This study employs the Land Slope IV based on this rationale.

4.2 Households' time allocation

The MTF data doesn't contain information on individual time usage. Instead, it provides the total time spent by household members on a typical day, including women, men, girls, and boys. I focus on the time usage of women and men because these adult

groups often have responsibilities regarding household income, which is essential for maintaining sufficient household budget constraints.

My initial analysis examines the impact of LPG stove adoption on changes in household time allocation (in minutes). However, the time variable is censored below zero, making the standard linear two-stage least square method unsuitable for this analysis. Instead, I employ a control function approach for the IV and use the Tobit model in the second stage regression. In the first stage, I use probit regression because the endogenous variable is binary, indicating whether the household has an LPG stove or not. The equation below shows what I estimated in the first stage.

$$Pr[T_{hj} = 1|Z_j, X_{hj}] = \Phi(\beta_0 + \beta_1 Z_j + X'_{hj}\delta) \quad (2)$$

The variable T_{hj} indicates whether household h in region j has adopted an LPG stove. Z_j is an instrumental variable representing the average land slope of region j , while X_{hj} includes control variables such as total household expenditure, housing structure quality, cooking fuel availability, credit, the number of households, household head's education level, age, gender, and marital status.

In the control function approach, I should extract the residual from the first-stage regression. Since the first-stage regression is non-linear, I calculate the generalized residual $\hat{r}_{hj}$ to capture the non-linearity with the following equation.

$$\hat{r}_{hj} \equiv T_{hj}\lambda(\hat{\beta}_0 + \hat{\beta}_1 Z_j + X'_{hj}\hat{\delta}) - (1 - T_{hj})\lambda(-(\hat{\beta}_0 + \hat{\beta}_1 Z_j + X'_{hj}\hat{\delta})) \quad (3)$$

where, $\lambda(\cdot)$ is inverse Mills ratio (IMR).

The second stage regression includes the $\hat{r}_{hj}$, so I have

$$y_{hj}^* = \alpha_0 + \alpha_1 T_{hj} + X'_{hj}\alpha_2 + \alpha_3 \hat{r}_{hj} + \epsilon_{hj}, \quad \epsilon_{hj}|T_{hj}, X_{hj}, \hat{r}_{hj} \sim \mathcal{N}(0, \sigma^2) \quad (4)$$

$$y_{hj} = \max(0, y_{hj}^*) \quad (5)$$

The outcome variable is censored below zero, meaning that I only observe the value of y_{hj}^* . This can lead to downward biased results. Therefore, I decided to use Tobit regression in the second stage.

One drawback of the time usage variable in the MTF data is that it does not provide data at the individual level. It represents aggregated time for each group of household members: men, women, boys, and girls. Therefore, the multiple household members may change the time spent together. For example, they can increase the time spent on fuel collection almost equally, so the aggregate time for fuel collection increases. On the

other hand, the one member in each group with a comparative advantage spends most of the time on the relevant activities. For example, when it comes to collecting cooking fuel, one member of the men's group will be responsible for most of the activity, and his time spent on it will make up the largest portion of the total aggregated cooking fuel collecting time.

4.3 Individual workdays per year

To further investigate labor supply, I analyze individuals' work days using information from MTF data, which includes data on the number of months worked in the past 12 months and the number of days worked during a typical month. I combine these two variables to create a workdays per year variable. Two slightly different models are used because the workdays per year variable is only available for households that have worked in the past 12 months, resulting in a truncated dependent variable. To address this econometric issue, I employ the Heckman selection model with IV, which involves three steps. The first stage employs the probit model, as the endogenous variable, LPG stove adoption, is a dummy variable.

$$E[T_{hj}|Z_j, X_{ihj}, M_{hj}] = \Phi(\beta_0 + \beta_1 Z_j + X'_{ihj}\delta + M'_{hj}\zeta) \quad (6)$$

T_{hj} represents a dummy variable indicating stove adoption for household h in region j , equal to 1 if the household's main stove is an LPG stove. Z_j serves as an IV for this study, representing the average land slope of region j . X'_{ihj} refers to the characteristics of individual i in household h living in region j . M'_{hj} denotes the household characteristics. Similar to the previous model, a control function approach is utilized for the second-stage regression. To implement the control function approach, let $\hat{r}_{ihj}$ be the generalized residual extracted from the first-stage probit model. Then, I have.

$$\hat{r}_{ihj} \equiv T_{hj}\lambda(\hat{\beta}_0 + \hat{\beta}_1 Z_j + X'_{ihj}\hat{\delta} + M'_{hj}\hat{\zeta}) - (1 - T_{hj})\lambda(-(\hat{\beta}_0 + \hat{\beta}_1 Z_j + X'_{ihj}\hat{\delta} + M'_{hj}\hat{\zeta})) \quad (7)$$

$\lambda(\cdot)$ represents an IMR estimated from the first regression. For the second and third stages, I use the Heckman selection model with a two-step method. In the second stage, I include $\hat{r}_{ihj}$, obtained from equation 7, along with other control variables. To be specific, consider the following model:

$$W_{ihj} = \alpha_0 + \alpha_1 T_{ihj} + X'_{ihj}\alpha_2 + M'_{hj}\alpha_3 + \alpha_4 \hat{r}_{ihj} + u_{ihj} \quad (8)$$

$$Pr[W_{ihj} = 1|T_{ihj}, X_{ihj}, M_{hj}, r_{ihj}] = \Phi(\alpha_0 + \alpha_1 T_{ihj} + X'_{ihj}\alpha_2 + M'_{hj}\alpha_3 + \alpha_4 r_{ihj}) \quad (9)$$

W_{ihj} represents the employment status of individual i . Since W_{ihj} is a dummy variable and equal to 1 if the individual is working, the probit model is used. Similar to the standard Heckman Selection model, the estimated IMR from equation 9 is used for the third-stage regression equation 10.

$$E[D_{ihj}|T_{ihj}, X_{ihj}, M_{hj}, r_{ihj}, W_{ihj} = 1] = \gamma_0 + \gamma_1 T_{ihj} + X'_{ihj}\gamma_2 + M'_{hj}\gamma_3 + \rho\sigma_u\Lambda \quad (10)$$

Where,

$$\Lambda = \lambda(\hat{\alpha}_0 + \hat{\alpha}_1 T_{ihj} + X'_{ihj}\hat{\alpha}_2 + M'_{hj}\hat{\alpha}_3 + \hat{\alpha}_4 r_{ihj}) \quad (11)$$

$\lambda(\cdot)$ is the Inverse Mills Ratio. The standard deviation of u_{ihj} denoted by σ_u is used to estimate the impact of LPG stove adoption on individuals' workdays per year, conditional on their work.

