# Effects of information on energy related choices:

## Experimental evidence from rural Uttar Pradesh and Kerala*

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**Abstract**

This paper studies the effects of information on households' choices of fuels and appliances using data collected from a field experiment conducted in rural Uttar Pradesh and Kerala. The experiment consists of a set of interventions in the form of information campaigns which provides households with information regarding benefits and costs of using various cooking and lighting fuels, and energy related appliances. Furthermore, the information given to households differed in the mode of dissemination and recipient of information. I use propensity score matching with difference-in-differences to estimate the impact of information on choice of fuels and appliances used by households. Results suggest that households are more responsive to information about lighting alternatives than cooking alternatives. Increase in adoption of pressure cooker and improved stoves are witnessed only for households in Kerala where females were given information.

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# 1 Introduction

A vast majority of the Indian rural households are exposed to household air pollution due to their energy related practices. Both lighting and cooking energy sources are significant contributors to the ambient pollution in these homes (WHO[1], 2014). Continuous and prolonged exposure to household air pollution increases risks of morbidity and mortality by many times (Smith, 2000).

Several interventions have been implemented in the past to minimize household pollution levels and to mitigate the deleterious effects of smoke. These involve promotion of less polluting fuels and appliances in order to encourage households to switch to better alternatives[2]. In addition to stoves programmes, there are other policy interventions which promote the use of clean fuels such as biogas, LPG and kerosene through subsidies[3]. However, subsidies may not be sufficient to induce households to adopt better alternatives. The latest Census of India report states that almost 87 percent and 43.15 percent of the rural households still primarily use solid fuels[4] for their daily cooking and kerosene for lighting requirements (Houselisting and Housing Census Data Highlights - 2011, Census of India 2011[5]).

A recent study by Köhlin and Gundimeda finds that in rural India, the cross-price elasticity between firewood and LPG is in the range of 0.56 and 0.84 (Gundimeda and Köhlin, 2008). At such low cross-price elasticity, effects of price based instruments may not be fully realised. Furthermore, it seems like availability (Heltberg, 2003) and information (Masera et al., 2000) are possible factors that may affect households' choices of domestic fuels and related alternatives. Therefore, interventions such as awareness campaigns which alter valuations of fuels and appliances might be needed in addition to subsidies to make households

[1] http://www.who.int/indoorair/guidelines/hhfc/en/

[2] Globally, some of the organisations which promote clean cooking energy related practices are International Lifeline Fund, Shell Foundation, World Bank through Energy Sector Management Assistance Programme (ESMAP) and the Global Alliance for Clean Cookstoves. In India, initiatives such as National Programme on Improved Chulhas and National Biomass Cookstoves Initiative were aimed at providing efficient and smokeless stoves at subsidised rates to households.

[3] These include the National Biogas and Manure Management Programme, Rajiv Gandhi Gramin LPG Vitaran Yojana (RGGLVY), PAHAL-DBTL (Direct benefits transfer for LPG) consumers scheme and Solar Lantern Programme, among others.

[4] Solid fuels include fuels like firewood, coal, charcoal, agricultural residue, cow-dung cakes, twigs etc. .

[5] http://www.censusindia.gov.in/2011census/hlo/hlo_highlights.html Accessed on 18-July-2013

switch to clean alternatives (Hanna et al., 2012). One such example is the 'Energy clinic for housewives', a state level awareness programme pursued by Energy Management Centre in Thiruvananthapuram.

Furthermore, there is an increasing focus on how outcomes of intervention programmes vary with gender based characteristics of the targeted households (Miller and Mobarak, 2014). The premise for this is that within a household, preferences over goods and services, and say in the decision making may differ with gender identity of individuals. In particular, since females are primarily responsible for cooking, their valuation of costs and benefits from cooking-energy related fuels and related appliances is greater than that of males. However if females have very low or no say in decision making process then their preferences may not get reflected in households' choice of fuels and appliances. Therefore if policy interventions which promote alternatives are not valued by the decision maker then the efficacy of these interventions may be jeopardised. Evidence indicate that gender composition of the household can be an important determinant of females' bargaining power in the household. In particular, with greater bargaining power of females in a household, the switch to clean fuels is more likely (Chaudhuri and Pfaff, 2003). Nonetheless, females having a say in the decision making process may not always guarantee better outcomes in terms of clean fuel and appliance alternatives due to factors such as income, social and cultural constraints (Lewis and Pattanayak, 2012).

In this paper, I attempt to understand the extent to which information may affect fuel related decisions. More specifically, whether the mode of information dissemination and the gender of recipients have differential influences on the decisions regarding clean fuel and appliance usage. In order to accomplish this, I conducted a field experiment in the rural districts of Uttar Pradesh and Kerala from November 2012 to February 2013.

According to the Census of India (2011), a vast majority of rural households in Uttar Pradesh and Kerala use solid fuels as their primary cooking fuels. However, the extent of use of clean fuel alternatives is very different in these states. For instance, almost a quarter of the rural households in Kerala use LPG as their main cooking fuel whereas only about 10 percent use it as their primary cooking fuel in Uttar Pradesh (Table 4). Since the density of LPG distributors is higher in Kerala than in Uttar Pradesh[6], easier access to cleaner alternatives can be one of the possible explanations for the higher LPG usage levels in Kerala. However, the high prevalence rate of firewood use in Kerala indicates that removing supply-side bottlenecks for cleaner alternatives may not be enough to make households switch to better alternatives. Factors like income constraints, habits and lack of awareness may further hinder household from switching. These differences in availability and fuel-use variation provide an opportunity to study the effectiveness of awareness campaigns when initial conditions differ by geographical locations.

The field experiment included a baseline survey, a follow-up survey and a village-level intervention comprising of four different types of information campaigns. The information campaigns promoted clean fuel and appliance alternatives. Information regarding health benefits and costs of using different alternatives were imparted. These campaigns differed in the mode of information dissemination and the gender identity of the targeted recipients. In particular, there were four types of interventions, namely, (a) extensive information given to the primary female cooks, (b) intensive information given to the primary female cooks, (c) extensive information given to the male decision makers or the spouses of the cooks, and (d) intensive information given to the male decision makers or the spouses of the cooks. Details of these interventions are discussed in Section 2.2.

For the purpose of this study, I classify fuel alternatives into two broad groups: dirty fuels and clean fuels. These classifications differ for cooking and lighting fuels. In case of cooking fuels, dirty fuels comprise of solid fuels such as firewood, cow-dung cakes, agricultural residue, charcoal, coal, leaves and twigs. LPG, biogas, kerosene and electricity constitute the clean fuel category. For lighting fuels, clean fuels include electricity and battery operated lights whereas kerosene is considered to be dirty fuel.

The results show that there is a greater uptake of cleaner lighting alternatives such as battery operated LED lamps, among households who received information relative to those who were not given any information. In case of improved cook-stoves and pressure cookers, increase in adoption rates was witnessed only among households where females received information.

[6]According to the Census of India, 2011 and Ministry of Petroleum and Natural Gas, in Kerala, 517 LPG dealers are present for a population of 3.34 Crores whereas in Uttar Pradesh, there are 2319 distributors for 19.98 Crores persons in the state. (`http://pib.nic.in/newsite/PrintRelease.aspx?relid=116249`)

However, the magnitude of adoption of cooking appliances was much lower than that of LED lamps. This is in line with findings by Miller and Mobarak (Miller and Mobarak, 2014) which suggest that if females have a lower say in the household decision making then policies which promote technologies which are preferred by females may not be effective.

It is noteworthy that first, the intervention consisted of information campaigns, without any additional subsidy on promoted appliances. This is useful in estimation of impact of non-monetary instruments. Second, promotion of cooking and lighting energy alternatives helps in studying differences in adoption of appliances which are unequally preferred by individuals of different gender identities. Third, all fuels and appliances were already available in the villages and the local markets of nearest town centres, this removed any adoption driven by nuance[7] of the alternatives[8]. Last, the experiment did not include enumeration support from any non-governmental organisation (NGO).

The remaining paper is organised in the following way. Section 2 provides the location and design of the field experiment in detail. The next section (Section 3) presents the summary statistics. Section 4 describes the empirical strategy. Results from empirical analysis are discussed in Section 5. Finally, the conclusion of the paper is provided in Section 6.

## 2 Research location and experiment design

The location of this study are selected districts of Uttar Pradesh and Kerala. Field experiments were conducted in these states which included data collection and a village-level intervention in the form of awareness campaigns. The interventions comprised of four different information campaigns promoting clean fuels and appliances. The campaigns varied in the type of information provided and its targeted recipients. Details of the intervention are provided in section 2.2.

The baseline surveys were administered to selected households in November and December

[7]Lamps were not available in one village of the control group and one village of female-extensive information treatment group and male extensive treatment group.

[8]In villages where these LED lamps were not available, in order to create comparable supply conditions, the lights were made available at prevailing market prices.

2012 in Uttar Pradesh and Kerala, respectively. This was followed by implementation of interventions from November to December 2012, after the completion of the baseline surveys. The follow-up surveys were conducted in January-February 2013 (Table 1).

