#  **Do all the empowered women promote smokeless kitchens? Investigating rural India**

# Introduction

Dependence on solid fuels (SFs)- firewood, dung, agriculture residue like straw and shrub- for cooking continues to plague rural India. According to National Family Health Survey-5[1]*,* only 43 percent of the rural households use clean cooking fuel (Electricity, LPG/natural gas, biogas). Stacking SFs along with clean fuel options is common in rural India. According to a survey by CEEW (2019-2020) [2] only 28 percent of LPG users solely depend on it and the others use it along with SFs as frequently as every day or several times a week. Indoor air pollution results in severe health problems and loss of productive human years. in India, household air pollution is the fourth most important risk factor for mortality and the cause of 5 percent of India’s total Disability Adjusted Life Years [3]

The cooking fuel scenario in rural India, in fact, improved in the last two decades. The percentage of households using SFs as the main source of cooking fell from 94 percent in 1998-99 to 57 percent in 2019-2021 [1,4]. Rise in household income and subsidy on LPG cylinders are the two main reasons for this improvement. However, SFs usage, during this period, fell very gradually along the wealth deciles and notable changes occurred only at higher deciles (six and above) (See.fig1). This still left a significant percentage of the population dependent on the SFs.

In 2017, India launched a clean cooking fuel programme-Pradhan Mantry Ujwal Yojna- that achieved near universal LPG connection. Under this scheme, the State bore the upfront lumpsum cost of LPG connection and stove that poor households (below poverty line) would generally find unaffordable[[1]](#footnote-1). From figure 1 it is evident that post PMUY, uptake of LPG has increased among the targeted group (1-3rd/4th wealth decile households). The results, however, are from intended i.e., smokeless kitchens for all. Ideally, a universal clean cooking programme should iron out the inequalities in the usage of clean cooking fuel as depicted by the bottom most dotted line in figure 1. High recurring costs of refilling cylinder, difficulty in accessing urban centric LPG distribution system, easy access to solid fuels are a few main reasons that has driven the rural households back to SFs, after initial success of the programme [5].

**Figure 1: Solid Fuel Users Across Economic Group**

Source: Calculated using NFHS-4 (2014-15) and NFHS-5 (2019-21)

India’s efforts to promote smokeless kitchens for all, in the last two decades, including the recent attempt, primarily focused on the economic aspect of the clean cooking fuel. However, this still leaves more than half of the rural households dependent on SFs. Limited success of these polices clearly begs to look past the economic factors.

Clean cooking has a direct bearing on the time, health, and labor borne by the woman and it effects the rest of the household by extension. Therefore, adoption and consistent use of clean cooking technologies, should ideally rest on and driven by women. Gendered nature of energy access, benefits, and interlinkages between women’s agency and choice of clean cooking fuel is a growing body of literature. Studies examined economic- and socio-cultural factors to assess woman’s status in the household, her bargaining power and in turn the choice of cooking fuel. Recent study by Choudhuri and Desai [6] provides a comprehensive review of the literature in this regard.

So far, studies have laid down the relevance of gender factors in fuel choice, but a little has been offered in terms of applicability of this theoretical understanding to the policy. Absence of gender components in India’s decades long clean fuel policies is a partial indicator of the disengagement between theory and policy application. Present study is an attempt to bridge this gap by asking the following questions.

1. Do all the factors that improve women’s agency increase the household’s chances of using clean cooking fuel?
2. Does improvement in the woman’s status trump all economic and socio-cultural hindrances to use clean cooking fuel?

Rest of the paper is organized as the following. Section II presents a review of the relevant literature followed by an analytical frame of the paper in section III. Section IV provides details on the data and the methodology used. Section V and VI present results of the model and robustness check of the model respectively. Last section concludes the paper with a discussion relevant for policy.

# Literature Review

In this paper, we attempt to respond to a call by Pachauri and Rao 2013 study- “ more research is needed to understand the factors-both outside and within the household- that influence women’s decision-making power in relation to the adoption of modern energy services”[7]. Therefore, this section does not dwell on justifying the importance of understanding the gendered nature of energy access and use nor reiterate the effect of clean energy services on women’s welfare. Instead, we lay ground to investigate the association between factors that improve woman’s agency and the household’s choice of clean cooking fuel, and factors both within and outside the households that dictate this association.

First, we shall review the studies that have drawn association between gender empowerment and the household choice of cooking technologies. This is followed by a compilation of ideas put forth by studies that discussed women’s ability to exercise their agency, factors that determine this ability and what it means for the developmental outcomes.

##  Women empowerment and choice of cooking fuel

Woman’s intra household bargaining power and allocating resources for clean cooking technologies accounts for a significant body of literature in the field of gender and energy. Intra-household negotiations do not usually take place between equals [8]. A woman’s negotiating position in the household tend to be determined by both economical and socio-cultural factors. Doss presents a comprehensive review of different indicators and proxies- income and employment, ownership of assets, size of the dowry, education- studies used to examine woman’s bargaining power and their correlation with developmental outcomes- pre- and post-natal health care, reproductive choices, education, and nutrition for children etc [9]. Following are a few studies that found significantly positive association between owning clean cooking technologies/using clean cooking fuel and woman’s bargaining power in case of India- [10], [11], [12] [6]. Societal norms dictate woman’s status (and change in it) within a household thus influencing her bargaining power. In a son preferred Indian society, Kishore and Spears [13] prove that, having a girl first child is associated with a household three-fourths of a percentage point less likely to use clean fuel.

Studies identified that women’s employment influences household’s choice of cooking in two ways. First, woman’s participation in labor force is perceived in terms of the opportunity cost of her labor/ time. That is women have or do not have a next best alternative to the labor/time she spends on arduous cooking process- collecting and managing solid fuels like firewood, and cooking with it. Nathan argues that low-opportunity cost of women’s labor will inhibit the adoption of labor-saving equipment, while a high opportunity cost will promote it [14]. A study by Wickramasinghe, in the case of Sri Lanka, found that expanded opportunities of paid employment among young woman transformed the traditional lifestyle, influencing the decision to adopt easy and convenient cooking technologies [15]. Secondly, engaged in paid employment activities boosts the woman’s household bargaining power as she actively contributes to the household’s income. Therefore, women can articulate their energy needs better and have more authority to take decisions [16].

## Gains in Women’s Agency: Are there limits?

Social norms influence expectations, behaviors and values which in turn dictate *what* and *how* of exercising one’s agency. According to Galièa and Farnworth [17] social norms lie outside the immediate control (or agency) of individuals and play a role in determining ‘the possible’ when it comes to the choices women may decide to make and to enact. For example, if a particular society places restrictions on the movement of women (either actively or passively), travelling outside the village to nearby town or city to collect an LPG cylinder is challenging. In such a scenario, she might choose not to exercise her agency of freedom to decide to and/ or spend on clean cooking fuel, even if she does in the case of other goods/services. In some situations, for women, it is rational to avoid negotiation [18].

Studies prove that women are more sensitive to social cues in determining appropriate behavior than men [18,19]. For example, the pressure to adhere to the idea of a “good woman”- adeptly handling her domestic responsibilities, and being caring and understanding towards others [20]- will determine her choices and actions. Therefore, hardship involved in cooking with *freely* available solid fuels, especially when the household resources are limited, might just be another household responsibility a “good woman” is expected to bear. Studies have proved that in case of limited resources and greater prioritization of the good of the household, women prefer to divert the funds away from clean cooking technologies/fuel [21,22]. Women also are, in general, more altruistic than men in allocating and spending resources for the overall welfare of the household [23,24]. If women do not realize that clean cooking fuel benefits not only her but the entire household, especially the health of the children, it is highly unlikely she would bargain for or invest in it.

Social norms are typically sticky in areas that directly affect power or control and is generally upheld by all the parties involved [25]. Navigating these sticky norms to formulate preferences, exercise their agency while avoiding social costs is challenging for women. “What if women’s relative hesitation about initiating negotiations has less to do with their ability than with the way they are treated when they attempt to negotiate” [26]. Women bargaining and/or spending resources on (seemingly) self-serving goods and services involves a high risk of *backlash* from the husband/partner or head of the household. In the face of pressure and control exerted by the husband, exercising her agency i.e., spending her earnings on clean cooking fuel, is a risky proposition. Females interpret risky situations as threats that encourage avoidance [27].

Social norms determine the context in which the markets and institutions operate. The nature, degree of rigidity/persistence of these norms and women’s response to it determines the success of laws, schemes, or developmental programmes. The “stickiest” aspect (of the social norms) is the way patterns of gender inequality are reproduced over time that is often passed on over generations [25]. Therefore, even though complementary or sequential policies are in place to iron out the gender inequalities and bring forth their combined impact on women’s welfare, their success is highly contextual i.e., dependent on the degree of stickiness of the social norms.

# Analytical Framework

Building on the existing literature, we examine association between three women empowerment indicators- women’s decision on household spending, her financial independence and improved opportunity cost of her time- and the household’s choice of cooking fuel.