4.4 Individual workdays per year conditional on employment type

I examine the impact of LPG stoves on workdays per year by analyzing different types of occupation characteristics. I am particularly interested in understanding the differences in job types, such as self-employment and non-farm employment, as the impact of LPG stoves may vary depending on the type of job. To account for additional choices, I use a more advanced model than the Heckman selection model.

I use the method introduced by Dahl (2002) to address selection bias with multiple choices. Unlike the Heckman selection model, which allows only binary "work" or "not work" options, Dahl's model accommodates multiple choices. For self-employed individuals, I categorize main occupations into three groups: self-employed, working but not self-employed, and not working. Similarly, I categorize non-farm-employed individuals into non-farm-employed, working but not non-farm-employed, and not working. Since I have three choices in the model, I apply the methodology from Dahl's study. Detailed application procedures can be found in Dahl (2002); Bourguignon et al. (2007)

Dahl's method is not the only method for this type of econometric issue, selection bias with multiple choices. There are other similar methodologies introduced by Lee (1983); Dubin and McFadden (1984); Vijverberg (1995) other than Dahl's. According to the Bourguignon et al. (2007), the Monte Carlo simulation test results with three choices with 5000 observations; Dahl's model with full specification performs better than the other method and yields less biased results. Since I have a similar case, three choices with

around 6000 observations, I decided to employ Dahl's model. In addition, Dahl's model has an advantage over the other models, which has a more flexible functional form to capture the non-linearity.

The first stage of the methodology is similar to the previous model. I calculate the r_{ihj} from equation 6 and incorporate it into the second stage regression, which is a logit model with three options.

Suppose I have the following model

$$D_{ihj} = \gamma_0 + \gamma_1 T_{ihj} + X'_{ihj} \gamma_2 + M'_{hj} \gamma_3 + v_{ihj} \quad (12)$$

$$W_{ihjk} = \alpha_{0k} + \alpha_{1k} T_{ihj} + X'_{ihj} \alpha_{2k} + M'_{hj} \alpha_{3k} + \alpha_{4k} r_{ihj} + u_{ihjk}, \quad k = 1, 2, 3 \quad (13)$$

The variable k represents different categories, specifically nonfarm-employed, farm-employed, and not working, or self-employed, not self-employed, and not working. The variable D_{ihj} is observable if category 1 is chosen, which is equivalent to being nonfarm-employed or self-employed. Furthermore, there may be a lack of independence between v_{ihj} and U_{ihjk} , so using least square estimates may lead to biased results.

$$W_{ihj1} > \max_{k \neq 1} W_{ihjk} \quad (14)$$

Then,

$$\begin{aligned} \max_{k \neq 1} (W_{ihj1} - W_{ihjk}) = \\ \max_{k \neq 1} (\alpha_{0k} + \alpha_{1k} T_{ihj} + X'_{ihj} \alpha_{2k} + M'_{hj} \alpha_{3k} + \alpha_{4k} r_{ihj} + u_{ihj1} \\ - \alpha_{01} - \alpha_{11} T_{ihj} - X'_{ihj} \alpha_{21} - M'_{hj} \alpha_{31} - \alpha_{41} r_{ihj} - u_{ihjk}) > 0 \end{aligned} \quad (15)$$

Define,

$$\Psi_{ihj1} = \max_{k \neq 1} (W_{ihj1} - W_{ihjk}) > 0 \quad (16)$$

Assume that the u_{ihjk} is independent and identical and follows the Gumble distribution. Then, following Bourguignon et al. (2007); McFadden (1974), it becomes the multinomial logit model such that

$$\begin{aligned} P(\Psi_{ihj1} > 0 | T_{ihj}, X_{ihj}, M_{hj}, r_{ihj}) = \\ \frac{\exp(\alpha_{01} + \alpha_{11} T_{ihj} + X'_{ihj} \alpha_{21} + M'_{hj} \alpha_{31} + \alpha_{41} r_{ihj})}{\sum_k \exp(\alpha_{0k} + \alpha_{1k} T_{ihj} + X'_{ihj} \alpha_{2k} + M'_{hj} \alpha_{3k} + \alpha_{4k} r_{ihj})} \end{aligned} \quad (17)$$

Define,

$$\Omega = \{\alpha_{01} + \alpha_{11}T_{ihj} + X'_{ihj}\alpha_{21} + M'_{hj}\alpha_{31} + \alpha_{41}r_{ihj}, \dots, \{\alpha_{03} + \alpha_{13}T_{ihj} + X'_{ihj}\alpha_{23} + M'_{hj}\alpha_{33} + \alpha_{43}r_{ihj}\}\} \quad (18)$$

Then, the conditional mean of the error term from the equation12 is

$$E(v_{ihj1}|_{ihj1} > 0, \Omega) = \int \int_{-\infty}^0 \frac{v_{ihj1}f(v_{ihj1}, \Psi_{ihj1}|\Omega)}{P(\Psi_{ihj1} > 0|\Omega)} d\Psi_{ihj1} dv_{ihj1} = \lambda(\Omega) \quad (19)$$

Hence, the simple regression using the equation12 with the non-randomly selected sample omits this term, which yields biased results. For simplicity, I can redefine this term.

$$E(v_{ihj1}|\Psi_{ihj1} > 0, \Omega) = \mu(P_1, P_2, P_3) \quad (20)$$

Where,

$$P_l = \frac{\exp(\alpha_{0l} + \alpha_{1l}T_{ihj} + X'_{ihj}\alpha_{2l} + M'_{hj}\alpha_{3l} + \alpha_{4l}r_{ihj})}{\sum_k \exp(\alpha_{0k} + \alpha_{1k}T_{ihj} + X'_{ihj}\alpha_{2k} + M'_{hj}\alpha_{3k} + \alpha_{4k}r_{ihj})} \quad (21)$$

It is the probability that the l choice is made. Hence, what I estimate is

$$\begin{aligned} D_{ihj} &= \gamma_0 + \gamma_1T_{ihj} + X'_{ihj}\gamma_2 + M'_{hj}\gamma_3 + \mu(P_1, P_2, P_3) + \eta_{ihj} \\ &= \gamma_0 + \gamma_1T_{ihj} + X'_{ihj}\gamma_2 + M'_{hj}\gamma_3 + \kappa(\Omega) + \eta_{ihj} \end{aligned} \quad (22)$$

Dahl (2002) requires the assumption that

Assumption 1.

$$f(v_{ihj1}, \Psi_{ihj1}|\Omega) = f(v_{ihj1}, \Psi_{ihj1}|P_{L,L=1,2})$$

Hence, the equation22 becomes

$$D_{ihj} = \gamma_0 + \gamma_1T_{ihj} + X'_{ihj}\gamma_2 + M'_{hj}\gamma_3 + \mu(P_{L,L=1,2}) + \eta_{ihj} \quad (23)$$

Therefore, if I assume that the probability of choosing 1 includes sufficient information for estimating equation23. Then, I have

$$D_{ihj} = \gamma_0 + \gamma_1T_{ihj} + X'_{ihj}\gamma_2 + M'_{hj}\gamma_3 + \mu(P_1) + \eta_{ihj} \quad (24)$$

5 Results

5.1 Impact on work minutes and time spending

LPG stoves are advanced technology stoves compared to traditional three-stone and improved cook stoves. They use LPG as a clean energy fuel, enabling households to optimize their time and increase their welfare.