Table 1: Timeline of experiment

| | |
|---|---|
| Baseline survey | 1st to 11th November 2012 in Bijnor, 1st to 10th December 2012 in Thiruvananthapuram |
| Intervention after baseline survey | 12th to 22nd November 2012 in Bijnor, 12th to 20th December 2012 in Thiruvananthapuram |
| Follow-up survey | 1st to 25th January 2013 in Bijnor, 2nd to 17th February 2013 in Thiruvananthapuram |

## 2.1 Sampling design

The sampling frame of this study comprises of villages in selected districts of Uttar Pradesh and Kerala. A total of 723 households were surveyed from this frame. Of these, 423 belonged to Uttar Pradesh. In order to sample these households, I chose one district in each state, namely, Bijnor and Thiruvananthapuram in Uttar Pradesh and Kerala, respectively. These districts were chosen since the fuel-use distributions in these districts were fairly similar to the aggregate fuel-use distributions at their respective state levels. Within these districts, 2 to 4 blocks were selected. These were, Najibabad and Kiratpur in Bijnor, and Nemom, Perumkadavila, Vellanad and Chiranyinkeezhu in Thiruvanathapuram. Gram-panchayats were then chosen from these blocks using weighted random sampling, where weights were the population of each of these Gram-panchayats[9]. Following this procedure, the number of Gram-panchayats selected in Bijnor and Thiruvananthapuram were 11 and 10, respectively. Households selected in each of these Gram-panchayats usually belonged to a single village randomly picked from these Gram-panchayats. The survey was conducted such that all households belonging to a village were interviewed on the same day. This prevented

[9]In Bijnor, the list of blocks, Gram-panchayats, and villages and their respective population were obtained from the District Magistrate's office, Vikas Bhawan and Block Development office. The District Panchayat office and local self-governance website (http://lsg.kerala.gov.in/) provided me with the same lists in Thiruvananthapuram.

discussions among respondents regarding the queries listed in the survey and its influence on attitude based responses in the survey.

In Bijnor, 40 households were randomly sampled from each of the selected villages[10]. In Thiruvananthapuram, the selected villages were larger and there was relatively large spatial distances between dwellings. In addition, the terrain conditions were not similar within villages. Therefore the number of household surveyed per-village was restricted to approximately 30.

Two types of household survey questionnaires and a village survey questionnaire were used to collect the relevant data. More specifically, in each of the selected households, one male and one female were surveyed. The female respondents were the women who were primarily responsible for cooking in their households whereas the male respondents were the spouses of the females who were surveyed. However, if the spouse was not available, the head of the household was interviewed in case the household head was a male. The surveys were conducted during the day when both respondents were available at home[11]. Each household was interviewed by a team of two trained enumerators. Both respondents were surveyed simultaneously but in separate parts of the dwelling using different questionnaires. This was done to prevent any incidence of answers being influenced by the other respondent. Most of the female respondents from Bijnor remained in veils and were not allowed to speak to males outside the households. Therefore in order to avoid non-response, the questionnaires for females were administered by female enumerators.

Both questionnaires gathered information related to the households' fuel related history, perceptions and preferences over different fuels and cooking and lighting appliances, autonomy of respondents and demographic characteristics. In addition, households were asked to mention the fuels which were considered primary[12] within their fuel portfolio. This data was collected to construct a comprehensive structure of the households' fuel portfolios. Since the

[10] In one of the Gram-panchayats, only 20 households could be surveyed because of bad weather conditions and time limitations.

[11] Selected households were informed about the survey and inquired about the time of the day when both respondents were available for the interview. The team of enumerators visited the households accordingly.

[12] The fuel which was used for most of the cooking (most of the meals) or lighting purposes was called the primary fuel. In case of multiple fuel use, fuels which were used in greater physical quantities, relative to other fuels, were termed as primary.

female respondents were the primary cooks, they answered detailed queries regarding fuel use. They also responded to questions related to their health and the health profile of the households and child schooling. Using information collected in the pilot surveys, it was found that males were typically responsible for purchase of fuels, groceries and other goods in the households. This was particularly true for the sampled blocks of Uttar Pradesh. Therefore, information related households' assets and consumption-expenditure was collected from male respondents. The questionnaires used for the baseline and follow-up surveys were almost identical except that those used in the latter had an additional module on the intervention. This module contained specific questions regarding how households changed or attempted to change their fuels and appliances based decisions after the information campaigns and the difficulties faced by them in these attempts.

Information about villages' characteristics and amenities were collected using the village level questionnaires. This was generally administered to the Gram-Pradhans of the respective Gram-panchayats. In case she or he was not available for the survey, responses of an Anganwadi worker or a teacher from the local government school were recorded.

## 2.2 Intervention

I implemented four treatments that varied in the type of information provided and its targeted recipients. The treatments were administered in the form of information campaigns held in the chosen villages. In particular, each treatment was administered to two villages in each of the states. The remaining five villages serve as our comparison group[13]. In a given treatment group, all surveyed households of a village were exposed to only one type of treatment. This was done to prevent any spillover of information from the treated households to the ones which received no information.

Only one respondent per household received this additional information. These treatments could be classified into two broad categories: extensive and intensive, based on the type and the mode of information dissemination. The intensive treatment included more individual and village based information dissemination methods than its counterpart (Table 2). These

[13] This group includes the village which was partially surveyed due to bad weather conditions.

broad treatment categories were further divided into two sub-treatments, each. These sub-treatments varied by the gender identity of the information recipient.

Table 2: Information dissemination scheme

| Type of information | Extensive treatment | Intensive treatment |
|---|---|---|
| 1. Illustrated information leaflet stuck to dwelling's inner walls. | √ | √ |
| 2. One to one explanation of the leaflets to the selected household member. | × | √ |
| 3. Workshop training households to construct smokeless chimney-chulhas using locally available materials in Bijnor. Information about "Parishad chulhas" provided by Gram-Panchayat given in Thiruvananthapuram. | √ | √ |
| 4. Pictorial posters put around the village | × | √ |

In particular, illustrated leaflets were distributed under both extensive and intensive treatments. These leaflets attempted to help households to identify different sources of household air pollution. In addition, these also indicated the long-run health related costs and benefits associated with usage of various types of fuels and related appliances. Since the surveyed households had a sizable number of illiterate individuals, information provided in these leaflets was mainly pictorial. Specifically, these leaflets promoted use of clean fuel alternatives such as LPG and kerosene in addition to appliances like pressure cooker, chimney fitted wood-stoves and battery operated[14] lamps. Although all the promoted appliances were locally available in the villages, households faced availability constraints in case of clean fuel alternatives. For instance, there were ceilings on the available quantity of subsidised kerosene in both states. Rural households in Thiruvananthapuram had free access to the facility of door-to-door delivery of authorised LPG refills, however, households in villages of Bijnor had to travel to the LPG distribution agency situated in the nearest town-center to

[14] In Bijnor, these were battery operated LED lamps.

receive refills[15].

Furthermore, in the extensive treatment groups, selected household members was given the leaflet which was later stuck to inner walls of the dwellings. This enabled households to repeatedly view these leaflets. The intensive campaign involved an additional one-to-one explanation of these leaflets. Each of such session lasted 10 to 15 minutes in isolation in the dwellings of the respondents. Also, in each village covered under the intensive treatment, 12 posters, similar to the leaflets were stuck around the villages.

All households in the treated villages were given information about building or obtaining improved stoves. In Bijnor, a workshop for training households to make smokeless chimney-fitted chulhas was held in each of the treated villages. These workshops were conducted by a master chulha craftsman who taught households to make these improved stoves using materials such as clay, bricks and a chimney (metal pipe). Clay and bricks were locally available in the villages but the metal pipe for chimney, had to purchased from the nearest town. The workshops were held at the village center, such as the 'Panchayat-Ghar'. The workshop usually lasted between 30 to 45 minutes, after which the craftsman answered queries of individuals who attended the workshop. Each of the surveyed households was informed about the workshop and convinced to attend it. At least one respondent from the surveyed households attended the workshop. In addition to the respondents, the workshop was also attended by households which were not chosen for the experiment. On an average, about 70 individuals attended these workshops, in each village. The households were also given the option to get the chulha constructed by the craftsman at a fixed cost, later at their convenience.

In Thiruvananthapuram, since sturdier stoves were used which were difficult to build, households were given additional information about the smokeless stoves, 'Parishad Aduppu'. Parishad Aduppus were smokeless and efficient stoves made available by Gram-Panchayats as an initiative by Kerala Integrated Rural Technology Centre.

Table 3 summarises the price and availability of the promoted fuels and appliances.

[15] Each month, these refill cylinders were available on scheduled dates at these agencies. As a result, all LPG users affiliated to a particular agency had to wait in long queues on these allotted dates to receive refills.

Table 3: Prices and availability of promoted fuels and appliances

| Fuel/appliance | Price | Availability/ access |
|---|---|---|
| Kerosene | Rs. 16/ litre | Bijnor: upto 3 litres/month; Thiruvananthapuram: upto 0.5 litre/month |
| LPG | Rs. 400-450/ subsidised cylinder | Bijnor: once a month at the agency; Thiruvananthapuram: delivered at doorstep |
| Stoves fitted with chimneys | Bijnor: Rs. 300 if self-made and Rs 500 if made by craftsman; Thiruvananthapuram: Rs 800 for material and installation | Available throughout the year |
| Pressure cooker | Rs 300-800 | Available throughout the year |
| Battery operated lamps/ LED lamps | Bijnor: Rs 100 onwards; Thiruvananthapuram: Rs 400 onwards | Available throughout the year |

# 3 Data and descriptive statistics

Sample characteristics by treatment groups are presented in Table 13. On average, households comprised of 4 to 5 members.Among these, a large number had illiterate heads. Most of these were men. Likewise, among the females who were interviewed, a significant share of the female respondents were not literate. More than 20 percent of households did not have access to privately owned toilets. This was particularly true for the sample from Bijnor.