## Participating in household spending

Women with decision making authority on household spending, are likely to bargain for cooking fuel that involves less drudgery, more leisure and lessens health risks to the entire household. Literature argues that women with autonomy generally make decisions that are beneficial to the household in general and children in particular like better diet, clothes, decision about sending to school etc [28]. Considering the improvement clean cooking fuel brings over burning solid fuels, women with a say on household spending are likely to bargain for clean cooking fuels [6,10,12].

## Financial independence

Financially independent woman would invest on goods and services that accrue welfare to the household in general. Therefore, they are highly likely to play a key role in choosing clean cooking fuel [29]. Access to ready cash and freedom to use it allows them to make decision about refilling LPG cylinders whenever required, therefore ensuring its consistent use.

## Contexts

Men and women have unequal capacity to exercise their agency [25]. These capacities determine the degree to which women’s agency manifests into a desirable household outcome i.e., gains of woman’s agency. Clancy et al proposes that household outcomes, especially in a gender equitable way, are a result of an interplay of factors at *individual, household, and institution* spheres [8]*.*  Loosely adopting this framework, present paper studies women’s empowerment in these three domains. Less/more favourable capacities women have in each of these domains are termed as *context* in this paper. These contexts define the atmosphere in which the woman’s empowerment will have varying association with the household’s choice of cooking fuel.

At the **individual** context woman’s knowledge (or lack of) about the ill effects of using solid fuels for cooking on the health will influence her to bargain for or spend on clean cooking fuel. We hypothesise that woman’s (spending) decision making authority and financial independence will have higher chances to translate into cleaner fuel choice if she is aware of health damage caused by burning solid fuels.

At the **household** context, gender relations between the husband and the wife affects her autonomy in the economic sphere, especially her spending decisions. Studies show that the trust and level of communication between spouses has a telling impact on the decisions made within the household (Doss, 2013). In this case, if the husband distrusts the wife or restricts her autonomy, we hypothesise that it is less likely she will exercise her financial independence and autonomy to spend on clean cooking fuel which perceivably benefits ‘only her' and can be ’easily’ replaced with freely available solid fuels. Finally, in the context of the **society**, rules, regulations, and restrictions by which women operate is highly likely to define the degree of and the way in which she will exercise her autonomy and financial independence. For example, restrictions on woman’s movement outside home to marketplace and beyond affects her access to goods and services. Therefore, despite her ‘ability’ to spend on or bargain for clean cooking fuel like LPG, we hypothesise that, difficulty in accessing these services reduces the chances of opting them. In such cases, households prefer to depend on homemade or freely collectable solid fuels.

We test the following hypotheses

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| **Spending decisions*****Hypothesis 1****: Woman with decision-making power enhances the household’s chances of opting clean fuel.****Hypothesis 2****: Woman’s decision-making power if clubbed with her awareness* *(of the health benefits of clean cooking fuel), the odds for the household to use clean cooking fuel will increase* ***Hypothesis 3****: Woman’s decision-making power have lesser odds to translate into clean fuel choice if the husband controls her.****Hypothesis 4****: If woman who have decision making power also have the freedom to travel to the market and beyond will increase the household’s chances of opting clean cooking fuel.***Financial Independence*****Hypothesis 1****: If the woman of the house is financially independent, it improves the household’s odds of opting clean cooking fuel.****Hypothesis 2****: If a financially independent woman is also aware of the health problems caused due to burning solid fuels, the odds of the household to use clean cooking fuel will improve further* ***Hypothesis 3****: A financially independent woman is less likely to improve the household’s chances of opting clean cooking fuel further if her husband controls her.****Hypothesis 4****: If had the freedom of unrestricted movement outside the house, a financially independent woman can further increase the household’s chances of opting clean cooking fuel.* |

## Improvement in opportunity cost of women’s time

Time spent by woman away from home on productive activities, is expected to increase the chances of opting clean cooking fuel [14]. However, ‘improvement’ in the opportunity cost of women’s time is contingent on the nature of employment, especially comprising of two components- time spent on employment activities and mode of payment for her work.

### Time

Yearlong engagement in employment activities sends strong signals about woman’ s time use away from home and her unavailability to take up time intensive household chores. In such a case, woman’s labour to collect and maintain solid fuels is unavailable thus household is likely to use less cumbersome cooking technologies like LPG. However, if the woman is engaged in employment activities occasionally or seasonally, i.e., when her labour and time for the major part of the year is ‘free’ and ‘available’, households are unlikely to make a permanent shift towards time-saving cooking technologies.

### Pay

Monetary emoluments for woman’s work are a visible indicator of her contribution to the household economy. Therefore, women engaged in employment activities that rewards in cash is highly likely to be relieved from the drudgery of collecting and using solid fuels for cooking. On the other hand, if the woman is not paid in cash for their work i.e., receiving payment in kind, or not at all (lending labour for family-owned business or working on own agriculture land without pay), it is unlikely that the choices will be made to free her from the drudgery of labour-intensive cooking processes.

We test the following hypotheses

***Hypothesis 1****:* *Households where women work year-long has higher chances to use clean fuel as opposed to household were women work occasionally or seasonally*.

***Hypothesis 2***: *Households where women are engaged in yearlong paid work have better odds to use clean cooking fuel than those households where women don’t get paid in cash for their yearlong work.*

Household choice of fuel

 Nature of employment

Time

*(consistently/occasionally)*

Pay

*(cash/kind)*

Women Empowerment

Participation in household spending

Financial Independence

Improved Opportunity Cost of Time

Context

Individual

*(Awareness)*

Household

*(Gender relations)*

Society

*(Freedom of movement)*

**Figure 2: Analytical Framework of the Study**

# Data and Methodology

## Data

 The data source for this study is National Family Health Survey (NFHS). Though primarily focuses on the health and related indicators, NFHS also provides information on social (religion and caste) economic characteristics (a wealth score is calculated based on ownership of few major assets and appliances), amenities like housing, water, electricity, cooking fuel, and sanitation. Information about age, education attainment, access to media, employment, mode of payment of the household members is also available. Most importantly, for this study, survey provides clues for studying women empowerment through gender relations, spousal violence, employment and earning, ownership of assets, intra household bargaining power among others.

In this study, we conduct analysis at two points of time 2015-16 and 2019-21 by using two rounds of NFHS data- NFHS-4 (conducted between January 2015 to December 2016) and NFHS-5 (conducted between June 2019 to April 2021) [1,30]. These two time periods mark the completion of the first five years of implementation of Pradhan Mantry Ujwal Yojna. Examining the gendered dynamics in the household’s cooking fuel choice pre and post key policy intervention is one of the major contributions of the study and, to our knowledge, first of its kind, especially using large sample national survey like NFHS. This exercise is crucial in establishing the relevance of gender dynamics in the household’s choice of *using* cooking fuel even after the economic based policy intervention eased *owning* it.

Since solid fuel usage is disproportionately high among the rural households, present study solely focuses on them. Further, keeping in view the objectives and analytical framework of the study, the model considers the sample of households comprising of eligible women[[2]](#footnote-2) who are presently married and selected to be interviewed for domestic violence module. Only this selected sample are questioned about components that are relevant to this study. For example, “who makes a decision of large household purchases?” “Who decides how to spend husband’s earnings” “are you allowed to go to the market?” and other “control” questions. The sample size[[3]](#footnote-3) of NFHS-4 and NFHS-5 is 45033 and 46340 respectively.

## Variable Definitions

Definitions of all the variables are given in the table 1.

### Dependent variable

The dependent variable is a binary variable that indicates weather the household uses clean fuel (that takes the value 1) as main source of cooking or not (taking the value 0).

### Independent variables

1. Women’s **participation in household spending** is measured as a combination of her involvement in large household purchases and her say on spending of husband’s earnings. Studies often considered women’s participation in large household purchases as an indicator of her bargaining power [6] . We argue that this is only a partial indicator as far as cooking fuel is considered. Unlike one-time large household purchases like appliances, vehicle, furniture etc, spending on clean fuel like LPG or electricity for cooking will affect the monthly budget of the household. Woman’s participation in occasional purchases reveal little about her say on how household resources are spent on day-to-day needs. To account for this, the woman of the household is considered to participate in household spending only if she also has a say in her husband’s earnings. This is a binary variable that takes value 1 if both the conditions are satisfied and 0 otherwise.
2. A woman is **financially independent** if she has money that either she alone can decide how to spend or has bank or savings account that she can use. This too is a binary variable that takes value 0 or 1. Use of services like clean cooking fuel like LPG involves cash transactions and therefore woman’s access to ready cash, rather than ownership of assets, is likely to determine her autonomy and readiness to choose clean cooking fuel.
3. **Contexts**: Woman’s access to media is a considered as a proxy of her **awareness**. Especially newspaper and radio could be sources of information on health damages caused due to smoke-filled kitchens, range of health problems to children if they are exposed to indoor air pollution. This is a dichotomous variable that takes value 1 if the respondent accesses newspaper or radio at least once a week and 0 otherwise. **Husband’s distrust or control**of wife is a cumulative score calculated based on the number of times the respondent answered ‘yes’ to six questions depicting husband’s distrust or control he exerts on the wife. The value of the score ranges from 0 to 6. Finally, if women are not restricted to travel to the market and outside the village alone then the variable **mobility**takes the value 1 and 0 if not. As we examine empowerment indicators in these three contexts, we use interactive variables i.e., interaction of the *indicator* and *context*.
4. **Women’s opportunity cost of time** Here we examine the two components of employment -*time* and *mode of payment*. Weather she is engaged in employment throughout the year/not, and engaged in employment throughout the year for cash/not. For both these components, the independent variable is a dichotomous variable that takes value 1 or 0.
5. **Control variables**: Following are the indicator specific control variables. As we examine the association between women’s financial independence and clean cooking fuel, we want to isolate the effect of her unrestricted ability to spend on periodical expenditure such as cooking fuel (due to access to ready cash) from her general ‘financial strengths’- ownership of assets and earnings. By doing do so, we remove the possible influence of the bargaining power, accrued to women due to the ownership of assets, which could influence the household outcomes[31] Therefore, the model controls for ownership of assets like land and/or house and her earnings in cash.