Adopting improved technology stoves saves fuel and cooking time, allowing households to allocate more time to work. LPG stoves, being clean energy stoves, contribute to the overall health of household members, particularly the main cook. Verma and Imelda (2022); Imelda (2020)

The initial analysis, as shown in table 1, examines the impact of LPG stove adoption on time spent on work outside for men and women in households. Specifically, I investigate how the adoption of LPG stoves affects the amount of time men and women spend on work outside on typical days. I conduct separate analyses for men and women due to significant differences between the two groups. The results of the simple linear regression indicate that the key variable, LPG adoption, does not have a significant impact on the time spent on work outside. However, the two-stage least squares regression, which is a linear model with instrumental variables, reveals a significant impact of LPG stove adoption with different effects for women and men. When controlling for non-linearity using the Probit model in the first stage and the Tobit model in the second stage, along with the control function approach, the impact of LPG stove adoption for women becomes not significant, while for men, it is found to be significant and positive. Clean energy access increases the time men spend on work outside by 151 minutes on a typical day but does not have a significant impact on women.

The analysis raises the question of how people reallocate their time when they have access to clean energy and whether this reallocation differs between men and women. Fortunately, the MTF data provides information on the time spent on various activities for both men and women, including work inside, fuel collection, fuel preparation, cooking, staying in the cooking area, childcare, study, and entertainment.

In my analysis of table2 and table3, I discovered that the adoption of LPG stoves has different effects on time allocation for women and men. Both groups experienced a decrease in fuel collection and preparation time, but the reduction was not the same for each group. Specifically, fuel collection time decreased by 454 minutes for women and by 209 minutes for men. Conversely, fuel preparation time decreased more for the men. These findings suggest that adopting an LPG stove can significantly reduce the time spent on fuel-related activities, particularly in cooking. These results align with

existing literature that highlights the time-saving benefits of clean energy and advanced technology stoves, such as LPG and ICS (Berkouwer and Dean, 2022b).

One interesting finding from the results is that men save time on cooking fuel-related activities, and they use that saved time for other activities such as work, studying, and entertainment. On the other hand, women also save time on cooking fuel-related activities, but they tend to use that saved time for studying and entertainment. Despite the decrease in cooking time, women still spend more time on activities in the cooking area compared to men.

The time information in the MTF data has a limitation because it combines the time spent for each group (men, women, boys, and girls). As a result, it's difficult to determine which individual increased or decreased their time spent on those activities. To gather more supporting evidence for this study, I created the variable for individual work days per year.

5.2 Impact on Work Days Per Year

The tables 4 and 5 presents the results on the effect of clean stove adoption on the number of workdays per year. The first column provides estimates from the linear regression model, while the second column shows the findings using the IV method with the control function approach. Specifically, the generalized residual from the probit model in the first regression is included in the second regression. The third column reports the outcome from the Heckman selection model with an IV, and the final two columns present the results from the first and second-stage regressions.

The analysis shows that women work around 27 additional days per year with LPG stove adoption, while men work around 25 more days. The second stage regression, which incorporates the generalized residual from the probit model, reveals the different estimation results between men and women. Interestingly, while the men's extensive margin of labor supply is more likely to increase, women's extensive margin of labor supply is more likely to decrease. Consequently, fewer women are willing to work with LPG stove adoption, but those who do tend to work more days.

To investigate the heterogeneity in occupation type, I construct two categorical variables, indicating the nonfarm employed and the self-employed. The results are similar to the Heckman selection model results with a binary choice: work or not work, but with slightly different coefficients. The table6 and table7 show the result with the outcome variable, workdays per year, conditional on the nonfarm employed. For nonfarm employed workers, men work around 18 more days per year while women work around 25

more days per year. In the case of the self-employed, women work 19 more days per year, while the men work 29 more days per year. Even though the results show positive and significant results, the magnitude is slightly different for occupation types and genders.

The impact of LPG stoves may vary depending on household income levels. I conducted the Heckman selection model with IV analysis for five different quintiles as part of further analysis. Table 10 and Table 11 display the results of the Heckman selection model with the IV model for the five different total expenditure quintiles. For women, each regression result is positive, but only the fourth quintile group yields a significant result. In contrast, for men, the first four regression results are both positive and significant. The impact is particularly strong for the second and third-quintile groups. The impact is smaller and not significant for quintile 5, which represents the highest income group. One possible argument for adopting LPG stoves is that households with higher wealth or incomes are more affordable clean stoves, so only the households with high wealth or incomes benefit from the adoption of LPG stoves. However, the result of 10 and 11 provides suggestive evidence that the adoption of clean stoves can increase labor supply, especially for low and mid-income households.

6 Channels for Time Allocation and Labor Supply

6.1 Home Production

The adoption of clean stoves has a significant impact on time allocation and labor supply, primarily through home production. The theoretical model discussed in section 3 illustrates how clean stove adoption influences the labor supply decisions of household members. Empirical evidence confirms that the home production factor plays a crucial role in explaining households' labor supply decisions.

The LPG stove is an advanced cooking technology that is more developed than traditional stoves and ICS. With advanced technology, a clean stove can produce fire faster with fewer biomass emissions, which are harmful to respiratory and eye health. Many studies have discussed the benefits of this LPG stove. Therefore, acquiring an LPG stove can be seen as having a similar impact on the advancement of home production Afridi et al. (2023)

The collective intra-household model suggests that making improvements in home production can either increase or decrease the labor supply of household members. For example, better technology can reduce the time spent on cooking activities, while improved stove technology can lead to increased resource-sharing among household mem-

bers because of a more efficient use of the household budget. This increase in available resources can provide more leisure time, ultimately improving the well-being of household members. As a result, the changes in labor supply can impact all adult household members engaged in economic activities.