## 3.1 Fuel and related appliance usage

The primary fuel use patterns recorded in the survey corroborated those reported by the Census of India and other large scale surveys. However, the absolute fuel use in the sample show that the incidence of solid fuel use was much greater than that portrayed by primary fuel use data. In particular, although the number of households using LPG in Kerala was substantially higher than that in Uttar Pradesh, in both these states, more that 90 per cent of households relied on firewood for cooking fuel.

Also, as expected, several households in the sample reported fuel-stacking or multiple fuel use. Households that reported use of clean fuel alternatives such as LPG and biogas often used solid fuels, as well. In case of lighting fuels, most households which had access to electricity used subsidiary fuels such as candles, battery and kerosene etc. to cover lighting requirements during power-cuts. The extent of usage of these subsidiary fuels was greater in Bijnor due to long durational power-cuts in the region. Nevertheless, there were households that used single fuel for cooking and lighting needs. Almost 90 per cent of households used multiple cooking fuels in the sample from Bijnor. Among the single fuel using households in Kerala, majority of households relied on firewood. Almost equal number of single fuel using households in Uttar Pradesh used firewood and LPG. In addition, households also reported the amount of time spent on preparation of different food items cooked on the day before survey and fuels used to prepare these.

Examining the variation in sources of primary cooking fuels used by different income levels, it appears that in Bijnor, with rise in income, share of households which used LPG was also higher. Likewise, as compared to poorer households, a smaller share of wealthier households reported the use of solid fuels as their main fuel.

Furthermore, comparison of the incidence of fuel use in households across different treatment groups shows that there is no significant increase in the incidence in the use of clean cooking fuels in households. However, there is evidence of increase in the number of households using solid fuels such as cow-dung cakes and agricultural residue (Table 7).

Further, I use a standard logit model to determine the factors that influenced use of various energy related appliances that were promoted during the intervention. Results suggest that household and community characteristics play an important role in households' decisions to use these. More specifically, wealthier households are more likely to use pressure cookers. One point increase in the household's asset index leads to an increase in the probability of using a pressure cooker by 3 percentage points. It is worth noting that educational status of the person responsible for cooking has a large effect on the likelihood of pressure cooker usage in the household. That is, if the primary cook is literate then the probability of using a pressure cooker goes up by 15 percentage points. Also, households belonging to the sample drawn from Bijnor are more likely to use pressure cookers as compared to those from Thiruvananthapuram. This is because pressure cooker was typically a part of dowry among the households from Bijnor.

In contrast, households from Thiruvananthapuram are more probable to use chimneys. Furthermore, households in which the primary cook has completed grade 12 in school are 5 percentage points more likely to use chimneys than their counterparts with less educated cooks.

Finally, for battery operated lamps/ LED lamps, as households become more affluent their probability of using these lamps increase. One point increase in the household's asset index make them 2 percentage points more likely to use these lamps. In addition, households in Bijnor are 36 percentage points more likely to use the lamps than households from Thiruvananthapuram. This is possibly because of the long durational power cuts faced by households in that region (Table 14).

## 3.2 Construction of energy usage measure

Unlike the incidence of fuel use, estimating changes in levels of clean fuel-use by households which use both clean and dirty fuels is not straight forward. Since clean fuels have higher thermal efficiency and therefore take less time to cook food, comparing quantities of fuels used or time taken to cook food is not an effective way to study changes in levels of clean fuel usage. Thus, I estimate a measure of use of clean cooking energy in the following way.

1. I estimate the number of meals, $N$, cooked by households in each state, Uttar Pradesh and Kerala.

2. In each of these states, I identify the households which use single fuels to cook food.

3. For these households, I compute the average fraction of time spent on each meal, $f_n$, where $n \in N$. These numbers ($f_n$) give the mean energy requirement for each meal for households, in a given state.

4. For households which use multiple fuels, I identify the meals which are cooked using only clean (dirty) fuels. For such households, I assign the mean values, $f_n$, as the cooking energy requirement of the households which are fulfilled by clean (dirty) fuels.

5. In case the meals are cooked using mixed fuels (clean and dirty), the procedure given below was followed.

   (a) For single fuel using households in each state, average cooking time for cooking each type of food items using clean fuels and dirty fuels were calculated, keeping the household size constant.

   (b) I then calculate per capita average cooking time for cooking each type of food item.

   (c) For each item, I estimate the ratio, ($R_i$), of average time taken to cook the same food item using dirty fuels and clean fuels.

   (d) For items cooked on clean fuels in meals cooked on mixed fuels, I compute the time taken to cook it and multiply it with respective $R_i$. This gives the comparable time taken to cook that item on dirty fuels, $D_i$.

(e) Calculate the ratio $G_i = (\sum D_i/\text{time taken to cook a meal})$. I further multiply $G_i$ with $f_n$ to obtain share of clean energy requirement for such mixed meals.

6. I finally add up all clean energy needed to cook various meals of a given household to get clean energy needs for that household.

Estimates of energy needs of households met using clean fuels needed for meals are provided in Table 9. In particular, for energy needs, I use two measures based on the average time taken to cook by single fuel using households which used clean fuel: LPG; and dirty fuel:firewood or cow-dung cakes (Table 8). Using these, it seems that there is no significant change in clean energy used by households.

Comparing use of promoted clean appliances: pressure cookers, chimney fitted stoves and battery operated lamps in the baseline and follow-up surveys, it seems that there is no significant increase in the use of clean cooking appliances. However in case of battery operated lamps, for both Bijnor and Thiruvananthapuram, there appears to be an increase in the use of these lamps in villages which received treatments vis-à-vis those which were in the control group (Table 10).

## 3.3 Say and preferences

Using responses to questions regarding degree of freedom experienced by the female respondents in terms of mobility outside household, degree of acceptability of domestic violence and degree of say in household decisions, I construct an index of bargaining for the female respondents. For instance, if the female is allowed to go alone to certain place then I assign a score of 1 to the response, in case someone needs to accompany her to go out then I assign 0.5, instead; and if she is not allowed to go, then a 0. Likewise, if the female had an exclusive say in a certain household decision, I assign a score of 1; if she jointly decides then 0.5 and 0, otherwise. Lastly, if the female thinks that it is acceptable for the male to hit a female for a certain reason, then I assign 0 and 1, otherwise. The bargaining power index is then constructed by adding these scores. The range of this index lies in the interval between 0 and 20. The average bargaining index for the sampled households is 8.5. For households belonging to Bijnor, this is 7 whereas for those sampled from Thirvananthapuram, it is 10.5.

Furthermore, for households which started using chimney fitted stoves or pressure cookers, this is 8.9. This, however, is not very different from that for households which did not start using these appliances, i.e., 8.5. In case of battery operated lamps, those who switched had an average index value of 7.4 as compared to 8.5, for those who did not.

The questionnaires also recorded responses about the degree of satisfaction associated with each of the used fuels and appliances, from males and females, separately. In particular, respondents were allowed to rank their satisfaction levels on a scale of 3, where '1' indicated the state of being highly satisfied and '3' suggested dissatisfaction. Analysing these for solid fuel using households, it appears that almost equal shares (49 percent) of females and males report that they are highly satisfied with the solid fuels used for cooking. Yet, a state-wise examination shows that in Thiruvananthapuram, the share of females who are highly satisfied (59 percent) is significantly lower than that of males (65 percent). In Bijnor, however, the share of males who are highly satisfied solid cooking fuels is similar to that for females.

In households which switched to chimney fitted stoves or pressure cookers, the share of males who are highly satisfied with existing inefficient appliances (69 percent) is significantly lower than that of females (88 percent). This is contrary to the conventional wisdom which suggests that females attach a higher valuation to cooking fuels and appliances, these preferences in combination with greater say may get translated in decisions of switching to clean alternatives. In contrast, among households which use kerosene lamps for lighting needs, only in 35 percent of households, males are very satisfied with this alternative vis-á-vis 49 percent of females who appear to be satisfied. This gap is broader for households which switched to battery operated lamps.

Therefore it seems that it is the males' preferences for alternatives which may be driving the adoption of the clean alternatives.

### 3.4 Attrition

An attrition rate of 9.35 per cent was recorded in the sample during the follow-up survey. Of the 47 households which dropped out completely from the survey, only 10 households belonged to the sample from Kerala. The main reasons for attrition were: households' refusing to answer the questionnaire, followed by household members being out of village either to visit relatives, to treat ailments or to attend weddings. A few households in the sample from Bijnor relocated due to the damages caused to the dwellings because of excess rainfall (Table 6). As a result, the findings from this study are based on the remaining 676 households. I further use a probit model to check for any incidences of selective attrition based on household characteristics [16]. Except for literacy status of the primary cook, none of the covariates appear to significantly influence the decision to drop-out[17].

## 4 Empirical strategy

I use difference-in-differences (DID) estimates and DID estimates combined with propensity score matching (PSM) (Heckman et al., 1997) to obtain the effects of intervention on the use of fuels and appliances. In particular, the outcome variables of interest are (i) dirty-clean energy mix, constructed in the previous section and (ii) adoption of promoted appliances: pressure cooker, chimney fitted stoves and battery operated lamps/ LED lamps.