The other indicator specific control variable is with respect to the improved opportunity cost of woman’s time. In order to isolate the association between the time component of the women’s employment and the choice of fuel, the model controls for two effects- mode of payment and employer. By controlling for the mode of payment for woman’s work, we remove influence of the monetary benefits component of her work on the model. If the woman is paid in cash, it will improve her chances of bargaining for clean fuel thereby the association between time spent away from home and the household’s choice of fuel becomes unclear. Value of the time women spend on employment activities is partly determined by whom she is working for i.e., whom she is spending time working for. A woman might be engaged in working for the family (on family-owned business, on family-owned agriculture land) or self-employed or working for somebody else. On the one hand, working forthe family is often considered merely as one of her many responsibilities, thus her engagement in employment activities does not have to necessarily lead to freeing up her time from labour intensive cooking processes. On the other, a woman’s time might be valued better if she is considered contributingto the family-owned enterprise/agricultural activity over working for someone else or self-employed therefore the household is likely to opt for less time-intensive cooking processes. Either way whom she is working for influences the household’s perception of usefulness of her time spent on employment activities outside the house, which in turn dictates the choice of fuel. Therefore, in the model we control for whom the respondent works for.

## Methodology

We conduct binary logit model. Let U\* be the maximum attainable utility the household gets by adopting one of the two choices of energy- clean and unclean cooking fuel. *U\*ij* as the realised utility that a household *I* gets by choosing particular choice *j*. Stochastic utility of the i*th* household faced with *j*(=1 or 0) choices is

U\*ij = βi.Xi+βiYi+εij …(1)

Xi represents variables representing empowerment indicators of the woman of the given household i. Yi is a set of other explanatory variables controlling for individual, household and regional characteristics. If the household makes choice j=1 or j=0, then we assume that U\*ij is the maximum among the J pay-offs. Hence, the statistical model is driven by the probability that choice j=1 is made, such that Pi1=Prob(U\*i1>U\*i0). Our interest is to predict the probability Pi1.We assume that the logit L is a linear explanation

Li= βi.Xi+βiYi …(2)

Equation 2 is expanded according to the empowerment indicator or indicator context interactive variable, depending on the model. Other than the control variables discussed in the section 4.2.2, we controlled the model for other factors that might influence the choice of fuel. General socio-economic characteristics of the household like the State it is situated in, economic status of the household, social factors like religion and caste the household belongs to, household size i.e., number of members in the household. Other control variables include characteristics of woman like her age, her education.

### Organisation

The models pertaining to spending decision and financial independence are conducted in two phases. First, is the association between the indicator and fuel choice. Second, is the association between the indicator and the household’s fuel choice in each of the three contexts- individual, family and society. The model depicting the relationship between the improved opportunity cost of woman’s time and the household fuel choice is run in two parts. First, in order to examine the association between time spent on employment activities and the household’s choice of cooking fuel we consider only those households where women are engaged in employment activities. Second, we examine the relationship between the type of pay among the woman engaged in yearlong work and the household’s choice of cooking fuel. In this case the sample includes only those households that reported to be engaged in employment activities throughout the year.

Economic status is one of the major factors that determines the household’s expenditure on cooking fuel. Further, gender factors operate differently across economic classes. Across and within countries, gender gaps widen at lower incomes,, and, in the poorest economies, gender gaps are larger [25]. Therefore, we examine the association between women’s agency and the choice of cooking fuel across broad economic categories. We carry out analysis for three wealth groups- poor, middle income and rich and two time periods (pre and post PMUY). See Table 2 for summary statistics.

# Results

At the outset woman empowerment, has a significant association with households using clean cooking fuel. Returning to the questions we set to answer in this paper: Do all the factors that improve women’s agency increase the household’s chances of using clean cooking fuel? No, all the three women empowerment indicators do not have positively significant association with the household’s choice of clean cooking fuel across all the wealth groups.

Second: does improvement in the woman’s status trump all economic and socio-cultural hindrances to use clean cooking fuel? knowledge and awareness, ‘sticky’ social norms and economic inequalities dictate the degree to which women empowerment translates into smokeless kitchens. Figures 3-6 present the household’s odds to use clean cooking fuel. See appendix for the detailed results of the model.

Financial independence-woman’s access to cash which she can spend at her will- notably improves the household’s odds to use clean cooking fuel. Among the poorest, of all the wealth groups, the odds for clean fuel significantly improves if the woman has access to ready cash. As expected, the contexts in which women exercise their agency determines the household’s odds to use clean cooking fuel[[4]](#footnote-4). If a financially independent woman is aware of the health problems caused by burning solid fuels, it improves the household’s odds of using clean fuel by many points than having access to cash but unaware of the hazards of burning solid fuels. As far as gender relations are concerned, with every one unit increase in the distrustscore, the chances of a financially independent woman promoting the use of clean cooking fuel falls. These results i.e., association between women’s financial independence operated at favourable/unfavourable individual and household contexts and the household’s choice of fuel, are applicable to all the wealth groups pre and post PMUY. The third context i.e., freedom to move had varying impact across the wealth groups and between two time periods. Freedom to travel to the market and outside the village does not influence the odds of the poor households to use clean fuel in the first period. However, in the second period woman’s freedom to travel improves the household’s chances of using clean fuel by 2 points.

Women’s participation in household spending too significantly improves the chances for clean cooking fuel. While this is true in the case of middle and rich wealth group in both the periods, it is true for the poor households only post PMUY (though statistically significant at 10 percent). It is possible that, when PMUY eased the ownership of expensive clean cooking equipment- LPG connection and the stove- among the poor, only then women’s intra household bargaining power could influence the households to subsequently invest in refilling the cylinders. PMUY, in a way, is a threshold for the poor households to *access* clean cooking fuel but *using* it is still dependent on women’s agency. Again, the context in which women’s agency is exercised significantly altered the household’s chances of using clean fuel. Among women who have a say in the household spending, awareness improves the chances for clean fuel by many folds compared to those who are unaware. As expected, as the distrust score increases, even though the wife reports to participate in household spending, the odds for clean cooking fuel diminishes. Restrictions (or not) to travel among the women who participate in spending decisions, too influences the odds for clean cooking fuel. It is interesting to observe that post PMUY, unrestricted travelling to market and outside the village significantly improves the chances for using clean fuel among the poor households. This is in fact in tandem with what has been observed at the ground level where women reported that though PMUY facilitated owning an LPG connection and a stove, they are not able to use it consistently since they must often rely on their male relatives to travel to nearby towns for its refill.

As anticipated improvement in opportunity cost of women’s time has a positive association with the household’s choice of clean cooking fuel. Household’s where woman work throughout the year, as opposed to working occasionally or seasonally improve the household’s chances of using clean fuel. However, this positive association is not uniform across the wealth groups. Among the poor households, woman’s engagement in employment activities throughout the year does not promote the use of less-labour intensive cooking technologies. Paid work, in contrast to working for kind or no pay, improves the chances for clean fuel. We observed this positive association across all the wealth groups pre PMUY (though, statistically significant only at 10 percent among the poor households). However, post PMUY, being engaged in paid work, does not promote usage of clean fuel among the poor households. During this period, LPG refill cost is disproportionately higher than the wage rates among rural woman. While the subsidised LPG refill cost between 2015-16 and 2020-21, increased by 65% [32], the average daily wage among rural women increased only by 28%[[5]](#footnote-5) [33]. Therefore, it is possible that women’s time away from home for relatively meagre earnings is unlikely to encourage a poor household to opt clean cooking fuel.