It can be the other channel between the labor supply and the adoption of LPG stoves. However, according to my empirical results, some of those results can be explained by the home production channel. Empirical results from this study show that women tend to spend more time doing activities other than working outside. Interestingly, they also spend more time in the cooking area doing activities other than cooking. Also, men and women both increased their work days per year with the adoption of an LPG stove, but fewer women worked. Therefore, home production can be a good link or explanation of how the LPG stove influences the labor supply for all household members.

6.2 Other Channels

The link between the use of clean stoves and labor supply can be explained through several channels: time-saving, health benefits, impact on the local economy, and spillover effects.

One direct and easily observable link is the time-saving aspect of using a clean stove. It is widely known that using clean fuel reduces the time spent on cooking-related activities. Not only does the use of ICS save time for cooking activities, but it also contributes to a cleaner environment. According to a study by Krishnapriya et al. (2021), which uses the MTF data from multiple countries, there are varying levels of time-saving impacts. However, the study did not discuss the impact on labor supply.

The next link is the health. Verma and Imelda (2022) conducted a study and found empirical evidence that health plays a significant role in explaining the impact of an increase in the main cook's labor supply. Instead of relying on self-reported survey data, they measured lung capacity to accurately assess the impact of LPG on respiratory health. The health channel operates on the logic that improved health leads to reduced sickness among household members, allowing them to engage in more activities. If the main cook or their children experience less illness due to clean cooking fuel, other household members who are not usually involved in cooking can increase their work time due to the positive impact. (Verma and Imelda, 2022)

7 Policy Discussion

The use of clean and improved technology stoves brings about health benefits and saves cooking time, as proven by numerous studies. This leads to improved well-being for household members. By encouraging the adoption of these better technology stoves, such as ICS and clean stoves, households can engage in more productive activities leading to increased welfare. Additionally, the use of higher technology stoves can also increase labor supply. With improved home production, the opportunity cost of work decreases, making it more likely for individuals to work, thus leading to higher income. Ultimately, better stoves can act as a social safety net for low-income households, enabling them to increase their income by working more.

8 Conclusion

The study examined the impact of adopting LPG stoves on the labor supply and time allocation for men and women separately. Using instrumental variable analysis with average land slope, the study found empirical evidence that LPG stove adoption increased work hours, employment, and work days for men while women did not work more. Fewer women worked with the adoption of LPG stoves, but among those who did, the number of work days increased. Instead of increasing work hours, women tended to spend more time on other activities such as entertainment and study. Interestingly, they spent more time in the cooking area even though they used the cookstoves less. It is suspected that men have a higher potential wage, resulting in a strong work preference. On the other hand, women with a lower potential wage tended to work less and spend more time on household work or leisure due to higher household budget constraints from other members' labor supply. Therefore, women whose household budget constraints did not increase enough with other household members' labor supply decided to work and increased their work days.

The main limitation of this study is that the time allocation variable aggregates the time spent for each group: women and men. This makes it difficult to track which individuals are increasing or decreasing their work minutes. As a result, I am relying on the assumption that, most of the time, changes in response to the adoption of LPG stoves are due to individuals who have a comparative advantage within their respective groups.

For future studies, it is essential to gather more detailed data on time usage for each individual to conduct a more in-depth analysis. Additionally, this study focuses on clean stoves, specifically LPG stoves, but for households in extreme poverty, these types of

stoves may not be affordable or may require significant subsidies. Therefore, it is important to assess the impact of ICS, which are more affordable, on labor supply.

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Table 1: Work outside minutes per day

	Work outside-women			Work outside-men		
	OLS	2sls	IV-Tobit	OLS	2sls	IV-Tobit
LPG	4.735 (7.218)	-90.599* (38.382)	-97.132 (61.507)	2.590 (10.291)	311.125*** (51.960)	151.670*** (39.355)
Total expenditure (NPR)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000* (0.000)	-0.000 (0.000)	0.000 (0.000)
Urban	-34.593*** (5.793)	-18.042* (8.563)	-115.729*** (20.807)	-26.809*** (8.085)	-81.263*** (12.422)	-79.229*** (13.243)
Bank account own	10.344 (6.397)	27.649** (9.403)	42.796 (22.532)	11.634 (9.003)	-46.388*** (13.806)	-16.672 (14.642)
Household size	-4.689 (2.792)	-8.462** (3.188)	-18.248* (9.017)	4.567 (3.833)	17.277*** (4.752)	14.852** (5.687)
Stove burner number	-20.430** (6.465)	4.466 (11.418)	-65.067** (23.580)	33.018*** (7.925)	-43.986** (15.635)	4.526 (14.766)
Age (HH head)	0.474 (0.286)	0.753* (0.317)	1.622 (0.828)	-0.621 (0.363)	-1.581*** (0.424)	-1.629** (0.531)
Gender (HH head)	35.430*** (8.777)	44.789*** (9.444)	104.115*** (24.803)	-12.177 (13.089)	-43.060** (15.064)	-36.784* (17.950)
Educ year (HH head)	0.380 (0.699)	1.809* (0.909)	2.048 (2.319)	-0.702 (0.931)	-5.230*** (1.292)	-3.209* (1.451)
Elevation	0.014*** (0.003)	0.008 (0.004)	0.042*** (0.011)	-0.047*** (0.004)	-0.027*** (0.006)	-0.056*** (0.007)
Self emp (HH head)	22.624*** (5.724)	19.008** (5.904)	100.191*** (17.944)	-3.460 (7.660)	6.519 (8.824)	4.188 (11.111)
Non farm emp (HH head)	15.461* (6.788)	26.535** (8.091)	36.826 (21.338)	78.413*** (8.922)	41.144*** (11.623)	87.128*** (13.212)
Age (main cook)	-0.141 (0.275)	-0.095 (0.277)	-0.037 (0.769)	-0.673 (0.362)	-0.877* (0.394)	-0.895 (0.495)
Women number	38.677*** (5.072)	42.080*** (5.267)	103.242*** (14.071)	4.046 (6.629)	-7.034 (7.420)	-4.243 (8.821)
Men number	-1.535 (4.180)	-0.550 (4.235)	-6.110 (13.155)	53.243*** (6.551)	50.047*** (7.095)	64.303*** (8.266)
Kids number	-5.451 (4.947)	-5.894 (5.028)	-12.785 (15.168)	4.311 (7.271)	4.708 (7.931)	1.154 (9.559)
Generalized residual			54.574 (37.269)			-101.680*** (23.880)
Constant	40.212 (56.880)	-47.219 (65.560)	-479.897** (161.636)	202.898** (72.732)	477.875*** (83.750)	250.524* (99.994)
Fuel availability	Yes	Yes	Yes	Yes	Yes	Yes
House quality	Yes	Yes	Yes	Yes	Yes	Yes
N	4905	4905	4905	4525	4525	4525