For impact estimates obtained using DID estimators, I compare the changes in the outcome variables for households in the comparison group with those which were administered a certain type of information campaign. Using this approach, I control for the time invariant

[16] The dependent variable is whether the household dropped out or not. I controlled for covariates — state to which the household belonged, household size, household asset index (calculated using Principal Component analysis on the assets owned by the household), age of the household head, gender of the household head, literacy status of the household head, if the household head has completed secondary school education, age of the female respondent, literacy status of the female respondent, if the female respondent has completed secondary school education, bargaining index, access to private toilets, shortest distance to the nearest town centre, whether the household used pressure cooker, whether the household used chimney fitted stove and whether the household used battery operated lamps/ LED lamps.

[17] In particular, households in which the female respondents are literate are 8 percentage points less likely to drop out.

covariates, both observed and unobserved. In order to estimate the impact of interventions on the mix of energy used by the households, I use the standard DID model using ordinary least squares. The estimated coefficients of interaction between treatment and time are the DID estimates. Likewise, to estimate impact on appliance take-up, I estimate DID model using a binary logit model. As suggested in literature (Athey and Imbens, 2002; Ai and Norton, 2003; Puhani, 2008), in non-linear models, effects of the intervention are not independent of the values of covariates at which the change is computed. Therefore, marginal effects of the interaction terms are more meaningful measures of the effects of intervention (Greene, 2012).

The specification used is as the following.

$$y_{ijt} = f(\alpha + \sum_{j}^{4} \beta_j.treatment_j + \gamma.timeperiod_t + \sum_{j}^{4} \delta_j.treatment_j.timeperiod_t + \rho_i + \epsilon_{ijt}) \quad (1)$$

where $y_{ijt}$ is the outcome variable for the $ith$ household which is administered the $jth$ intervention in time period $t$. $\rho_i$ is the household fixed effect. Note that $j$ takes the value $1, 2, 3$ or 4 if the intervention administered to the $i$th household was such that males were given extensive information, males were given intensive information, females were given extensive information or females were given intensive information, respectively. For the comparison group, I assume $j = 0$. $t$ specifies the time period such that it is equal to 0 for baseline survey and 1 for follow-up survey.

I further augment the DID models with additional covariates in order to condition the effects of intervention on observable household characteristics' levels in baseline period.

$$y_{ijt} = f(\alpha + \sum_{j}^{4} \beta_j.treatment_j + \gamma.timepetod_t + \sum_{j}^{4} \delta_j.treatment_j * timeperiod_t + \theta_i X'_{ij1} + \rho_i + \epsilon_{ijt}) \quad (2)$$

Where, $X$ is the vector of baseline covariates which account for observed characteristics of the households. These covariates are measure of access (distance to nearest town centre), asset index of the household (an index for asset constructed using Principal Component Analysis on number of assets owned by households), whether the head completed secondary school education, whether the primary cook had completed higher secondary school education and access to private toilet.

As mentioned in the previous section, even though chosen villages were randomly allotted different information campaigns, the characteristics of households appear to differ across various treatment groups[18]. These differences may lead to bias in the results obtained using a standard DID estimator. Therefore in order to address the issue of observable differences in baseline characteristics of households across different groups, I use PSM to obtain impact of intervention on treated households vis-á-vis comparable households in the comparison group. In particular, for each household in the treatment group, I construct a counterfactual within the comparison group who have similar propensity scores. This propensity score is based on the observable characteristics of the households (Rosenbaum and Rubin, 1983). One of the key assumptions of this approach is the conditional independence assumption which requires probability of being chosen in the treatment to be independent of the potential outcome of the intervention, given other characteristics of the households. This assumption is satisfied by virtue of sampling design and intervention assignment scheme in my field experiment. Since four different types of information campaigns were administered to households, I use multinomial probit to estimate propensity scores, based on which the counterfactual group is identified[19]. The distributions of observable characteristics between the treatment group and counterfactuals are balanced after matching[20].

I then use DID estimators to evaluate impact of interventions by comparing one treatment group at a time with its matched counterfactual. The modified specification estimates the average treatment effect for the treated (ATT) for jth treatment group after matching as

[18] I test this statistically using a multinomial probit model where the dependent variable is the household being chosen in different treatment groups and independent variables being household, village and state characteristics. Estimated coefficients of the covariates are significant indicating that observable characteristics do not balance across treatment and comparison groups.

[19] Propensity scores obtained from multinomial probit accounts for interdependent probabilities of being in other treatment groups as compared to the one estimated using standard probit (Lechner, 2002a).

[20] I use t-test and Pseudo $R^2$ to check balancing of covariates (Caliendo and Kopeinig, 2008).

expressed below (Heinrich et al., 2010).

$$ATT_j^{PSM-DID} = \frac{1}{N_t}\sum_{i=1}^{N_T}\left[(y_{i,j\neq 0,t=1} - y_{i,j\neq 0,t=0}) - \sum_{k\in C(j)} w_{ki}(y_{k,0,t=1} - y_{k,0,t=0})\right] \quad (3)$$

where, $N_T$ is the number of households in the treatment group which have matches[21]. $C(i)$ is the set of households in the comparison group matched to the $ith$ household in the treatment group. $w_{ki}$ is the weight[22] associated with household $k$ in the comparison group used in construction of the counterfactual to household $i$ in the treatment group $j$ such that $w_{ki} \in [0,1]$.

It is important to note that the variable of interest is change in the outcomes across the two time periods. For any given treatment group, first, for each household in that treatment group and the comparison group, the difference in the outcome between the baseline and the follow-up periods is estimated, i.e., $(y_{i,j,t=1} - y_{i,j,t=0})$, where $i \in N$. Therefore, like before, even if households in the treatment group vary from their counterparts in the comparison group such that the variations are time invariant, they get washed out when the second difference is taken.

For robustness check, I report results using two different matching algorithms using PSM, namely, radius matching with replacement[23] and kernel matching[24]. In the former, I match each treated household within the common support to all households from the comparison group which are closest to the treated household in terms of propensity scores, for a given caliper[25] (Cochran and Rubin, 1973). The weights attached to households in the coun-

[21] Households with matches or contained in the common support are such that their propensity score $\in (0,1)$.

[22] The weights assigned differ depending on the PSM algorithm used for matching households.

[23] A household in the comparison group can be used multiple times as a match to different treated households.

[24] The standard errors of the estimates are obtained using bootstrapping (Lechner, 2002b). Standard errors obtained using bootstrapping for matching methods that use fixed number of households of the comparison groups to match with treated households can be asymptotically biased (Abadie and Imbens, 2006 as in Heinrich et al., 2010).

[25] Caliper is the tolerance on the maximum distance allowed between the propensity score of the treated and comparison group households.

terfactual are equal, that is, $w_{ki} = \frac{1}{N_i^C}$ such that $N_i^C$ is the number of comparison group households matched with the *ith* treated household. This method allows the number of comparison group households matched to each treated household to vary. The caliper used for matching is twice the standard deviation of the propensity scores[26].

In kernel matching, I match each treated household in the common support to a weighted average of counterfactuals. In particular, the weights are derived from kernel weights from a normal distribution[27] which are a function of distance between the propensity scores of the households in the treatment and comparison groups (Caliendo and Kopeinig, 2008). As compared to the radius matching, this method uses more information as it utilises all households of the comparison group, which in turn lowers the variance of the estimator. However, using all households may deteriorate the quality of matching due to large distances between the treated unit and certain units of the comparison group.

# 5 Results

The results for DID estimates for cooking and lighting appliances using equation (1) are summarised in Table 16 and that from using equation (2) in Table 18. The coefficients on the interaction terms - 'Timeperiod∗Treat-males' and 'Timeperiod∗Treat-females', are the DID estimators of impact of information, when given to males and females, respectively. PSM-DID estimates are given in Table 19. For brevity, the results pertain to treatment groups which vary by gender identity of the recipient of information[28]. Results for subsamples from each of the states and that for the combined sample are presented.

The DID estimates indicate that households from Thiruvananthapuram, in which females are given information, witness an increase in adoption of these appliances. Post intervention, there is an increase of 4 and 5 percentage points in the usage of pressure cookers and chimneys, respectively. There is no change in the use of pressure cookers or chimney fitted stoves in the sample from Bijnor. I do not find significant effect of any other factor in the

[26] This is considered as an optimal measure in the literature (Austin, 2011).
[27] Approximate density from normal distribution.
[28] Results do not significantly vary by mode of information dissemination.

results from augmented DID specifications. These findings are confirmed by the PSM-DID estimates as well. The differences in the outcomes for the samples from Bijnor and Thiruvananthapuram are partly driven by differences in the initial levels of chimney and pressure cooker usage in these states[29] (Table 10).

In case of DID estimates for battery operated lamps/ LED lamps, the magnitude of effects are large. In particular, the use of these lamps increase by almost up to 20 percentage points for households which received additional information. Like earlier, not only these results are significantly different from the outcomes for the comparison group, they also significantly vary across treatments groups with gender of the recipients and state. In particular, it appears that in Thiruvanathapuram, information was useful in those households in which females received information. Households in which males received information did not seem to have switched to clean lighting alternatives. On the contrary, the impact of information was stronger in households from Bijnor where males received information relative to when females received information. Also, on average the impact of information was greater for households belonging to Bijnor. PSM-DID estimates show that households from Thiruvananthapuram in which males received information are although likely to use more battery operated lamps than their counterparts in the comparison group, the extent of usage was less than that of households where females received information. Frequent and long-durational power outages can be a possible explanation for the greater response.