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| Figure 3:Women empowerment and household’s odds to use clean cooking fuel (2015-16 and 2019-21) |

Figure 4:Women's Financial Independence in three contexts: Individual, Household and Society and Household’s choice of cooking fuel: Odds Ratio



Note: black dots are placed on the bars to indicate that these results are statistically insignificant

Figure 5: Women's Decision to spend in three contexts: Individual, Household and Society and Household’s choice of cooking fuel: Odds Ratio

Figure 6: Women’s Improved Opportunity Cost of Time and Household’s choice of cooking fuel: Odds Ratio

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Note: black dots are placed on the bars to indicate that these results are statistically insignificant

# Robustness check

## Robustness check I

To be sure that the above observed results confirm the gendered nature of cooking fuel choice and does not reflect unobserved differences between the households, we conducted a placebo test similar to the one conducted by [34]. We estimated equation 1 (section 4.3) with two sets of household goods instead of cooking fuel. One set of goods that is of common interest to the household- TV and fridge and the second one is vehicle (two-wheeler and or car/truck) generally used by men (rather than women) in rural India. Unlike what has been hypothesised and proved in case of cooking fuel, we do not expect women empowerment to have positive association with household’s choice of owning appliances or vehicle. Women’s access to ready cash aids in procuring goods and services that benefits the household members (especially children) and her (like cooking fuel) and less likely on the general material wealth of the household. Similarly, women’s intra household bargaining power is less likely to be used to negotiate for household goods that do not accrue welfare to the household.

## Robustness check II

Woman’s employment and choice of cooking fuel are interlinked and can work both ways. That is woman of the household spending long hours away from home on employment activities throughout the year might encourage the household to use less labour-intensive cooking processes i.e., clean cooking fuel. However, at the same time, less labour-intensive cooking process might free up time for woman to engage in employment activities consistently throughout the year. This poses a simultaneity bias in our analysis while we examine the association between improvement in opportunity cost of woman’s time and choice of clean fuel. To address this challenge, we conducted an exercise to prove that the average time spend cooking does not (statistically) differ for the woman engaged in two different employment options- work occasionally/seasonally or year-long, thereby negating the possible impact of (less/more) of cooking time on woman’s employment options. To conduct this exercise, we employed Time Use Survey (2019) [35]. The sample consists of currently married woman who are engaged in employment activities. A t-test is conducted on the total time spent on meal preparing and related activities by two groups of employed women- women who are engaged in employment activities throughout the year and those who work occasionally/seasonally. Table 9 and 10 presents the results for the robustness check.

## Robustness check results

Women’s access to ready cash or her bargaining power is not associated with the household owning household appliances or vehicle. This is in contrast to what we have observed in case of clean cooking fuel. This differentiated association between women empowerment indicators, and cooking fuel and other household own goods confirms our hypothesis of strong interlinkages between women’s agency and cooking fuel that eventually has a bearing on her labour, time, and health.Also,the t-test confirms that the average time spent on meal making and related activities by the two groups of women- those engaged in yearlong employment activities or seasonally or occasionally- is not statistically different. This indicates that less/more time spent cooking (due to less/more labour-intensive cooking technologies) does not necessarily influence woman’s employment choices thus negating the simultaneity issue.

# Conclusion and Discussion

In this paper we have shown that households in which woman has access to cash, partake in the household spending decisions and have the advantage of better opportunity cost of her time, have better odds of using clean cooking fuel. It is important to note that, this is true for both the time periods-pre and post PMUY. This reiterates our argument that usage of clean cooking technologies rests on the woman of the household and continue to do so even when a policy intervention eases the ownership of the said technologies. Furthermore, we proved that policy that limits [36] to providing LPG connections in the woman’s name offers very little in terms of making meaningful connection between gender and clean cooking fuel. Our analysis also passed robustness check for the potential endogeneity.

Following are a few key contributions of the paper. Unlike the prior studies, the present study observes that the association between women empowerment indicators and using clean cooking fuel is not uniform across different wealth groups. For example, while the woman’s yearlong engagement in employment activities have a statistically significant association with clean cooking fuel among the middle and rich-income class, it is irrelevant among the poor. Instead, it is woman’s access to ready cash that improves the odds for using clean fuel among the poor. Identifying this differentiated association is relevant from the policy point of view. Though studies propose policies to promote clean cooking fuel via boosting women’s agency, it is crucial to recognise that the success of such policies lie in targeting specific inequalities backed by the knowledge of gender dynamics at play among different economic classes.

Second, the study establishes the relevance of less/more favourable (individual, household, and society) contexts in determining the degree to which women empowerment translates into a desirable household outcome. Regular access to media improves women’s awareness of the benefits of clean cooking fuel as well as about related schemes/policies. Similarly, women who are free to travel to market and outside the village has better access to urban centric LPG distribution system. In our paper we observed that women who exercise their agency in these favourable circumstances are more likely to bargain for and/or use clean fuel, as opposed to those who do not. The study also brings forth the stickiness of socio-cultural factors that limits the degree to which women’s agency manifests into a clean fuel choice. For example, we found that a distrusting (or a controlling) husband lessens the chances of a financially independent woman to bargain for and/or spend on clean cooking fuel. In such a case, a cash transfer policy to encourage her to spend on clean fuel, is unlikely to yield desired results. Our study reiterates the observations made by Kabeer’s influential study on State’s policies and women empowerment [37] “These various interventions (for women empowerment) are simply different entry points into this larger project, each with the potential for social transformation, but each contingent on context, commitment and capacity if this potential is to be realised”

Following the above observations, the study offers two interlinked policy lessons. First, policies set to improve women’s agency thereby improve the odds for the desirable household outcomes must acknowledge the limits to this association. That is limits of women empowerment in overcoming sticky, habitual and persistent economic constraints, and social norms. Women, therefore, should be eased of the burden to exercise their agency in the face of challenging and unrelenting structures to bargain for, spend on and consistently use clean cooking fuel. Therefore, secondly, a supportive system must be set up comprising of necessary demand- *knowledge and awareness* and supply- *better access to the fuel and resources to spend on-* networks to escalate the odds of woman’s agency to translate into smokeless kitchens. For example, In the wake of high fuel costs or if households fall on hard times, women’s agency and their choices to spend on clean cooking fuel could meet with significant resistance. Allocating a lump sum amount even for subsidized LPG cylinders might be difficult in some cases. A micro-payment scheme, accessed and managed by small groups of women (akin to self-help groups), for the clean cooking fuel program could be helpful. It would reduce the burden of high refilling costs and help to build a social setting that promotes clean fuel.

The two major take aways of this study- *policies based on the* *knowledge of varying gender dynamics at play at different economic classes* and *creating a set up to circumvent/override sticky social norms-* are evident, implementable, and assessable at a decentralised level. Top-down, large scale, national level policies are unlikely to successfully integrate gender component in clean cooking policies.

**Table 1: Variable Definitions**

|  |  |  |
| --- | --- | --- |
| **Sl. No** | **Variable** | **Definition** |
| 1 | **Clean cooking fuel** | Clean cooking fuel=1 if cooking fuel is electricity/ LPG/biogas and 0 if cooking fuel is coal, lignite, charcoal, wood, straw/shrub/grass, agricultural crop, animal dung, kerosene and others |
| 2 | **Financial Independence** | Financial Independence=1 if respondent has access to cash which she alone can decide how to spend or has bank or savings account the respondent can use, 0 otherwise  |
| 3 | **Spending Decision** | Decision=1 if woman part takes in two decisions involving money: decision on household purchases and decision on husbands’ earnings, 0 otherwise |
| 4 | **Improved Opportunity Cost** | Work all year=1 if the woman who reported to work throughout the year and 0 if she works seasonally or occasionally |
| Salaried=1 if the woman who reported to work throughout the year is paid in cash and 0 if not paid or paid in kind. |
| 5 | **Education**  | Education= 1 if the respondent’s highest education level is at least primary education and 0 if the respondent has no education |
| 6 | **Religion (Ref: Hindu)** | Christian, Muslim and Others |
| 7 | **Household size** | Number of the household members |
| 8 | **Age of the woman** | In years |
| 9 | **Financial Strength** | Financial strength=1 if woman either possess assets (land or house) or earn cash for her employment |
| 10 | **Caste (Ref: SC)** | ST, OBC and Others |
| 11 | **Wealth group** | The entire sample is divided into five deciles based on wealth index factor score\*. Poor:1st +2nd deciles, Middle Income:3rd +4th deciles andRich: 5th deciles |
| 12  | **Awareness** | Awareness=1 if women access newspaper or radio at least once a week, 0 otherwise  |
| 13 | **Husband’s distrust/control** | Score ranging from 0-6 depending on the number of times the respondent answered ‘yes’ to six control/trust questions\*\*. |
| 15 | **Mobility** | Mobility=1 if women can go to market and outside the village alone **and** 0 if with someone else or not at all |
| 16 | **Work** | Work=1 if the woman is in workforce and 0 if not |
| 17 | **Work all year** | Work all year=1 if the woman is employed all year and 0 if employed seasonally or occasionally |
| 18 | **Salaried** | Salaried=1 if woman works all year and paid in cash and 0, works all year and not paid in cash |
| 19 | **Employer** | Employer =1 if respondent works for the family and 0 if works for somebody else or self-employed. |

Note: \*: Wealth index score is a composite measure that is calculated using easy-to-collect data on a household’s ownership of selected assets. \*\*” husband/partner jealous if respondent talks with other men” “accuses respondent of unfaithfulness” “does not permit respondent to meet female friends”, “limits contact with family and friends”, “insists on knowing where respondent is”, “doesn’t trust respondent with money”