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Women time allocation (minutes per day)

	IV-Tobit Work inside	IV-Tobit Fuel collect	IV-Tobit Fuel prepare	IV-Tobit Cooking	IV-Tobit Cooking area	IV-Tobit Child care	IV-Tobit Study	IV-Tobit Entertain
LPG	-158.455* (80.543)	-453.783*** (25.160)	-79.228*** (7.285)	-48.235*** (7.199)	33.430*** (8.614)	-18.295 (53.530)	119.841*** (31.053)	97.814*** (13.745)
Total expenditure (NPR)	0.001** (0.000)	0.000 (0.000)	0.000* (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000** (0.000)
Urban	44.617 (27.494)	7.603 (7.894)	1.653 (2.246)	3.052 (2.394)	-1.941 (2.849)	0.487 (17.794)	33.238** (10.361)	-14.707** (4.604)
Bank account own	103.239*** (30.197)	26.360** (8.581)	-8.332*** (2.438)	-1.883 (2.620)	2.112 (3.144)	26.072 (19.511)	-7.661 (11.336)	21.372*** (5.034)
Household size	13.853 (11.526)	2.290 (3.430)	2.847** (0.973)	4.008*** (1.030)	3.727** (1.218)	31.977*** (7.407)	57.812*** (4.399)	-5.104* (1.984)
Stove burner number	54.292 (31.412)	45.049*** (9.120)	9.992*** (2.588)	-4.071 (2.753)	3.835 (3.261)	35.515 (20.145)	-34.751** (11.933)	-11.177* (5.331)
Age (HH head)	-0.667 (1.109)	0.268 (0.325)	0.168 (0.094)	0.123 (0.095)	0.003 (0.111)	0.671 (0.693)	-0.894* (0.404)	0.197 (0.182)
Gender (HH head)	90.093** (32.944)	33.167** (10.126)	-0.758 (2.992)	-6.339* (2.902)	-11.122** (3.502)	-8.706 (22.163)	-4.031 (12.397)	-2.151 (5.530)
Educ year (HH head)	2.426 (2.996)	0.250 (0.941)	0.003 (0.272)	0.364 (0.266)	-1.082*** (0.315)	0.961 (1.991)	3.845*** (1.114)	0.802 (0.502)
Self emp (HH head)	94.695*** (23.799)	3.210 (6.949)	2.969 (1.998)	5.233* (2.040)	6.385** (2.437)	28.820 (15.328)	11.546 (8.742)	22.272*** (3.901)
Non farm emp (HH head)	153.733*** (27.738)	27.308** (8.463)	-0.866 (2.438)	-5.340* (2.445)	-2.255 (2.898)	-22.841 (18.433)	-14.233 (10.490)	-17.529*** (4.638)
Age (main cook)	-0.671 (1.059)	-0.835** (0.308)	-0.163 (0.088)	-0.148 (0.090)	-0.294** (0.105)	-7.029*** (0.683)	-2.081*** (0.400)	-0.388* (0.171)
Women number	23.309 (17.770)	11.496* (5.551)	-1.817 (1.598)	3.749* (1.619)	11.678*** (1.885)	-3.437 (12.002)	16.741** (6.412)	18.084*** (3.069)
Men number	3.026 (16.660)	-11.736* (5.119)	-3.857** (1.479)	2.619 (1.494)	1.542 (1.747)	-59.930*** (11.476)	-63.526*** (6.395)	12.939*** (2.830)
Kids number	-29.958 (19.683)	-19.304*** (5.811)	-0.242 (1.639)	1.120 (1.734)	0.045 (2.045)	352.829*** (12.115)	-47.177*** (7.032)	-3.723 (3.341)
Elevation	0.093*** (0.014)	0.042*** (0.004)	0.004*** (0.001)	-0.002 (0.001)	-0.006*** (0.001)	0.014 (0.009)	-0.013* (0.005)	-0.004 (0.002)
Generalized residual	151.118** (48.976)	142.302*** (14.845)	13.784** (4.302)	13.330** (4.372)	-15.447** (5.219)	35.014 (32.230)	-50.802** (18.947)	-40.184*** (8.331)
Constant	-987.337*** (184.436)	97.274 (57.162)	49.471** (15.698)	70.371*** (18.143)	46.916* (19.968)	-418.185*** (124.035)	-242.473** (78.153)	-113.090* (44.020)
Fuel availability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
House quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4905	4905	4905	4905	4905	4905	4905	4905

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Men time allocation (minutes per day)

	IV-Tobit Work inside	IV-Tobit Fuel collect	IV-Tobit Fuel prepare	IV-Tobit Cooking	IV-Tobit Cooking area	IV-Tobit Child care	IV-Tobit Study	IV-Tobit Entertain
LPG	-122.257 (82.114)	-208.544*** (24.430)	-120.979*** (10.975)	-28.847* (14.391)	-9.798 (15.554)	25.046 (25.818)	81.195* (40.859)	42.914*** (12.040)
Total expenditure (NPR)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000* (0.000)
Urban	39.467 (27.587)	-24.629** (8.029)	0.494 (3.356)	12.261* (5.100)	12.892* (5.718)	5.776 (8.691)	24.037 (13.747)	-18.075*** (4.063)
Bank account own	88.875** (30.829)	5.998 (8.896)	-8.332* (3.676)	-14.910** (5.522)	-1.382 (6.160)	3.036 (9.562)	-38.958* (15.139)	23.002*** (4.470)
Household size	-5.257 (11.958)	6.703 (3.466)	0.458 (1.465)	-1.634 (2.189)	-0.650 (2.406)	10.076** (3.605)	53.689*** (5.880)	-9.398*** (1.761)
Stove burner number	13.465 (31.303)	13.879 (8.979)	13.961*** (3.708)	7.180 (5.293)	12.533* (5.786)	-6.261 (9.463)	-24.449 (15.315)	-9.121* (4.572)
Age (HH head)	-0.352 (1.132)	-0.345 (0.327)	-0.084 (0.141)	0.039 (0.205)	0.315 (0.219)	0.143 (0.341)	-1.089 (0.562)	0.041 (0.162)
Gender (HH head)	19.266 (38.727)	-23.622* (11.422)	-0.923 (5.151)	4.592 (6.956)	3.794 (7.579)	-3.247 (12.277)	88.871*** (18.281)	6.127 (5.382)
Educ year (HH head)	3.262 (3.055)	-2.932** (0.916)	-0.147 (0.407)	0.596 (0.561)	0.339 (0.603)	-0.347 (0.967)	7.260*** (1.493)	0.655 (0.441)
Self emp (HH head)	228.849*** (25.130)	15.697* (6.895)	10.264*** (2.985)	21.194*** (4.388)	-3.334 (4.863)	35.416*** (7.445)	36.871** (11.655)	19.374*** (3.405)
Non farm emp (HH head)	70.413* (27.864)	-2.258 (8.237)	0.093 (3.600)	-2.283 (5.134)	15.861** (5.640)	-23.879** (8.976)	-10.191 (13.725)	-12.129** (4.042)
Age (main cook)	-0.753 (1.067)	-0.583 (0.304)	-0.260* (0.132)	0.354 (0.191)	0.020 (0.206)	-2.670*** (0.332)	-1.223* (0.536)	-0.164 (0.150)
Women number	19.043 (18.294)	-7.572 (5.459)	0.710 (2.385)	-19.010*** (3.549)	-7.231 (3.819)	-13.300* (5.904)	-68.681*** (9.154)	10.773*** (2.697)
Men number	51.378** (17.026)	6.668 (5.099)	6.902** (2.190)	13.016*** (3.192)	9.643** (3.507)	-16.860** (5.686)	43.505*** (7.966)	24.384*** (2.527)
Kids number	4.314 (19.878)	-9.116 (5.832)	-1.255 (2.457)	-4.561 (3.768)	0.634 (4.130)	102.043*** (5.944)	-70.573*** (9.940)	-0.153 (2.952)
Elevation	0.076*** (0.013)	0.035*** (0.004)	0.011*** (0.002)	0.040*** (0.003)	0.029*** (0.003)	0.017*** (0.004)	-0.004 (0.007)	0.000 (0.002)
Generalized residual	92.606 (49.773)	79.942*** (14.800)	26.777*** (6.412)	10.153 (8.743)	18.004 (9.357)	-11.266 (15.639)	-60.936* (25.090)	-18.968** (7.319)
Constant	-700.897*** (187.111)	195.297*** (57.118)	2.910 (22.723)	-94.848** (31.122)	-112.788*** (31.221)	-43.678 (55.049)	-502.107*** (101.940)	-63.819 (33.145)
Fuel availability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
House quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4525	4525	4525	4525	4525	4525	4525	4525