Next, there are almost no differences in the clean energy usage among households (Table 15 and Table 17). Although there is an increase in use of solid bio-fuels by households, the increase appears to be constant across different treatment groups[30]. A plausible reason may be the high lump-sum costs and greater prices associated with adoption of clean fuels (Masera et al., 2001; Smith, 1994; Reddy and Reddy, 1994; Hiemstra-van der Horst and Hovorka, 2008).

Delving deeper, I examine heterogeneous effects of treatment on the use of different appliances (Table 20). Note that each of the odd numbered model includes interaction terms: 'Bijnor*Timeperiod', 'Bijnor*Timeperiod*Treat-males' and 'Bijnor*Timeperiod*Treat-females'.

[29] Also, the use pressure cookers was widespread in Bijnor. A vast majority of sampled households use pressure cookers during the baseline survey.

[30] The only exception being the group where males were given extensive information.

Likewise, the even numbered specifications have additional interaction terms: 'Cook 10th graduate* Timeperiod', 'Cook 10th graduate *Timeperiod* Treat-males' and 'Cook 10th graduate*Timeperiod*Treat-females'. The coefficient on 'Bijnor*Timeperiod*Treat-males' in column (5) is positive and significant suggesting that there is a positive (heterogeneous) effect of being from Bijnor relative to Thiruvananthapuram on the usage of battery operated lamps. That is, households from Bijnor in which males received information are more likely to use these lamps as compared to their counterfactuals. However, the overall impact of male specific treatment given by the coefficient on 'Timeperiod*Treat-males' is now insignificant showing that the effect is indeed driven by households' location. Nevertheless, the coefficient on'Timeperiod*Treat-females' is still positive and significant, though smaller in magnitude.

In contrast, the coefficient on 'Bijnor*Timeperiod*Treat-females' in column (1) is negative and significant indicating that households from Thiruvananthapuram in which females received information are more probable to use pressure cookers. This confirms the results obtained from subsamples from each of these states. The coefficient on 'Timeperiod*Treat-females' is also still positive and significant.

Only in column (2), the coefficient on 'Cook 10th graduate*Timeperiod*Treat-females' is positive and significant. That is, households in which females had at least secondary school education and received information are more likely to use pressure cookers. Here, the coefficient on 'Timeperiod*Treat-females' becomes insignificant implying that impact of information to female was mainly due to the presence of females who had at least secondary school education.

# 6 Conclusions

Information campaigns indeed appear to have a positive impact on the uptake of clean energy alternatives. I find that there is an increase in the usage of battery operated lamps among households which received additional information. This effect is dissimilar across different treatment groups by identity of the recipient of information and location of households. In particular, households which belonged to Bijnor are more likely use battery operated lamps as compared to their counterparts from Thiruvananthapuram. Also, for the sample from Bijnor, impact of information when given to males is greater than when it is provided to the females. The opposite is true for Thiruvananthapuram. This reflects the varying preferences and say in decision making of household members over different alternatives.

Provision of information also seems to improve adoption of cooking appliances such as pressure cookers and chimney fitted stoves. However in Thiruvananthapuram, these effects appear only when information is provided to females as compared to when recipients are males. It is often believed that since females care more for these appliance than males, there will be a positive impact when information is delivered to females. Females must also have some say in the decision making within households. Moreover, the increase in the use of pressure cookers is driven by households with females who have atleast completed secondary school education. But, this may not be the only reason driving these results.

It is noteworthy that the magnitude of impacts for cooking appliances are smaller as compared to impacts for battery operated lamps. A tentative reason for positive impact of information on the use of battery operated lamps across treatment groups can be individuals' utilities associated with the appliance. Unlike benefits from cooking appliances, light from the battery operated lamps could be used by individuals, regardless of their gender identity.

Furthermore, for fuel usage, I do not find any change. A plausible reason may be the high capital costs associated with adoption of clean fuels. Unlike in the case of appliances, households are required to switch to appropriate appliances when they commence the use of clean fuels. Moreover, in Bijnor, although LPG and other clean cooking fuels were available, these were not easily accessible. Thus, availability and ease of access might further dissuade households from switching to clean fuels.

Programmes which ease price and availability constraints for clean fuels are important steps in the direction of helping households to switch to cleaner alternatives. In addition to subsidies, information campaigns can be a useful tool in improving the overall efficacy of policies which promote clean fuel related alternatives. Also, interventions which promote clean fuel alternatives might need to be supplemented with policies which increase females' say and bargaining power.

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# Tables

Table 4: Distribution (%) of rural households by primary cooking-fuel use

| State/ district | Solid fuels | LPG |
|---|---|---|
| Kerala | 74.10 | 24.70 |
| Thiruvananthapuram, Kerala | 73.60 | 25.10 |
| Uttar Pradesh | 92.90 | 6.40 |
| Bijnor, Uttar Pradesh | 88.80 | 10.30 |

*Source: Census of India, 2011*

*Note: Solid fuels include firewood, agricultural residue, cow-dung cakes, coal, lignite and charcoal.*

Table 5: Sample size (number of households surveyed) under various treatment assignment schemes

| Treatment | All | | | Kerala | | | Uttar Pradesh | | |
|---|---|---|---|---|---|---|---|---|---|
| | Baseline | Follow-up | Attrition (%) | Baseline | Follow-up | Attrition (%) | Baseline | Follow-up | Attrition (%) |
| Control | 160 | 144 | 10.00 | 60 | 56 | 6.67 | 100 | 88 | 12.00 |
| Male-extensive | 140 | 131 | 6.43 | 60 | 60 | 0.00 | 80 | 71 | 11.25 |
| Male-intensive | 144 | 139 | 3.47 | 62 | 62 | 0.00 | 82 | 77 | 6.10 |
| Female-extensive | 141 | 134 | 4.96 | 59 | 57 | 3.39 | 82 | 77 | 6.10 |
| Female-intensive | 138 | 128 | 7.25 | 59 | 55 | 6.78 | 79 | 73 | 7.60 |
| Total | 723 | 676 | 6.50 | 300 | 290 | 3.33 | 423 | 386 | 8.75 |

*Source: Survey data collected from Kerala and Uttar Pradesh in 2012-2013*

Table 6: Percentage of households by reasons for attrition in sample

| Reasons | Kerala | Uttar Pradesh |
|---|---|---|
| Unwilling to participate | 50.00 | 36.11 |
| Not in village | 10.00 | 38.89 |
| Locked dwelling or relocated | 20.00 | 13.89 |
| Other reasons | 20.00 | 11.11 |

*Source: Follow-up survey data collected from Kerala and Uttar Pradesh in 2013*

Table 7: Cooking fuel use in households across various treatment groups

| | Baseline survey | | | | | Follow-up survey | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Comparison group | Extensive treatment-male | Intensive treatment-male | Extensive treatment-female | Intensive treatment-female | Comparison group | Extensive treatment-male | Intensive treatment-male | Extensive treatment-female | Intensive treatment-female |
| Firewood | 94.44 | 95.42 | 92.81 | 96.27 | 99.22 | 88.89** | 95.42 | 92.09 | 97.01 | 90.63*** |
| | (22.99) | (20.99) | (25.93) | (19.02) | (8.84) | (31.54) | (20.99) | (27.09) | (17.08) | (29.26) |
| Cow-dung cakes | 55.56 | 41.22 | 41.73 | 50.75 | 53.91 | 54.17 | 44.27 | 48.92*** | 55.97*** | 50.00 |
| | (49.86) | (49.41) | (49.49) | (50.18) | (50.04) | (50.00) | (49.86) | (50.17) | (49.83) | (50.20) |
| Other solid bio-fuels | 6.94 | 0.00 | 15.83 | 1.49 | 6.25 | 10.42 | 10.69*** | 15.83 | 10.45*** | 9.38 |
| | (25.51) | (0.00) | (36.63) | (12.17) | (24.30) | (30.65) | (31.01) | (36.63) | (30.70) | (29.26) |
| LPG | 51.39 | 48.85 | 44.60 | 68.66 | 57.03 | 50.69 | 48.09 | 43.88 | 70.90 | 57.81 |
| | (50.16) | (50.18) | (49.89) | (46.56) | (49.70) | (50.17) | (50.16) | (49.80) | (45.59) | (49.58) |
| Kerosene | 4.86 | 3.82 | 2.88 | 8.96 | 3.91 | 4.17 | 5.34 | 3.60 | 5.97 | 2.34 |
| | (21.58) | (19.23) | (16.78) | (28.66) | (19.45) | (20.05) | (22.58) | (18.69) | (23.78) | (15.19) |
| Biogas | 0.00 | 0.00 | 0.72 | 0.75 | 0.00 | 0.00 | 0.00 | 0.72 | 0.75 | 0.00 |
| | (0.00) | (0.00) | (8.48) | (8.64) | (0.00) | (0.00) | (0.00) | (8.48) | (8.64) | (0.00) |
| Electricity | 9.72 | 3.82 | 2.16 | 10.45 | 5.47 | 1.39 | 4.58 | 2.16 | 5.97 | 0.78 |
| | (29.73) | (19.23) | (14.58) | (30.70) | (22.83) | (11.74) | (20.99) | (14.58) | (23.78) | (8.84) |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

*Note: Standard errors are given in the parenthesis; Comparison between baseline and follow-up data - * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;*

Table 8: Share (%) of time taken to prepare different meals by single fuel using households

| Meals | Kerala | | | Uttar Pradesh | | |
|---|---|---|---|---|---|---|
| | Dirty fuels | Clean fuels | All | Dirty fuels | Clean fuels | All |
| Morning | 59 | 61 | 59 | 18 | 30 | 24 |
| Afternoon | 26 | 17 | 25 | 32 | 30 | 31 |
| Evening | 15 | 22 | 16 | 50 | 40 | 45 |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