**Table 2: Summary Statistics in percentage**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Wealth Group1** | **Wealth Group 2** | **Wealth Group 3** | **All** |
|  **Year** **Variables** | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** |
| Clean cooking fuel | 1.31 | 11.16 | 23.47 | 50.79 | 67.06 | 79.57 | 23.28 | 40.69 |
| Financial Independent | 54 | 83.36 | 65 | 88.35 | 76 | 89.77 | 63 | 86.64 |
| Decision maker | 79 | 71.36 | 81 | 70.16 | 83 | 70.08 | 81 | 70.62 |
| Works\* | 41 | 40.75 | 34 | 39 | 25 | 28.67 | 35 | 37.63 |
| Works all year\* | 17 | 18.80 | 18 | 21.80 | 16 | 17.92 | 17 | 19.82 |
| Salaried\* | 13 | 14.53 | 13 | 17.99 | 13 | 14.94 | 13 | 15.99 |
| **Educated** | 40 | 51 | 69 | 72 | 87 | 88 | 61 | 67 |
| **Religion**: Christian | 6.34 | 9.07 | 8.36 | 7.39 | 6.78 | 4.32 | 7.24 | 7.45 |
| Hindu | 79.36 | 75.92 | 74.88 | 77.07 | 73.24 | 75.17 | 76.35 | 76.23 |
| Muslim | 11.13 | 11.35 | 11.84 | 10.80 | 10.44 | 10.27 | 11.28 | 10.91 |
| Others | 3.16 | 3.66 | 4.92 | 4.74 | 9.54 | 10.24 | 5.14 | 5.41 |
| Avg. age of the woman | 32.11 | 33.12 | 32.57 | 33.71 | 33.65 | 34.17 | 32.60 | 33.56 |
| Avg. size of the household | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Caste**: SC | 22.25 | 21.73 | 20.52 | 21.03 | 14.01 | 16.70 | 19.92 | 20.43 |
| ST | 32.18 | 36.31 | 19.53 | 18.57 | 10.00 | 7.35 | 22.75 | 23.33 |
| OBC | 36.20 | 32.77 | 40.22 | 43.47 | 41.99 | 43.57 | 38.95 | 39.26 |
| Others | 9.38 | 8.46 | 19.73 | 16.38 | 33.99 | 32.06 | 18.38 | 16.41 |
| Awareness | 5.18 | 3.51 | 5.11 | 8.86 | 5.23 | 20.23 | 5.16 | 8.99 |
| Average control score\*\* | 1.41 | 1.24 | 1.02 | 1.03 | 0.82 | 0.83 | 1.13 | 1.08 |
| Free to travel | 38.70 | 45.24 | 43.82 | 45.69 | 49.14 | 47.56 | 42.83 | 45.88 |
| Assets | 49.00 | 44.90 | 44.66 | 41.79 | 40.20 | 38.62 | 45.51 | 42.40 |
| Sample Size | 18032 | 18536 | 18036 | 18536 | 8965 | 9268 | 45033 | 46340 |

Note: A: 2015-16 and B:2019-21. \*: As a percentage of entire sample \*\*: As a percentage of woman who reported to work.

 \*\*: Score ranges from 0-6.

# Appendix

Table :: Odds ratio of the association between women’s Financial Independence and household’s choice of clean cooking fuel (2015-16)

|  | **Financial Independence** | **Financial Independence in three contexts:** *Individual, household and Society* |
| --- | --- | --- |
|  | **I** | **Awareness** | **Control** | **Movement** |
|  | **II** | **III** | **IV** |
| **Wealth Group** | **1** | **2** | **3** |  | 1 | **2** | **3** | **1** | **2** | **3** |  | **1** | **2** | **3** |
| **Financial Indicator** | 1.48\*\*\*(2.51) | 1.27\*\*\*(4.98) | 1.39\*\*\*(5.41) | **No** | 1.53\*\*(2.52) | 1.24\*\*\*(4.02) | 1.38\*\*\*(4.37) | 0.98(-0.30) | 1.04\*\*(2.42) | 1.03(1.07) | **No** | 1.18(0.89) | 1.18\*\*\*(2.76) | 1.35\*\*\*(3.87) |
| **Yes** | 1.80\*\*(2.14) | 1.57\*\*\*(6.34) | 1.92\*\*\*(7.84) | **Yes** | 1.32(1.48) | 1.45\*\*\*(6.07) | 1.44\*\*\*(4.57) |
| **Religion** Christian | 1.35(0.64) | 0.91(-0.71) | 1.11(0.60) | 1.34(0.62) | 0.91(-0.73) | 1.10(0.57) | 1.18(0.32) | 0.90\*\*\*(-0.83) | 1.09(0.52) | 1.35(0.63) | 0.92(-0.68) | 1.11(0.60) |
| Muslim | 0.94(-0.38) | 1.51\*\*\*(5.18) | 1.66\*\*\*(4.67) | 0.89(-0.41) | 1.51\*\*\*(5.12) | 1.65\*\*\*(4.66) | 0.87(-0.51) | 1.49\*\*\*(4.86) | 1.61\*\*\*(4.39) | 0.90(-0.37) | 1.53\*\*\*(5.29) | 1.66\*\*\*(4.68) |
| Others | 1.91(1.58) | 1.66\*\*\*(4.52) | 1.57\*\*\*(3.52) | 1.91(1.57) | 1.64\*\*\*(4.42) | 1.58\*\*\*(3.59) | 2.09\*(1.79) | 1.73\*\*\*(4.79) | 1.59\*\*\*(3.61) | 1.92(1.59) | 1.66\*\*\*(4.52) | 1.57\*\*\*(3.53) |
| Educated | 1.34\*(1.92) | 1.02\*(1.82) | 1.49\*\*\*(4.72) | 1.32\*(1.75) | 1.06(1.15) | 1.35\*\*\*(3.46) | 1.34\*(1.85) | 1.12\*\*(2.12) | 1.48\*\*\*(4.55) | 1.34\*(1.88) | 1.09\*(1.76) | 1.49\*\*\*(4.66) |
| HH size | 0.83\*\*\*(-4.24) | 0.84\*\*\*(-15.16) | 0.83\*\*\*(-15.22) | 0.84\*\*\*(-4.25) | 0.83\*\*\*(-15.2) | 0.83\*\*\*(-15.1) | 0.83\*\*\*(-4.25) | 0.83\*\*\*(-15.21) | 0.83\*\*\*(-15.0) | 0.83\*\*\*(-4.35) | 0.84\*\*\*(-15.1) | 0.83\*\*\*(-15.2) |
| Age of the woman | 1.00(1.11) | 0.99(-0.49) | 1.00\*(1.78) | 1.011(1.13) | 0.99(-0.51) | 1.00\*(1.75) | 1.01(1.27) | 1(-0.14) | 1.00\*(1.78) | 1.01(1.25) | 0.99(-0.99) | 1.01(1.62) |
| Caste (Ref: OBC) SC | 0.83(-1.04) | 0.91(-1.59) | 1.63\*\*\*(5.58) | 0.818(-1.08) | 0.90(-1.57) | 1.62\*\*\*(5.51) | 0.85(-0.84) | 0.88\*(-1.95) | 1.68\*\*\*(5.88) | 0.83(-1.03) | 0.91(-1.60) | 1.63\*\*\*(5.57) |
| ST | 0.95(-0.20) | 1.28\*\*\*(3.16) | 1.17(1.32) | 1.00(-0.22) | 1.27\*\*\*(3.04) | 1.15(1.10) | 0.97(-0.14) | 1.33\*\*\*(3.55) | 1.17(1.30) | 0.95(-0.20) | 1.28\*\*\*(3.14) | 1.18(1.32) |
| Others | 0.81(-0.79) | 1.07(1.07) | 1.22\*\*\*(3.02) | 0.81(-0.78) | 1.06(0.95) | 1.20\*\*\*(2.82) | 2.09\*(1.79) | 1.06(0.91) | 1.24\*\*\*(3.21) | 0.82(-0.81) | 1.07(1.06) | 1.22\*\*\*(3.01) |
| Paid in cash | 0.68(-1.48) | 1.05(0.74) | 1.14(1.43) | 0.68(-1.47) | 1.05(0.65) | 1.12(1.18) | 0.66(-1.54) | 1.08(1.11) | 1.17\*(1.17) | 0.67(-1.50) | 1.03(0.43) | 1.14(1.37) |
| assets | 1.22(1.21) | 0.96(-0.73) | 1.02(0.34) | 1.21(1.14) | 0.95(-0.93) | 1.00(0.05) | 1.23(1.21) | 0.96(-0.71) | 1.01(0.23) | 1.22(1.17) | 0.96(-0.74) | 1.02(0.33) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -954.33 | -7116.52 | -4338.29 | -953.47 | -7108.47 | -4321.52 | -918.53 | -6784.84 | -4221.37 | -951.32 | -7108.39 | -4337.77 |
| LR χ2  | LRχ2 (35)= 343.85 | LRχ2 (50)= 3992.11 | LRχ2 (48)=2206.37 | LRχ2 (35)= 345.85 | LRχ2 (50)= 4008.21 | LRχ2 (48)= 2239.92 | LRχ2 (36)= 345.02 | LRχ2 (51)= 3992.11 | LRχ2 (49)= 2109.55 | LRχ2 (37)= 350 | LR chi2(52) = 4008.36 | LR chi2(50) = 2207.41 |
| Sample Size | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 |