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Work days per year - Women

	OLS	IV	Heckman & IV		
	workday per year	workday per year	3rd Stage workday per year	2nd Stage Employment	1st Stage LPG
LPG	15.981*** (3.847)	4.804 (9.170)	27.458*** (8.121)	-0.391* (0.168)	
Total expenditure (NPR)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000** (0.000)	0.000*** (0.000)
Married	12.726** (4.583)	12.656** (4.591)	25.951*** (6.244)	-0.205** (0.069)	0.049 (0.091)
Urban	0.769 (3.107)	2.706 (3.481)	7.565 (4.638)	-0.059 (0.047)	0.537*** (0.047)
Bank account own	3.341 (3.546)	1.404 (3.750)	1.417 (4.618)	-0.019 (0.051)	-0.702*** (0.055)
Household size	1.914** (0.621)	1.692** (0.647)	1.793 (0.991)	-0.002 (0.011)	-0.082*** (0.012)
Stove burner number	-8.842** (2.896)	-5.837 (3.580)	12.349 (8.769)	-0.239*** (0.051)	1.180*** (0.060)
House quality	18.552*** (3.081)	19.853*** (3.237)	9.315 (5.643)	0.152*** (0.038)	0.527*** (0.045)
Age (HH head)	-0.359 (0.210)	-0.304 (0.212)	-1.043* (0.423)	0.010*** (0.003)	0.020*** (0.003)
Educ year (HH head)	-0.248 (0.348)	-0.011 (0.382)	-2.622* (1.181)	0.038*** (0.006)	0.087*** (0.006)
Elevation	0.020*** (0.002)	0.019*** (0.002)	0.004 (0.008)	0.000*** (0.000)	0.000 (0.000)
Kids number	-3.816 (2.179)	-4.021 (2.186)	-1.080 (3.244)	-0.043 (0.026)	-0.097** (0.035)
HH head	6.840 (4.053)	6.837 (4.058)	-22.157 (12.216)	0.408*** (0.051)	0.091 (0.074)
Generalized residual		7.361 (5.505)		0.150 (0.103)	
lambda			-113.545* (48.221)		
slope					-0.081*** (0.006)
Constant	102.453 (60.113)	98.095 (60.048)	294.678* (115.634)	-1.271** (0.445)	-4.217*** (0.521)
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	2169	2169	5163	5163	5163

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Work days per year - Men

	OLS	IV	Heckman & IV		
	workday per year	workday per year	3rd Stage workday per year	2nd Stage Employment	1st Stage LPG
LPG	22.508*** (2.886)	5.303 (8.135)	25.111*** (3.400)	0.935*** (0.231)	
Total expenditure (NPR)	0.000 (0.000)	0.000* (0.000)	0.000 (0.000)	-0.000*** (0.000)	0.000*** (0.000)
Married	8.437* (4.147)	7.370 (4.159)	18.831** (6.618)	0.549*** (0.092)	-0.105 (0.082)
Urban	2.406 (2.502)	5.653 (2.931)	-0.186 (3.601)	-0.391*** (0.066)	0.580*** (0.052)
Bank account own	1.686 (2.922)	-1.890 (3.288)	3.207 (3.203)	0.299** (0.096)	-0.739*** (0.061)
Household size	2.688*** (0.555)	2.240*** (0.599)	2.803*** (0.565)	0.026 (0.015)	-0.091*** (0.014)
Stove burner number	-11.894*** (2.657)	-7.477* (3.385)	-13.138*** (2.264)	-0.311*** (0.084)	1.049*** (0.066)
House quality	1.562 (2.195)	3.812 (2.424)	1.296 (2.872)	-0.130* (0.059)	0.561*** (0.049)
Age (HH head)	-0.133 (0.169)	-0.039 (0.175)	0.146 (0.212)	0.023*** (0.005)	0.016*** (0.004)
Educ year (HH head)	0.238 (0.281)	0.476 (0.298)	0.238 (0.315)	-0.010 (0.009)	0.054*** (0.006)
Elevation	0.002 (0.002)	0.000 (0.002)	0.001 (0.002)	0.000 (0.000)	0.000* (0.000)
Kids number	-0.542 (1.701)	-0.696 (1.701)	0.643 (1.842)	0.117** (0.041)	-0.064 (0.039)
HH head	6.505* (2.851)	5.607 (2.887)	10.504* (4.413)	0.425*** (0.077)	-0.166* (0.068)
Generalized residual		11.126* (4.811)		-0.453*** (0.134)	
lambda			47.001 (28.115)		
slope					-0.091*** (0.007)
Constant	252.870*** (26.364)	247.279*** (26.645)	210.380*** (45.853)	-0.560 (0.450)	-3.845*** (0.625)
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	3723	3723	4123	4123	4123