Table 9: Clean energy needs of households across various treatment groups

| | Comparison group | Extensive treatment-male | Intensive treatment-male | Extensive treatment-female | Intensive treatment-female |
|---|---|---|---|---|---|
| | | | Baseline survey | | |
| Clean fuel using households' index | 0.23 (0.32) | 0.25 (0.33) | 0.22 (0.22) | 0.27 (0.32) | 0.21 (0.27) |
| Dirty fuel using households' index | 0.25 (0.32) | 0.19 (0.28) | 0.20 (0.33) | 0.26 (0.30) | 0.20 (0.30) |
| | | | Baseline survey | | |
| Clean fuel using households' index | 0.22 (0.31) | 0.23 (0.32) | 0.22 (0.33) | 0.25 (0.32) | 0.19 (0.27) |
| Dirty fuel using households' index | 0.23 (0.31) | 0.18 (0.28) | 0.19 (0.32) | 0.24 (0.30) | 0.20 (0.30) |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

*Note: Standard errors are given in the parenthesis; Comparison between baseline and follow-up data - * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;*

Table 10: Mean and median usage (in fractions) of battery operated lights, pressure cooker and chimney fitted stoves as recorded in baseline survey full sample

| Treatment | stats | All: Battery operated lamps | All: Pressure cookers | All: Chimney fitted stoves | Kerala: Battery operated lamps | Kerala: Pressure cookers | Kerala: Chimney fitted stoves | Uttar Pradesh: Battery operated lamps | Uttar Pradesh: Pressure cookers | Uttar Pradesh: Chimney fitted stoves |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | mean | 0.225 | 0.7125 | 0.1375 | 0.1333 | 0.5000 | 0.3333 | 0.2800 | 0.8400 | 0.0200 |
| | sd | 0.4189 | 0.4540 | 0.3455 | 0.3428 | 0.5042 | 0.4754 | 0.4513 | 0.3685 | 0.1407 |
| Male-extensive | mean | 0.2000 | 0.8214 | 0.1286 | 0.1667 | 0.6500 | 0.3000 | 0.2250 | 0.9500 | 0.0000 |
| | sd | 0.4014 | 0.3844 | 0.3359 | 0.3758 | 0.4810 | 0.4621 | 0.4202 | 0.2193 | 0.0000 |
| Male-intensive | mean | 0.1667 | 0.7014 | 0.0556 | 0.0645 | 0.4194 | 0.1129 | 0.2439 | 0.9146 | 0.0122 |
| | sd | 0.3740 | 0.4592 | 0.2299 | 0.2477 | 0.4975 | 0.3191 | 0.4321 | 0.2811 | 0.1104 |
| Female-extensive | mean | 0.2270 | 0.8014 | 0.1986 | 0.0678 | 0.5763 | 0.3898 | 0.3415 | 0.9634 | 0.0610 |
| | sd | 0.4204 | 0.4004 | 0.4004 | 0.2536 | 0.4984 | 0.4919 | 0.4771 | 0.1889 | 0.2408 |
| Female-intensive | mean | 0.2319 | 0.6667 | 0.1377 | 0.1695 | 0.2881 | 0.2881 | 0.2785 | 0.9494 | 0.0253 |
| | sd | 0.4236 | 0.4731 | 0.3458 | 0.3784 | 0.4568 | 0.4568 | 0.4511 | 0.2206 | 0.1581 |
| Total | mean | 0.2102 | 0.7400 | 0.1314 | 0.1200 | 0.4867 | 0.2833 | 0.2742 | 0.9196 | 0.0236 |
| | sd | 0.4078 | 0.4390 | 0.3381 | 0.3255 | 0.5007 | 0.4514 | 0.4467 | 0.2722 | 0.1521 |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

*Note: The data contains households which did not drop out in the follow-up survey.*

Table 11: Mean and median usage (in fractions) of battery operated lights, pressure cooker and chimney fitted stoves as recorded in baseline survey- after accounting for attrition

| | | All | | | Kerala | | | Uttar Pradesh | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | stats | Battery operated lamps | Pressure cookers | Chimney fitted stoves | Battery operated lamps | Pressure cookers | Chimney fitted stoves | Battery operated lamps | Pressure cookers | Chimney fitted stoves |
| Control | mean | 0.2361 | 0.7083 | 0.1528 | 0.1429 | 0.4821 | 0.3571 | 0.2955 | 0.8523 | 0.0227 |
| | sd | 0.4262 | 0.4561 | 0.3610 | 0.3531 | 0.5042 | 0.4835 | 0.4589 | 0.3569 | 0.1499 |
| Male-extensive | mean | 0.1985 | 0.8092 | 0.1374 | 0.1667 | 0.6500 | 0.3000 | 0.2254 | 0.9437 | 0.0000 |
| | sd | 0.4004 | 0.3945 | 0.3456 | 0.3758 | 0.4810 | 0.4621 | 0.4208 | 0.2322 | 0.0000 |
| Male-intensive | mean | 0.1583 | 0.6978 | 0.0576 | 0.0645 | 0.4194 | 0.1129 | 0.2338 | 0.9221 | 0.0130 |
| | sd | 0.3663 | 0.4609 | 0.2337 | 0.2477 | 0.4975 | 0.3191 | 0.4260 | 0.2698 | 0.1140 |
| Female-extensive | mean | 0.2239 | 0.7985 | 0.1940 | 0.0351 | 0.5614 | 0.3684 | 0.3636 | 0.9740 | 0.0649 |
| | sd | 0.4184 | 0.4026 | 0.3969 | 0.1856 | 0.5006 | 0.4867 | 0.4842 | 0.1601 | 0.2480 |
| Female-intensive | mean | 0.2266 | 0.6484 | 0.1328 | 0.1273 | 0.2545 | 0.2727 | 0.3014 | 0.9452 | 0.0274 |
| | sd | 0.4203 | 0.4793 | 0.3407 | 0.3364 | 0.4396 | 0.4495 | 0.4620 | 0.2292 | 0.1644 |
| Total | mean | 0.2086 | 0.7322 | 0.1346 | 0.1069 | 0.4759 | 0.2793 | 0.2850 | 0.9249 | 0.0259 |
| | sd | 0.4066 | 0.4431 | 0.3416 | 0.3095 | 0.5003 | 0.4494 | 0.4520 | 0.2639 | 0.1591 |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

*Note: The data contains households which did not drop out in the follow-up survey.*

Table 12: Mean and median usage (in fractions) of battery operated lights, pressure cooker and chimney fitted stoves as recorded in follow-up survey - after accounting for attrition

| | | All | | | Kerala | | | Uttar Pradesh | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | stats | Battery operated lamps | Pressure cookers | Chimney fitted stoves | Battery operated lamps | Pressure cookers | Chimney fitted stoves | Battery operated lamps | Pressure cookers | Chimney fitted stoves |
| Control | mean | 0.2153 | 0.7083 | 0.1528 | 0.1429 | 0.4821 | 0.3571 | 0.2614 | 0.8523 | 0.0227 |
| | sd | 0.4124 | 0.4561 | 0.3610 | 0.3531 | 0.5042 | 0.4835 | 0.4419 | 0.3569 | 0.1499 |
| Male-extensive | mean | 0.3664 | 0.8015 | 0.1374 | 0.2167 | 0.6333 | 0.3000 | 0.4930 | 0.9437 | 0.0000 |
| | sd | 0.4837 | 0.4004 | 0.3456 | 0.4155 | 0.4860 | 0.4621 | 0.5035 | 0.2322 | 0.0000 |
| Male-intensive | mean | 0.3453 | 0.6978 | 0.0576 | 0.1613 | 0.4194 | 0.1129 | 0.4935 | 0.9221 | 0.0130 |
| | sd | 0.4772 | 0.4609 | 0.2337 | 0.3708 | 0.4975 | 0.3191 | 0.5032 | 0.2698 | 0.1140 |
| Female-extensive | mean | 0.3657 | 0.8284 | 0.2313 | 0.2281 | 0.6316 | 0.4035 | 0.4675 | 0.9740 | 0.1039 |
| | sd | 0.4834 | 0.3785 | 0.4233 | 0.4233 | 0.4867 | 0.4950 | 0.5022 | 0.1601 | 0.3071 |
| Female-intensive | mean | 0.4297 | 0.6641 | 0.1641 | 0.2364 | 0.2909 | 0.3273 | 0.5753 | 0.9452 | 0.0411 |
| | sd | 0.4970 | 0.4742 | 0.3718 | 0.4288 | 0.4584 | 0.4735 | 0.4977 | 0.2292 | 0.1999 |
| Total | mean | 0.3417 | 0.7396 | 0.1479 | 0.1966 | 0.4931 | 0.2966 | 0.4508 | 0.9249 | 0.0363 |
| | sd | 0.4746 | 0.4392 | 0.3553 | 0.3981 | 0.5008 | 0.4575 | 0.4982 | 0.2639 | 0.1872 |

*Source: Follow-up survey data collected from Kerala and Uttar Pradesh in 2013*

*Note: The data contains households which did not drop out in the follow-up survey.*