Table :: Odds ratio of the association between women’s Decision making and household’s choice of clean cooking fuel (2015-16)

|  | **Decision making** | **Decision making in three contexts: Individual, household and Society** |
| --- | --- | --- |
|  | **Awareness** | **Control** | **Movement** |
|  | I | II | III | IV |
| Wealth Group | 1 | 2 | 3 |  | 1 | 2 | 3 | 1 | 2 | 3 |  | 1 | 2 | 3 |
| **Decision making** | 1.01(0.06) | 1.18\*\*\*(2.85) | 1.18\*\*(2.31) | **No** | 1.08(0.42) | 1.18\*\*(2.55) | 1.22\*\*(2.27) | 0.95(-0.93) | 1.03\*(1.85) | 1.00(0.06) | **No** | 0.94(-0.24) | 1.20\*\*(2.52) | 1.14(1.50) |
| **Yes** | 1.30(0.91) | 1.46\*\*\*(4.88) | 1.73\*\*\*(5.81) | **Yes** | 0.95(-0.23) | 1.44\*\*\*(5.02) | 1.28\*\*(2.71) |
| **Religion** Christian | 1.33(0.60) | 0.91(-0.79) | 1.09(0.54) | 1.34(0.61) | 0.90(-0.84) | 1.09(0.54) | 1.19(0.33) | 0.89(-0.83) | 1.09(0.53) | 1.36(0.65) | 0.90(-0.80) | 1.11(0.56) |
| Muslim | 0.90(-0.37) | 1.50\*\*\*(5.09) | 1.61\*\*\*(4.47) | 0.90(-0.39) | 1.49\*\*\*(5.00) | 1.61\*\*\*(4.46) | 0.88(-0.45) | 1.49\*\*\*(4.77) | 1.59\*\*\*(4.26) | 0.92(-0.31) | 1.52\*\*\*(5.24) | 1.62\*\*\*(4.50) |
| Others | 1.92(1.59) | 1.66 \*\*\*(4.53) | 1.56\*\*\*(3.47) | 1.92(1.58) | 1.66\*\*\*(4.48) | 1.57\*\*\*(3.55) | 2.06\*(1.75) | 1.73\*\*\*(4.83) | 1.58\*\*\*(3.59) | 1.91(1.58) | 1.68\*\*\*(4.59) | 1.55\*\*\*(3.47) |
| Educated | 1.39\*\*(2.12) | 1.12\*\* (2.12) | 1.54\*\*\*(5.09) | 1.35\*(1.94) | 1.08(1.42) | 1.38\*\*\*(3.75) | 1.35\*\*(1.92) | 1.13\*\*(2.19) | 1.50\*\*\*(4.73) | 1.39\*\*(2.14) | 1.11\*\*(2.00) | 1.53\*\*\*(5.05) |
| HH size | 0.83\*\*\*(-4.34) | 0.83\*\*\* (-15.17) | 0.83\*\*\*(-15.29) | 0.83\*\*\*(-4.40) | 0.84\*\*\*(-15.21) | 0.83\*\*\*(-15.23) | 0.84\*\*\*(-4.23) | 0.83\*\*\*(-14.99) | 0.83\*\*\*(-14.96) | 0.83\*\*\*(-4.33) | 0.84\*\*\*(-15.08) | 0.83\*\*\*(-15.27) |
| Age  | 1.01(1.35) | 0.99(-0.34) | 1.00\*(1.95) | 1.01(1.37) | 0.99(-0.16) | 1.00(2.10) | 1.01(1.24) | 1.00\*(2.29) | 1.00\*\*(1.98) | 1.01(1.24) | 0.99(-0.78) | 1.01\*(1.94) |
| Caste (Ref: OBC) SC | 0.83\*\*\*(-1.34) | 0.90\*(-1.67) | 1.63\*\*\*(5.59) | 0.82(-1.07) | 0.91(-1.58) | 1.63\*\*\*(5.63) | 0.84(-0.92) | 0.88\*\*(-1.90) | 1.68\*\*\*(5.85) | 0.82(-1.09) | 0.91(-1.57) | 1.63\*\*\*(5.57) |
| ST | 0.95(-0.19) | 1.29\*\*\*(3.23) | 1.18(1.36) | 0.95(-0.22) | 1.28\*\*\*(3.16) | 1.16(1.17) | 0.96(-0.15) | 1.34\*\*\*(3.63) | 1.18(1.31) | 0.96(-0.19) | 1.29\*\*\*(3.26) | 1.19(1.43) |
| Others | 0.81(-0.84) | 1.06(1.00) | 1.22\*\*\*(2.97) | 0.80(-0.87) | 1.05(0.85) | 1.20\*\*\*(2.71) | 0.81(-0.82) | 1.05(0.85) | 1.23\*\*\*(3.11) | 0.81(-0.82) | 1.06(0.99) | 1.21\*\*\*(2.89) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -960.12 | -7128.07 | -4354.63 | -958.71 | -7120.03 | -4334.88 | -992.67 | -6790.23 | -4231.07 | -959.92 | -7117.31 | -4352.96 |
| LR | LR chi2(32)= 332.28 | LR chi2(47)= 3968.99 | LR chi2(45)= 2173.69 | LR chi2(34)= 335.11 | LR chi2(49) =3985.08 | LR chi2(47) =2213.20 | LR chi2(33) = 336.70 | LR chi2(48)= 3713.75 | LR chi2(46)= 2090.16 | LR chi2(34)= 332.69 | LR chi2(49))= 3990.52 | LR chi2(47)= 2177.04 |
| Sample Size | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 | 18,032 | 18,036 | 8965 |

Table 5: Odds ratio of the association between Improved Opportunity Cost and household’s choice of clean cooking fuel (2015-16)

|  | **Yearlong Work** | **Yearlong Paid Work** |
| --- | --- | --- |
| **Wealth Group** | **1** | **2** | **3** | **1** | **2** | **3** |
| OC Indicator | 1.30(0.99) | 1.18\*\*(2.17) | 1.29\*\*(2.13) | 2.91\*(1.85) | 1.35\*\*(2.32) | 1.75\*\*\*(3.32) |
| Work for family | 0.78(-0.78) | 1.02(0.20) | 0.93(-0.54) |  |  |  |
| Paid in Cash | 0.13(0.37) | 1.28\*\*\*(2.64) | 1.82\*\*\*(4.69) |  |  |  |
| **Religion** Christian | 1.26(0.31) | 0.85(-0.77) | 0.96(-0.13) | 2.03(0.64) | 0.78(-0.84) | 1.06(0.16) |
| Muslim | 1.63(0.79) | 1.10(0.53) | 2.07\*\*(2.46) | 2.23(1.02) | 0.89(-0.46) | 1.95\*(1.88) |
| Others | 1(0.23) | 1.15(1.53) | 1.41(1.30) | 1(0.23) | 1.35(1.19) | 1.7(1.61) |
| Education  | 1.95\*\*(2.40) | 1.15(1.53) | 2.13\*\*\*(4.41) | 1.27(0.60) | 1.38\*\*(2.54) | 2.00\*\*\*(2.85) |
| Household size | 0.86\*(-1.87) | 0.77\*\*\*(-11.32) | 0.81\*\*\*(-7.57) | 0.97(-0.25) | 0.78\*\*\*(-7.65) | 0.82\*\*\*(-5.86) |
| Age  | 0.99(-0.43) | 0.99(-1.07) | 0.99(-0.11) | 0.98(-0.74) | 0.99(-1.50) | 1(0.04) |
| Assets | 1.35(1.12) | 1.08(0.98) | 1.14(1.07) | 1.61(1.24) | 1.06(0.56) | 1.05(0.29) |
| **Caste** SC | 0.95(-0.17) | 1.03(0.37) | 1.42\*(1.95) | 0.89(-0.23) | 1.04(0.25) | 1.311(1.17) |
| ST | 1.23(0.53) | 1.19(1.23) | 1.26(1.05) | 1.75(1.06) | 1.06(0.31) | 1.02(0.07) |
| Others | 0.55(-1.03) | 1.09(0.73) | 1.13(0.85) | 0.95(-0.07) | 1.15(0.87) | 1.02(0.08) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -295.64 | -2332.93 | -1017.55 | -143.39 | -1282.76 | -645.96 |
| LR | LR chi2(28)=119.93 | LR chi2(48)=1720.84 | LR chi2(44) =637.76 | LR chi2(25)=62.80 | LR chi2(46)=1005.89 | LR chi2(42)=359.92 |
| Sample Size | 7353 | 6121 | 2211 | 3059 | 3242 | 1451 |