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Nonfarm Workdays per year-Women

	DAHL P1	DAHL P3	Multinomial Logit		
	Workdays per year	Workdays per year	other job	non farm	
LPG	20.695** (6.984)	25.327* (10.144)	-1.525*** (0.262)	0.374 (0.374)	
Total expenditure (NPR)	-0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	-0.000 (0.000)	
Married	0.612 (7.581)	-3.006 (9.744)	-0.081 (0.152)	-0.507** (0.157)	
Urban	5.359 (5.528)	7.546 (6.931)	-0.138 (0.082)	0.097 (0.127)	
Bank account own	2.021 (6.303)	-2.393 (9.479)	-0.064 (0.090)	-0.365* (0.152)	
Household size	1.294 (1.078)	0.909 (1.298)	0.009 (0.019)	-0.038 (0.026)	
Stove burner number	-5.195 (5.320)	-5.931 (5.845)	-0.343*** (0.097)	-0.317* (0.150)	
House quality	8.111 (5.518)	9.208 (6.295)	0.320*** (0.071)	0.166 (0.117)	
Age (HH head)	0.587 (0.396)	0.825 (0.530)	0.012* (0.005)	0.028*** (0.007)	
Educ year (HH head)	1.762 (1.304)	3.478 (2.639)	0.010 (0.010)	0.165*** (0.015)	
Elevation	0.009** (0.003)	0.012* (0.005)	0.000*** (0.000)	0.000*** (0.000)	
Kids number	-5.902 (4.081)	-8.114 (4.887)	-0.028 (0.051)	-0.200* (0.079)	
HH head	9.943 (6.893)	14.995 (9.877)	0.708*** (0.111)	0.675*** (0.143)	
dahl p1	-84.291* (38.423)	-280.662 (256.002)			
dahl p2		353.338 (475.426)			
dahl p3		-232.533 (337.225)			
Generalized residual			0.612*** (0.158)	-0.084 (0.233)	
Constant	242.049*** (36.314)	247.820*** (40.051)	-2.779* (1.121)	-3.062** (1.027)	
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	5163	5163	5163	5163	5163

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Nonfarm Workdays per year-Men

	DAHL P1	DAHL P3	Multinomial Logit	
	Workdays per year	Workdays per year	other job	non farm
LPG	15.651* (7.895)	17.501* (7.732)	0.687 (0.457)	2.098*** (0.432)
Total expenditure (NPR)	0.000 (0.000)	0.000 (0.000)	-0.000* (0.000)	-0.000** (0.000)
Married	3.309 (6.082)	4.859 (5.942)	0.948*** (0.178)	0.935*** (0.164)
Urban	-0.593 (3.417)	-0.473 (3.531)	-0.866*** (0.156)	-0.578*** (0.154)
Bank account own	6.305 (5.798)	9.228 (5.933)	0.828*** (0.178)	0.200 (0.176)
Household size	2.582*** (0.618)	2.379*** (0.647)	0.062 (0.033)	0.039 (0.032)
Stove burner number	-9.768** (3.402)	-9.685** (3.335)	-0.574** (0.176)	-0.544** (0.170)
House quality	1.878 (2.906)	2.159 (2.943)	-0.288* (0.127)	-0.273* (0.125)
Age (HH head)	-0.342 (0.193)	-0.228 (0.193)	0.053*** (0.011)	0.045*** (0.011)
Educ year (HH head)	0.194 (0.619)	0.426 (0.627)	-0.064*** (0.018)	0.014 (0.017)
Elevation	-0.003 (0.002)	-0.003 (0.002)	-0.000 (0.000)	0.000 (0.000)
Kids number	1.194 (2.074)	1.733 (2.035)	0.191 (0.105)	0.257* (0.103)
HH head	7.281* (3.337)	8.645* (3.442)	0.833*** (0.174)	0.899*** (0.168)
dahl p1	9.195 (34.102)	-10.300 (210.194)		
dahl p2		210.390 (389.156)		
dahl p3		-223.381 (237.006)		
Generalized residual			-0.575* (0.274)	-0.849** (0.258)
Constant	291.590*** (34.810)	265.008*** (46.207)	-2.434* (0.978)	-1.446 (0.863)
Fuel availability	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes
N	4123	4123	4123	4123

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Self-employed Workdays per year-Women

	DAHL P1 Workdays per year	DAHL P3 Workdays per year	Multinomial Logit		
			other job	self emp	
LPG	19.092*** (4.649)	19.147*** (4.699)	-0.573 (0.377)	-0.669** (0.244)	
Total expenditure (NPR)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000*** (0.000)	
Married	14.668** (5.604)	14.341* (5.774)	-0.506** (0.169)	-0.291* (0.130)	
Urban	3.756 (3.662)	3.920 (3.609)	-0.346** (0.123)	-0.024 (0.081)	
Bank account own	6.166 (3.906)	5.643 (4.005)	0.106 (0.134)	-0.071 (0.090)	
Household size	2.691*** (0.811)	2.627** (0.825)	-0.042 (0.028)	0.009 (0.018)	
Stove burner number	-2.855 (7.102)	-1.664 (7.241)	-0.411** (0.141)	-0.382*** (0.094)	
House quality	13.353** (4.333)	12.341** (4.225)	0.147 (0.105)	0.287*** (0.071)	
Age (HH head)	-0.650 (0.363)	-0.725* (0.353)	0.004 (0.007)	0.021*** (0.005)	
Educ year (HH head)	-0.941 (0.733)	-1.166 (0.709)	0.054*** (0.015)	0.064*** (0.010)	
Elevation	0.017*** (0.005)	0.016*** (0.005)	0.000*** (0.000)	0.000*** (0.000)	
Kids number	-6.095* (2.570)	-5.786* (2.668)	-0.059 (0.076)	-0.073 (0.050)	
HH head	8.156 (9.494)	7.033 (9.418)	0.682*** (0.156)	0.663*** (0.103)	
dahl p1	16.989 (69.132)	434.870 (382.577)			
dahl p2		-880.910 (953.219)			
dahl p3		565.139 (797.083)			
Generalized residual			0.047 (0.234)	0.312* (0.149)	
Constant	217.255*** (33.221)	195.586*** (50.115)	-1.648 (1.183)	-3.190** (1.103)	
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	5163	5163	5163	5163	5163

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Self-employed Workdays per year-Men