Table 13: Sample cqharacteristics

| Average characteristics | Comparison group (1) | Male treatment (2) | Difference (1-2) | Female treatment (4) | Difference (1-4) |
|---|---|---|---|---|---|
| Household size (Number) | 5.69 | 5.32 | 0.37 | 4.99 | 0.70*** |
| | (0.21) | (0.14) | (0.24) | (0.11) | (0.22) |
| Household asset index | 0.34 | -0.50 | 0.84** | 0.33 | 0.02 |
| | (0.42) | (0.14) | (0.36) | (0.17) | (0.38) |
| Households with access to private toilets (share) | 0.79 | 0.77 | 0.03 | 0.78 | 0.02 |
| | (0.03) | (0.03) | (0.04) | (0.03) | (0.04) |
| Village size | 2221.64 | 2774.03 | -552.39** | 2795.14 | -573.50* |
| | (185.23) | (158.48) | (255.74) | (204.41) | (308.10) |
| Shortest distance to the nearest town (km) | 13.08 | 14.97 | -1.88*** | 13.80 | -0.72 |
| | (0.35) | (0.32) | (0.51) | (0.47) | (0.68) |
| Age of household head (in years) | 50.06 | 46.77 | 3.29** | 48.97 | 1.09 |
| | (0.17) | (0.83) | (1.42) | (0.83) | (1.42) |
| Number of household heads who are literate (share) | 0.75 | 0.84 | -0.09** | 0.89 | -0.14*** |
| | (0.04) | (0.02) | (0.04) | (0.02) | (0.04) |
| Number of household heads who completed class 10 (share) | 0.30 | 0.38 | -0.08 | 0.47 | -0.17** |
| | (0.04) | (0.03) | (0.05) | (0.03) | (0.05) |
| Age of primary cook (in years) | 39.97 | 37.42 | 2.55* | 37.85 | 2.12 |
| | (1.21) | (0.74) | (1.35) | (0.83) | (1.43) |
| Number of primary cooks who are literate (share) | 0.67 | 0.73 | -0.06 | 0.84 | -0.17*** |
| | (0.04) | (0.03) | (0.05) | (0.02) | (0.04) |
| Number of primary cooks who completed class 10 (share) | 0.31 | 0.36 | -0.05 | 0.39 | -0.08* |
| | (0.04) | (0.03) | (0.05) | (0.03) | (0.05) |
| Bargaining index | 8.22 | 8.86 | -0.64* | 8.30 | -0.07 |
| | (0.31) | (0.21) | (0.37) | (0.21) | (0.37) |

*Source: Baseline survey data collected from Kerala and Uttar Pradesh in 2012*

*Note: The data contains households which did not drop out in the follow-up survey. Standard errors are given in the parenthesis;* * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Incidence of appliance use: average marginal effects from logit estimations

| | Pressure cooker | Chimney fitted stoves | Battery operated lamps |
|---|---|---|---|
| HH size | 0.09 | 0.07 | -0.01 |
| | (0.07) | (0.09) | (0.05) |
| HH asset index | 0.28*** | 0.07* | 0.14*** |
| | (0.06) | (0.04) | (0.03) |
| Age of HH head (years) | -0.01 | 0.01 | -0.00 |
| | (0.01) | (0.01) | (0.01) |
| HH head is 10th graduate (d) | 0.25 | 0.57* | 0.20 |
| | (0.27) | (0.31) | (0.24) |
| Primary cook's age (years) | -0.00 | -0.02 | -0.01 |
| | (0.01) | (0.01) | (0.01) |
| Cook is 10th graduate (d) | 0.23 | 0.36 | -0.29 |
| | (0.30) | (0.32) | (0.28) |
| Bargaining index | -0.04 | 0.03 | -0.03 |
| | (0.04) | (0.05) | (0.04) |
| Distance to nearest town (km) | -0.03 | -0.04 | -0.02 |
| | (0.02) | (0.03) | (0.02) |
| Village size | 0.00 | -0.00 | 0.00** |
| | (0.00) | (0.00) | (0.00) |
| Bijnor | 3.35*** | -2.92*** | 2.60*** |
| | (0.54) | (0.68) | (0.76) |
| N | 676.00 | 676.00 | 676.00 |
| Log-likelihood | -270.47 | -207.13 | -309.31 |
| Chi-squared | 244.59 | 119.87 | 73.70 |

Marginal effects; Standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Differences in differences estimates for clean energy needs of households in different treatment groups

| Difference in difference estimates (%) | Energy needs using clean fuel using households | Energy needs using dirty fuel using households |
|---|---|---|
| All | | |
| Any treatment | -0.03 | -0.03 |
| | (0.03) | (0.03) |
| Information to males | -0.04 | -0.04 |
| | (0.03) | (0.03) |
| Information to females | -0.02 | -0.01 |
| | (0.03) | (0.03) |
| Kerala | | |
| Any treatment | -0.03 | -0.02 |
| | (0.04) | (0.04) |
| Information to males | -0.01 | -0.01 |
| | (0.04) | (0.04) |
| Information to females | -0.05 | -0.03 |
| | (0.05) | (0.04) |
| Uttar Pradesh | | |
| Any treatment | -0.01 | -0.01 |
| | (0.03) | (0.03) |
| Information to males | -0.04 | -0.05 |
| | (0.03) | (0.03) |
| Information to females | 0.02 | 0.02 |
| | (0.03) | (0.04) |

*Source: Baseline survey and follow-up survey data collected from Kerala and Uttar Pradesh in 2012-13*
*Note: The data contains households which did not drop out in the follow-up survey. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors are given in the parenthesis.*

Table 16: Difference in differences estimates for use of pressure cookers, chimney stoves and battery operated lamps in different treatment groups

| Difference in difference estimates (%) | Pressure cooker usage | Chimney stove usage | Lamp usage |
|---|---|---|---|
| | All | | |
| Any treatment | 0.01 | 0.02 | 0.20*** |
| | (0.01) | (0.01) | (0.04) |
| Information to males | 0.00 | 0.00 | 0.20*** |
| | (0.01) | (0.02) | (0.05) |
| Information to females | 0.02** | 0.03** | 0.19*** |
| | (0.01) | (0.02) | (0.05) |
| | Kerala | | |
| Any treatment | 0.02 | 0.02 | 0.11** |
| | (0.02) | (0.02) | (0.05) |
| Information to males | -0.01 | 0.00 | 0.07 |
| | (0.03) | (0.02) | (0.05) |
| Information to females | 0.05** | 0.04** | 0.15*** |
| | (0.03) | (0.02) | (0.05) |
| | Uttar Pradesh | | |
| Any treatment | 0.00 | 0.01 | 0.26*** |
| | (0.00) | (0.02) | (0.06) |
| Information to males | 0.00 | 0.00 | 0.30*** |
| | (0.00) | (0.02) | (0.07) |
| Information to females | 0.00 | 0.03 | 0.22*** |
| | (0.00) | (0.02) | (0.07) |

*Source: Baseline survey and follow-up survey data collected from Kerala and Uttar Pradesh in 2012-13*
*Note: The data contains households which did not drop out in the follow-up survey.* * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*; Standard errors are given in the parenthesis.*

Table 17: Effect of female and male targeted treatments - Augmented DID estimates

| | Energy needs1 | | | Energy needs2 | | |
|---|---|---|---|---|---|---|
| | All | Kerala | UP | All | Kerala | UP |
| Timeperiod | -0.08*** | -0.21*** | 0.01 | -0.06** | -0.19*** | 0.03 |
| | (0.02) | (0.04) | (0.02) | (0.02) | (0.03) | (0.03) |
| Treat-males | -3.24 | 0.99 | -0.04 | -2.71 | 0.80 | -0.04 |
| | (2.68) | (0.99) | (0.16) | (2.65) | (0.94) | (0.17) |
| Treat-females | -2.42 | 1.76 | -0.01 | -1.96 | 1.47 | 0.05 |
| | (2.00) | (1.59) | (0.14) | (1.98) | (1.51) | (0.15) |
| Timeperiod*Treat-males | -0.04 | -0.02 | -0.04 | -0.04 | -0.01 | -0.05 |
| | (0.03) | (0.04) | (0.03) | (0.03) | (0.04) | (0.03) |
| Timeperiod*Treat-females | -0.02 | -0.05 | 0.02 | -0.01 | -0.03 | 0.02 |
| | (0.03) | (0.04) | (0.03) | (0.03) | (0.04) | (0.03) |
| HH head is 10th graduate (d) | -3.20 | -3.20 | -0.02 | -2.72 | -2.72 | -0.01 |
| | (2.78) | (2.71) | (0.16) | (2.75) | (2.56) | (0.17) |
| Cook is 10th graduate (d) | 2.83 | 2.83 | -0.55** | 2.40 | 2.40 | -0.53** |
| | (2.34) | (2.27) | (0.24) | (2.31) | (2.15) | (0.25) |
| HH asset index | 0.94 | 0.94 | 0.13** | 0.79 | 0.79 | 0.12* |
| | (0.87) | (0.85) | (0.06) | (0.86) | (0.80) | (0.06) |
| Distance to nearest town (km) | 0.09 | 0.09 | 0.00 | 0.07 | 0.07 | 0.00 |
| | (0.08) | (0.08) | (0.03) | (0.08) | (0.08) | (0.03) |
| Toilet (d) | -1.50 | -1.50 | -0.16 | -1.27 | -1.27 | -0.16 |
| | (1.60) | (1.56) | (0.22) | (1.58) | (1.47) | (0.22) |
| Constant | 3.18 | -0.99 | 0.36 | 2.73 | -0.74 | 0.34 |
| | (2.68) | (1.09) | (0.53) | (2.65) | (1.03) | (0.55) |
| HH fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1352.00 | 580.00 | 772.00 | 1352.00 | 580.00 | 772.00 |