 Table :Odds ratio of the association between women’s Financial Independence and household’s choice of clean cooking fuel (2019-21)

|  | **Financial Independence** | **Financial Independence in three contexts: Individual, household and Society** |
| --- | --- | --- |
|  | Awareness | Control | Movement |
|  | **I** |  | **II** | **III** | **IV** |
| **Wealth Group** | **1** | **2** | **3** |  | 1 | **2** | **3** | **1** | **2** | **3** |  | **1** | **2** | **3** |
| **Financial Indicator** | 1.36\*\*\*(3.90) | 1.14\*\*(2.40) | 1.21\*\*(2.04) | **No** | 1.33\*\*\*(3.56) | 1.14\*\*(2.29) | 1.21\*(1.89) | 1.06\*\*\*(3.12) | 1.02(1.29) | 0.99(-0.46) | **No** | 1.34\*\*\*(3.09) | 1.05 (0.75) | 1.07 (0.61) |
| **Yes** | 1.41\*\*(2.26) | 1.29\*\*\*(2.96) | 1.60\*\*\*(3.63) | **Yes** | 1.37\*\*\*(3.27) | 1.18\*\*(2.51) | 1.31\*\*(2.38) |
| **Religion** Christian | .866(-0.91) | 1.06(0.52) | 0.83(-0.83) | 0.87(-0.86) | 1.06(0.50) | 0.81-(0.92) | 0.83(-1.18) | 1.09(0.72) | 0.83(-0.79) | 0.86(-0.91) | 1.06(0.54) | 0.82 (-0.87) |
| Muslim | 1.244\*\*(2.15) | 1.27\*\*\*(3.42) | 1.87\*\*\*(4.79) | 1.24\*\*(2.14) | 1.27\*\*\*(3.46) | 1.88\*\*\*(4.85) | 1.22\*(1.93) | 1.27\*\*\*(3.42) | 1.85\*\*\*(4.68) | 1.24\*\*(2.16) | 1.27\*\*\*(3.5) | 1.87\*\*\*(4.80) |
| Others | .768(-1.54) | 1.12(1.04) | 1.13\*\*\*(0.90) | 0.77(-1.55) | 1.11(1.01) | 1.12(0.87) | 0.79(-1.34) | 1.1(0.97) | 1.14 (0.94) | 0.76(-1.55) | 1.11(1.02) | 1.14(0.99) |
| Educated | .978(-0.38) | 1.10\*\*(2.18) | 1.31\*\*\*(2.91) | 0.98(-0.36) | 1.09\*(1.95) | 1.26\*\*(2.48) | 0.97(-0.46) | 1.11\*\*(2.25) | 1.32\*\*\*(2.98) | 0.97(-0.38) | 1.09\*\*(2.11) | 1.30\*\*\*(2.81) |
| HH size | .861\*\*\*(-9.55) | .82\*\*\*(-19.56) | 0.81\*\*\*(-14.91) | 0.86\*\*\*(-9.56) | 0.82\*\*\*(-19.57) | 0.81\*\*\*(-14.88) | 0.86\*\*\*(-9.30) | 0.82\*\*\*(-19.35) | 0.82\*\*\*(-14.53) | 0.86\*\*\*(-9.53) | 0.82\*\*\*(-19.48) | 0.82\*\*\*(-14.72) |
| Age  | .999(-0.25) | .99(-1.41) | 1.00(0.91) | 1.00(-0.26) | 1.00(-1.43) | 1.00(0.86) | 1.00(-0.28) | 1.00(-1.18) | 1.00(0.71) | 0.99(-0.29) | 0.99\*(-1.75) | 1.00(0.49) |
| Caste (Ref: OBC) SC | 1.28\*\*\*(3.62) | 1.25\*\*\*(4.58) | 1.32\*\*\*(2.95) | 1.28\*\*\*(3.63) | 1.25\*\*\*(4.58) | 1.32\*\*\*(2.99) | 1.28\*\*\*(3.55) | 1.26\*\*\*(4.60) | 1.32\*\*\*(2.90) | 1.27\*\*\*(3.61) | 1.25\*\*\*(4.56) | 1.31\*\*\*(2.92) |
| ST | .922(-1.01) | 1.28\*\*\*(3.93) | 1.03(0.19) | 0.92(-1.01) | 1.28\*\*\*(3.92) | 1.04(0.22) | 0.92(-0.96) | 1.29\*\*\*(4.03) | 1.07(0.39) | 0.92(-1.01) | 1.27\*\*\*(3.9) | 1.02(0.12) |
| Others | 1.273\*\*\*(2.61) | 1.16\*\*\*(2.79) | 1.04(0.53) | 1.27\*\*\*(2.60) | 1.16\*\*\*(2.75) | 1.03(0.43) | 1.29\*\*\*(2.68) | 1.16\*\*\*(2.70) | 1.04(0.55) | 1.27\*\*\*(2.61) | 1.16\*\*\*(2.81) | 1.04(0.50) |
| Paid in cash | .972(-0.35) | 1.15\*\*\*(2.72) | 1.29\*\*(2.45) | 0.97(-0.35) | 1.15\*\*\*(2.69) | 1.27\*\*(2.31) | 0.97(-0.38) | 1.16\*\*\*(2.82) | 1.31\*\*(2.52) | 0.97(-0.38) | 1.14\*\*(2.52) | 1.26\*\*(2.24) |
| assets | 1.056(0.84) | 1.00(0.02) | 1.11(1.53) | 1.06(0.86) | 1.00(0.00) | 1.11(1.42) | 1.02(0.29) | 1.00(-0.12) | 1.13 (1.63) | 1.05(0.84) | 0.99(-0.05) | 1.11(1.43) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -5139.30 | -9812.62 | -3487.93 | -5137.95 | -9810.90 | -3482.85 | -4950.44 | -9516.53 | -3378.53 | -5139.23 | -9807.45 | -3483.24 |
| LR | LR chi2(48)=1942.71 | LR chi2(50)= 4950.63 | LR chi2(47) = 2060.26 | LR chi2(50)= 1945.42 | LR chi2(52) = 4954.07 | LR chi2(49) = 2070.42 | LR chi2(49) = 1890.47 | LR chi2(51) = 4802.83 | LR chi2(48) = 1980.99 | LR chi2(50) = 1942.85 | LR chi2(52) = 4960.97 | LR chi2(49) = 2069.64 |
| Sample Size | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 |

Table 7: Odds ratio of the association between Decision and household’s choice of clean cooking fuel (2019-21)

|  | **Decision making** | **Decision making in three contexts: Individual, household and Society** |
| --- | --- | --- |
|  | Awareness | Control | Movement |
|  | **I** | **II** | **III** | **IV** |
| **Wealth Group** | **1** | **2** | **3** |  | 1 | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| **Decision** **making** | 1.11\*(1.82) | 1.11\*\*\*(2.61) | 1.09(1.25) | **No** | 1.12\*\*\*(1.93) | 1.11\*\*\*(2.61) | 1.03(0.46) | 1.05\*\*\*(2.81) | 1.03\*\*(2.06) | 0.99(-0.43) | **No** | 1.07(0.87) | 1.16\*\*\*(3.00) | 1.09(1.08) |
| **Yes** | 1.05(0.36) | 1.24\*\*\*(2.66) | 1.54\*\*\*(3.70) | **Yes** | 1.13\*(1.62) | 1.23\*\*\*(4.13) | 1.30\*\*\*(2.97) |
| **Religion** Christian | 0.87(-0.90) | 1.05(0.66) | 0.83(-0.81) | 0.87(-0.90) | 1.05(0.41) | 0.82 (-0.89) | 0.82(-1.19) | 1.08(0.66) | 0.83(-0.79) | 0.87(-0.90) | 1.05(0.44) | 0.82(-0.86) |
| Muslim | 1.24\*\*(2.13) | 1.26\*\*\*(3.33) | 1.82\*\*\*(4.62) | 1.24\*\*(2.13) | 1.27\*\*\*(3.37) | 1.84\*\*\*(4.70) | 1.23\*\*(2.00) | 1.27\*\*\*(3.35) | 1.81\*\*\*(4.54) | 1.24\*\*(2.15) | 1.27\*\*\*(3.40) | 1.84\*\*\*(4.68) |
| Others | 0.77(-1.53) | 1.12 (1.04) | 1.16(1.11) | 0.77(-1.5) | 1.11(1.02) | 1.15 (1.05) | 0.79(-1.36) | 1.11 (0.98) | 1.17(1.14) | 0.77(-1.53) | 1.11(1.01) | 1.17(1.16) |
| Educated | 0.99(-0.14) | 1.10\*\*(2.15) | 1.32\*\*\*(3.00) | 0.99(-0.14) | 1.09\*\*(1.92) | 1.27\*\*(2.53) | 0.98(-0.40) | 1.10\*\*(2.20) | 1.33\*\*\*(3.02)  | 0.99(-0.15) | 1.10\*\*(2.13) | 1.31\*\*\*(2.87) |
| HH size | 0.86\*\*\*(-9.59) | 0.82\*\*\*(-19.48) | 0.81\*\*\*(-14.92) | 0.86\*\*\* (-9.60) | 0.82\*\*\*(-19.55) | 0.81\*\*\*(-14.96) | 0.86\*\*\*(-9.32) | 0.82\*\*\*(-19.31) | 0.81\*\*\*(-14.59)  | 0.86\*\*\*(-9.58) | 0.83\*\*\*(-19.46) | 0.81\*\*\*(-14.78) |
| Age  | 1.00(0.01) | 0.99(-1.24) | 1.00(1.16) | 1.00(-0.06) | 1.00(-1.27) | 1.00(1.07) | 0.99(-0.18) | 0.99(-0.99) | 1.00(1.02) | 0.99(-0.08) | 0.99\*(-1.63) | 1.00(0.66) |
| Caste (Ref: OBC) SC | 1.28\*\*\*(3.60) | 1.26\*\*\*(4.73) | 1.32\*\*\*(3.04) | 1.28\*\*\*(3.59) | 1.26\*\*\*(4.73) | 1.32\*\*\*(3.07) | 1.28\*\*\*(3.54) | 1.26\*\*\*(3.54) | 1.32\*\*\*(2.97) | 1.28\*\*\*(3.57) | 1.26\*\*\*(4.70) | 1.32\*\*\*(2.98) |
| ST | 0.92(-1.02) | 1.28\*\*\*(3.94) | 1.03 (0.24) | 0.92(-0.96) | 1.28\*\*\*(3.91) | 1.04 (0.27) | 0.93(-0.92) | 0.29\*\*\*(4.01) | 1.07(0.44) | 0.92(-0.98) | 1.27\*\*\*(3.90) | 1.02(0.17) |
| Others | 1.27\*\*\*(2.61) | 1.16\*\*\*(2.74) | 1.03 (0.43) | 1.27\*\*\*(2.61) | 1.16\*\*\*(2.74) | 1.02(0.31) | 1.28\*\*\*(2.65) | 1.15\*\*\*(2.66) | 1.04(0.49) | 1.27\*\*\*(2.61) | 1.16\*\*\*(2.77) | 1.03(0.43) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -5146.26 | -9817.08 | -3493.28 | -5146.02 | -9815.29 | -3486.01 | -4953.18 | -9519.70 | -3384.51 | -5145.78 | -9811.20 | -3488.52 |
| LR | LR chi2(45) =1928.80 | LR chi2(47) = 4941.72 | LR chi2(44) = 2049.58 | LR chi2(47)=1929.29 | LR chi2(49) = 4945.31 | LR chi2(46) = 2064.10 | LR chi2(46) = 1885.88 | LR chi2(48) = 4806.40 | LR chi2(45) = 1977.42 | LR chi2(50) = 1929.77 | LR chi2(52) = 4953.48 | LR chi2(49) = 2059.08 |
| Sample Size | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 | 18,536 | 18,536 | 9,268 |