	(1) Workdays per year	(2) Workdays per year	(3) other job	(3) self emp
LPG	25.049*** (5.924)	29.614*** (6.879)	1.628*** (0.447)	1.816*** (0.428)
Total expenditure (NPR)	0.000 (0.000)	0.000 (0.000)	-0.000** (0.000)	-0.000* (0.000)
Married	13.319 (9.678)	17.136 (11.082)	0.870*** (0.162)	0.951*** (0.154)
Urban	0.916 (5.050)	-3.353 (6.383)	-0.601*** (0.159)	-0.815*** (0.155)
Bank account own	-3.371 (5.418)	-7.193 (6.755)	0.752*** (0.177)	0.400* (0.173)
Household size	2.567** (0.875)	2.020 (1.082)	0.072* (0.034)	0.030 (0.033)
Stove burner number	-12.237*** (3.649)	-11.727** (3.973)	-0.641*** (0.175)	-0.554** (0.169)
House quality	8.589* (3.545)	9.731* (3.826)	-0.359** (0.138)	-0.246 (0.135)
Age (HH head)	0.828 (0.688)	1.569 (0.847)	0.024* (0.011)	0.064*** (0.010)
Educ year (HH head)	0.371 (0.656)	1.000 (0.800)	-0.044* (0.017)	-0.003 (0.017)
Elevation	0.005* (0.002)	0.006* (0.002)	-0.000 (0.000)	0.000 (0.000)
Kids number	0.410 (2.307)	0.866 (2.599)	0.241* (0.100)	0.229* (0.098)
HH head	7.640* (3.771)	8.233 (4.266)	0.948*** (0.183)	0.834*** (0.176)
dahl p1	-84.838 (65.562)	-263.131 (493.366)		
dahl p2		414.928 (841.636)		
dahl p3		-351.842 (485.673)		
Generalized residual			-0.833** (0.273)	-0.820** (0.261)
Constant	245.600*** (40.509)	243.500** (93.094)	-1.237 (0.866)	-2.240** (0.837)
Fuel availability	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes
N	4123	4123	4123	4123

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Work days per year Quintile-Women

	Work days per year				
	Quntile 1	Quntile 2	Quntile 3	Quntile 4	Quntile 5
LPG	26.435 (14.041)	8.605 (11.968)	4.136 (12.078)	49.827* (19.550)	8.746 (16.547)
Total expenditure (NPR)	0.003 (0.002)	-0.002 (0.001)	0.002 (0.001)	0.000 (0.001)	-0.000 (0.000)
Married	23.218 (13.768)	8.559 (17.005)	24.820* (12.523)	23.236 (13.403)	-10.454 (25.796)
Urban	0.667 (9.897)	2.051 (8.654)	7.088 (9.403)	-8.415 (12.991)	-0.916 (11.328)
Bank account own	-8.899 (12.935)	9.527 (9.476)	-24.187 (12.773)	10.819 (21.666)	3.723 (12.310)
Household size	5.350 (4.370)	2.014 (1.796)	1.123 (2.376)	1.034 (2.875)	1.274 (1.178)
Stove burner number	-11.315 (11.714)	-18.980 (20.844)	42.201 (23.442)	-18.327 (10.008)	-4.537 (13.150)
House quality	13.036* (6.642)	24.559*** (5.782)	15.863* (6.593)	19.711 (14.620)	4.354 (20.251)
Age (HH head)	-0.780 (0.602)	0.222 (0.521)	-1.139 (1.052)	-1.483 (1.051)	0.132 (1.172)
Educ year (HH head)	-1.449 (0.852)	1.346 (1.256)	-6.206* (2.973)	-2.923 (2.682)	0.423 (2.201)
Elevation	0.027*** (0.006)	0.020* (0.010)	-0.033* (0.017)	0.012 (0.009)	0.022* (0.011)
Kids number	0.791 (5.669)	-0.588 (4.267)	5.759 (6.166)	-6.202 (8.875)	-7.648 (9.462)
HH head	35.273 (18.389)	6.849 (13.882)	-69.409* (29.190)	-18.626 (28.353)	1.710 (17.908)
Constant	164.523** (54.150)	179.791*** (50.556)	307.909* (144.957)	481.074** (175.254)	233.846 (139.967)
lambda	45.666 (56.176)	31.255 (52.618)	-231.421* (90.045)	-108.968 (81.404)	12.060 (71.080)
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	938	868	936	1179	1221

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Work days per year Quintile-Men

	Work days per year				
	Quntile 1	Quntile 2	Quntile 3	Quntile 4	Quntile 5
LPG	21.625* (9.970)	31.893*** (7.251)	46.541*** (9.698)	17.468* (6.833)	10.690 (5.771)
Total expenditure (NPR)	0.002* (0.001)	0.000 (0.001)	0.000 (0.001)	0.001** (0.000)	-0.000 (0.000)
Married	0.600 (23.869)	22.054 (22.093)	25.848 (14.128)	3.287 (17.652)	18.073 (9.301)
Urban	12.096 (7.218)	11.888 (6.497)	-13.370* (6.175)	-8.541 (4.782)	0.084 (6.368)
Bank account own	-15.707* (6.101)	5.277 (6.053)	21.710** (7.757)	6.570 (7.741)	2.128 (7.302)
Household size	3.598 (2.037)	2.656 (2.305)	3.346* (1.677)	0.328 (1.465)	3.340*** (0.891)
Stove burner number	-12.311 (6.644)	-13.033 (6.982)	-31.641*** (7.138)	-2.906 (3.904)	-8.072 (5.748)
House quality	3.099 (4.950)	2.108 (5.552)	13.923** (4.985)	3.549 (5.787)	-13.362** (4.265)
Age (HH head)	-0.419 (0.430)	0.764 (0.570)	0.326 (0.517)	-0.366 (0.447)	0.304 (0.518)
Educ year (HH head)	-0.023 (0.788)	0.480 (0.744)	0.513 (0.761)	-0.178 (0.675)	0.166 (0.591)
Elevation	-0.003 (0.004)	0.003 (0.004)	-0.007 (0.004)	0.009* (0.004)	0.002 (0.003)
Kids number	7.427 (4.469)	1.777 (4.924)	11.188* (4.451)	-1.477 (4.141)	-8.034* (3.450)
HH head	4.777 (9.069)	0.674 (8.655)	13.523 (8.467)	8.744 (5.162)	17.954 (11.009)
Constant	300.594*** (41.811)	218.492*** (48.017)	121.001 (100.705)	270.594*** (64.920)	217.860** (81.517)
lambda	-31.235 (46.695)	26.512 (54.312)	89.989* (43.604)	-7.293 (54.537)	70.735 (57.830)
Fuel availability	Yes	Yes	Yes	Yes	Yes
Cook frequency	Yes	Yes	Yes	Yes	Yes
N	692	664	730	944	1076

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$