Standard errors in parentheses

Energy needs1 and Energy needs2 obtained from clean and dirty fuel using households, respectively.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Effect of female and male targeted treatments - Augmented DID estimates

| | Pressure cooker | Chimney fitted stoves | | | Battery operated lamps | | |
|---|---|---|---|---|---|---|---|
| | Kerala | All | Kerala | UP | All | Kerala | UP |
| Timeperiod | -0.00 | 0.00 | -0.00 | -0.00 | -0.02 | -0.00 | -0.03 |
| | (0.02) | (0.01) | (0.02) | (0.02) | (0.04) | (0.04) | (0.05) |
| Treat-males | 0.00 | -1.00 | -0.00 | -0.00 | -0.10 | -1.04 | 0.26 |
| | (0.57) | (1.46) | (0.48) | (0.11) | (4.30) | (1.15) | (0.35) |
| Treat-females | -0.03 | -1.02 | 0.48 | -0.01 | 0.40 | -1.08 | 0.09 |
| | (0.92) | (1.09) | (0.78) | (0.10) | (3.21) | (1.84) | (0.32) |
| Timeperiod*Treat-males | -0.01 | -0.00 | 0.00 | 0.00 | 0.20*** | 0.07 | 0.30*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.04) | (0.05) | (0.07) |
| Timeperiod*Treat-females | 0.05** | 0.03** | 0.04** | 0.03 | 0.19*** | 0.15*** | 0.22*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.05) | (0.05) | (0.07) |
| HH head is 10th graduate (d) | -0.00 | -0.00 | 0.00 | 0.00 | 0.00 | -0.00 | -0.02 |
| | (1.56) | (1.51) | (1.32) | (0.11) | (4.46) | (3.13) | (0.36) |
| Cook is 10th graduate (d) | 1.00 | 0.00 | -0.00 | 0.00 | -0.00 | 0.00 | 0.17 |
| | (1.31) | (1.27) | (1.11) | (0.17) | (3.74) | (2.62) | (0.52) |
| HH asset index | 0.00 | 0.00 | -0.00 | -0.00 | -0.00 | 0.00 | 0.19 |
| | (0.49) | (0.47) | (0.41) | (0.04) | (1.40) | (0.98) | (0.14) |
| Distance to nearest town (km) | 0.00 | 0.00 | -0.00 | 0.00 | -0.00 | 0.00 | 0.01 |
| | (0.05) | (0.04) | (0.04) | (0.02) | (0.13) | (0.09) | (0.07) |
| Toilet (d) | -0.00 | -0.00 | 0.00 | 0.00 | 0.00 | -0.00 | -0.24 |
| | (0.90) | (0.87) | (0.76) | (0.15) | (2.57) | (1.80) | (0.47) |
| Constant | -0.00 | 1.00 | 0.00 | -0.00 | 0.01 | 1.00 | 0.56 |
| | (0.63) | (1.46) | (0.53) | (0.37) | (4.30) | (1.25) | (1.16) |
| HH fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 580.00 | 1352.00 | 580.00 | 772.00 | 1352.00 | 580.00 | 772.00 |

Standard errors in parentheses

Estimates for pressure cooker usage in UP are not presented since there was no change in usage over-time.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: Differences in differences estimates with propensity matching for energy appliances

| | Information to males | | Information to females | |
|---|---|---|---|---|
| | Kerala | UP | Kerala | UP |
| **Share energy needs using clean fuel using households** | | | | |
| Difference in difference estimates | -0.02 | -0.04 | -0.05 | 0.02 |
| | (0.04) | (0.03) | (0.04) | (0.03) |
| Difference in differences with Radius matching | -0.22 | -0.03 | -0.25 | 0.03 |
| | (0.06) | (0.03) | (0.05) | (0.03) |
| Difference in differences with Kernel matching | -0.22 | -0.03 | -0.25 | 0.03 |
| | (0.06) | (0.03) | (0.05) | (0.03) |
| **Pressure cookers** | | | | |
| Difference in difference estimates | -0.01 | 0.00 | 0.05** | 0.00 |
| | (0.02) | (0.00) | (0.02) | (0.00) |
| Difference in differences with Radius matching | -0.01 | 0.00 | 0.05** | 0.00 |
| | (0.01) | (0.00) | (0.02) | (0.00) |
| Difference in differences with Kernel matching | -0.01 | 0.00 | 0.05** | 0.00 |
| | (0.01) | (0.00) | (0.02) | (0.00) |
| **Chimney stoves** | | | | |
| Difference in difference estimates | 0.00 | 0.00 | 0.04** | 0.03 |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Difference in differences with Radius matching | 0.00 | 0.00 | 0.04** | 0.03 |
| | (0.00) | (0.00) | (0.02) | (0.02) |
| Difference in differences with Kernel matching | 0.00 | 0.00 | 0.05** | 0.03 |
| | (0.00) | (0.00) | (0.02) | (0.02) |
| **Battery operated lamps/ LED lamps** | | | | |
| Difference in difference estimates | 0.07 | 0.30*** | 0.15*** | 0.22*** |
| | (0.05) | (0.07) | (0.05) | (0.07) |
| Difference in differences with Radius matching | 0.07*** | 0.27*** | 0.15*** | 0.21*** |
| | (0.03) | (0.08) | (0.04) | (0.08) |
| Difference in differences with Kernel matching | 0.07*** | 0.27*** | 015*** | 0.21*** |
| | (0.03) | (0.07) | (0.04) | (0.07) |

*Source: Baseline survey and follow-up survey data collected from Kerala and Uttar Pradesh in 2012-13*
*Note: The data contains households which did not drop out in the follow-up survey.* * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; *Standard errors are given in the parenthesis.*

Table 20: Heterogeneity of effect of information on appliance usage

| | Pressure cooker | | Chimney fitted stoves | | Battery operated lamps | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Timeperiod | -0.00 | -0.00 | 0.00 | 0.00 | 0.00 | -0.04 |
| | (0.01) | (0.01) | (0.02) | (0.01) | (0.06) | (0.04) |
| Treat-males | 0.18 | 0.00 | -1.00 | -1.00 | -0.04 | -0.12 |
| | (8936.40) | (0.99) | (1.46) | (1.46) | (4.26) | (4.29) |
| Treat-females | -0.02 | -0.00 | -0.52 | -0.52 | -0.08 | -0.09 |
| | (223.10) | (0.77) | (1.14) | (1.14) | (3.32) | (3.35) |
| Timeperiod*Treat-males | -0.01 | -0.01 | -0.00 | -0.00 | 0.07 | 0.25*** |
| | (0.02) | (0.01) | (0.02) | (0.02) | (0.07) | (0.05) |
| Timperiod*Treat-females | 0.05*** | 0.01 | 0.04* | 0.04** | 0.15** | 0.19*** |
| | (0.02) | (0.01) | (0.02) | (0.02) | (0.07) | (0.06) |
| HH asset index | -0.14 | -0.00 | 0.00 | 0.00 | -0.00 | -0.00 |
| | (7018.33) | (0.32) | (0.47) | (0.47) | (1.39) | (1.40) |
| HH head is 10th graduate (d) | 0.44 | 0.00 | -0.00 | -0.00 | 0.00 | 0.00 |
| | (22341.27) | (1.03) | (1.51) | (1.51) | (4.42) | (4.46) |
| Cook is 10th graduate (d) | 0.64 | 1.00 | 0.00 | 0.00 | -0.00 | 0.04 |
| | (17983.43) | (0.86) | (1.27) | (1.27) | (3.71) | (3.74) |
| Bijnor | 1.16 | 1.00*** | -0.49*** | -0.50*** | 0.48 | 0.50 |
| | (6878.00) | (0.09) | (0.14) | (0.14) | (0.41) | (0.41) |
| Bijnor*Timeperiod | 0.00 | | -0.00 | | -0.03 | |
| | (0.02) | | (0.03) | | (0.07) | |
| Bijnor*Timeperiod*Treat-males | 0.01 | | 0.00 | | 0.22** | |
| | (0.02) | | (0.03) | | (0.09) | |
| Bijnor*Timeperiod*Treat-females | -0.05** | | -0.02 | | 0.07 | |
| | (0.02) | | (0.03) | | (0.09) | |
| Toilet (d) | 0.25 | 0.00 | -0.00 | -0.00 | 0.00 | 0.00 |
| | (12806.30) | (0.59) | (0.87) | (0.87) | (2.55) | (2.57) |
| Cook 10th graduate*Timeperiod | | 0.00 | | -0.00 | | 0.06 |
| | | (0.02) | | (0.03) | | (0.08) |
| Cook 10th graduate*Timeperiod*Treat-males | | 0.01 | | 0.00 | | -0.15 |
| | | (0.02) | | (0.03) | | (0.10) |
| Cook 10th graduate*Timeperiod*Treat-females | | 0.04* | | -0.02 | | -0.01 |
| | | (0.02) | | (0.03) | | (0.10) |
| Distance to nearest town (km) | | -0.00 | 0.00 | 0.00 | -0.00 | -0.00 |
| | | (0.03) | (0.04) | (0.04) | (0.13) | (0.13) |
| Constant | -0.49 | -0.00 | 1.00 | 1.00 | -0.00 | 0.02 |
| | (24750.68) | (0.99) | (1.46) | (1.46) | (4.27) | (4.30) |
| HH fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1352.00 | 1352.00 | 1352.00 | 1352.00 | 1352.00 | 1352.00 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$