Table 8: Odds ratio of the association between Improved Opportunity Cost and household’s choice of clean cooking fuel (2019-21)

|  | **Yearlong work** | **Year long paid work** |
| --- | --- | --- |
| **Wealth Group** | **1** | **2** | **3** | **1** | **2** | **3** |
| OC Indicator | 1.09 (0.98) | 1.15\*\*(2.44)  | 1.33\*\* (2.20)  | 1.23 (1.23) | 1.55\*\*\*(4.19)  | 1.75\*\*\* (2.59)  |
| Work for family | 0.98 (-0.23) | 0.87\* (-1.81)  | 1.02 (0.15) |  |  |  |
| Paid in Cash | 1.05 (0.43) | 1.43\*\*\* (4.94)  | 1.77\*\*\* (3.93)  |  |  |  |
| **Religion** Christian | 0.62\*\* (-2.08)  | 0.95 (-0.33) | 0.52 (-1.54) | 0.53\* (-1.83)  | .94(-0.27) | .68(-0.70) |
| Muslim | 1.48\*(1.88)  | 1.96\*\*\* (4.49)  | 1.81\* (1.68)  | 1.74\* (1.95)  | 1.99\*\*\*3.41  | 2.34 1.72  |
| Others | 0.84 (-0.76) | 1.05 (0.29) | 1.54 (1.33) | 1.04(0.11) | 1.04(0.18) | 1.69 1.25 |
| Education  | 0.94 (-0.63) | 1.17\*\* (2.26)  | 1.44\*\* (2.04)  | 1.01(0.11) | 1.24\*\*(2.25)  | 1.280.86 |
| Household size | 0.85\*\*\*(-6.41)  | 0.82\*\*\*(-11.65)  | 0.78\*\*\* -(7.84)  | 0.86\*\*\*(-4.09)  | 0.81\*\*\*(-9.14)  | 0.73\*\*\* (-6.86)  |
| Age  | 1.00 (-0.04) | 1.00 (-0.68) | 1.00 -(0.47) | 1.19(1.11) | 1 (-0.02) | .99(-0.40) |
| Assets | 1.10 (1.11) | 0.89\* (-1.93)  | 0.92 -(0.63) | 0.76(-1.60) | .80\*\*\*-2.71  | .84(-0.91) |
| **Caste** SC | 1.17 (1.42) | 1.14 (1.64) | 1.32 (1.48) | 1.18(1.11) | 1.22\*1.86  | 1.28(0.96) |
| ST | 0.88 (-1.10) | 1.23\*\* (2.23)  | 1.29 (0.91) | 0.76(-1.60) | 1.33\*\* 2.29  | 1.10(0.25) |
| Others | 0.93 (-0.40) | 1.12 (1.12) | 1.24 (1.26) | 0.70(-1.47) | 1.11(0.84) | 1.38(1.36) |
| State effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Log Likelihood | -2041.83 | -3686.94 | -831.05 | -1013.95 | -2026.08 | -446.25 |
| LR | LR chi2(44)=1060.73 | LR chi2(49) =2344.08 | LR chi2(43)=678.52 | LR chi2(41)=503.13 | LR chi2(47)= 1293.21 | LR chi2(38)=352.72 |
| Sample Size | 7533 | 7229 | 2657 | 3484 | 4041 | 1661 |

**Table 9: Women empowerment and Household ownership of appliances, vehicle and clean cooking fuel**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  **TV/Fridge** | **Vehicle** | **Cooking Fuel** |
|  | **Wealth group** | I | II | III | I | II | III | I | II | III |
| **Financial Independence** | 2015-16 | 1.07(1.44) | 1.08(1.74) | 1.19(0.64) | 0.99(-0.10) | 0.96(-1.14) | 0.98(-0.33) | 1.48\*\*\*(2.51) | 1.27\*\*\*(4.98) | 1.39\*\*\*(5.41) |
| 2019-21 | 1.11\*\*(2.00) | 1.13(1.91) | 1.06(0.13) | 1.02(0.42) | 1.02(0.33) | 1.04(0.34) | 1.36\*\*\*(3.76) | 1.14\*\*(2.20) | 1.21\*\*(2.04) |
| **Decision** |  | I | II | III | I | II | III | I | II | III |
| 2015-16 | 1.11(1.74) | 1.09(1.68) | 1.39(1.09) | 0.84\*\*(-2.45) | 0.84\*\*(-2.45) | 0.89\*\*\*(-2.62) | 1.00(0.00) | 1.18\*\*\*(2.83) | 1.18\*\*\*(2.31) |
| 2019-21 | 1.03(0.75) | 1.07(1.38) | 1.28(0.85) | 0.96(-0.95) | 0.93(-1.90) | 0.97(-0.32) | 1.11(0.07) | 1.11\*\*\*(2.63) | 1.07(1.08) |

**Table 10: Differences in Meal Making Time between women employed year long and women employed seasonally**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Groups** | **Mean** | **SD** | **Sig** | **t** | **df** | **Mean difference** | **Std Error Difference** | **95% confidence interval of the Difference** |
| **Lower** | **Higher** |
| **Clean cooking fuel** | Yearlong employment | 175.17 | 1.16 | 0.41 | -0.82 | 8523.19 | -1.43 | 1.74 | 172.89 | 177.45 |
| Seasonally employed | 176.60 | 1.30 | 174.05 | 179.16 |
| **Unclean cooking fuel** | Yearlong employment | 191.22 | 3.26 | 0.19 | -1.31 | 1278 | -4.72 | 3.61 | 184.83 | 197.61 |
| Seasonallyemployed | 195.95 | 1.56 | 192.89 | 199.00 |

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1. At the same time, however, there was a steady withdrawal of State’s subsidy on LPG cylinders. [↑](#footnote-ref-1)
2. i.e., between age group of 15-49 [↑](#footnote-ref-2)
3. after dropping the households with missing values on the dependent variable i.e., primary source of cooking [↑](#footnote-ref-3)
4. It should be noted that, the odds of the household to choose clean cooking fuel when women exercise their agency in unfavourable contexts are generally less than when operated in favourable contexts. However, in some cases they (odds in unfavourable contexts) are statistically significant and in the other they are not. We still report them (statistically significant or not) as less. On the other hand, we report the household odds in favourable contexts only when they are statistically significant at least by 90% confident interval. [↑](#footnote-ref-4)
5. More than 70% of rural women from poor wealth decile are engaged in agricultural activities. The average daily wage rate for rural women engaged in agricultural labor increased from Rs.190 to Rs.248 between 2015-16 and 2020-21 [↑](#footnote-ref-5)