Fueling Demand: The Effect of Rebates on Household Purchase of Improved Cookstoves in Rural India

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EXECUTIVE SUMMARY

Over one half of the world's population uses solid and biomass fuels, such as wood and crop residues, for cooking and heating (Legros, et al., 2008). Inefficient combustion from solid fuel use leads to emission of smoke, particulate matter, and black carbon and is associated with increased health risks (Bonjour et. al., 2013), local and global environmental degradation (Grieshop et. al. 2011; Ramanathan & Carmichael, 2008), and barriers to household economic development (Wilkinson et. al. 2009).

Improved cookstoves (ICS) represent a compelling option for decreasing the health, environmental, and economic costs associated with solid fuel use (GACC, 2012). ICS draw on clean energy sources or improve combustion of solid fuels, which decreases exposure to HAP in households and may limit the negative health outcomes in women and children, as well as reducing emissions that contribute to climate change (Ramanathan & Carmichael, 2008). Improved fuel efficiency suggests that smaller quantities of wood are required for cooking and heating, thus reducing each household's time spent collecting wood and decreasing local deforestation.

However, the challenge in realizing the potential gains from ICS lies in encouraging both initial investment and sustained use of ICS technology (Jeuland & Pattanayak, 2012, Ruiz-Mercado et al., 2011). Households in rural, low-resource settings, where solid fuel use is high, are often budget constrained and have exhibited low demand for ICS and other preventative health technology (Hanna et al., 2012, Levine & Cotterman, 2012, Lewis & Pattanayak, 2012, Dupas, 2011). Previous studies suggest that the low demand for ICS may be the result of a range of barriers, including inability to pay or low willingness to pay for ICS (Levine & Cotterman, 2012), as well as a lack of understanding of ICS benefits and use (Shell Foundation, 2013), low trust in new technologies (Miller & Mobarak, 2011), and poor cultural acceptability (Tronsoco et al., 2007).

Using two rounds of survey data from Duke University's stove sales randomized control trial in rural Uttarakhand, India, I use a household adoption framework to model a household's decision to purchase ICS (Pattanayak & Pfaff, 2009). I specifically examine the effect of a rebate offer in incentivizing ICS purchase and additionally consider the influence of local institutional, community, and household-level factors associated with a household's stove purchase decision.

The study's stove sales intervention targeted key barriers to ICS adoption by incorporating 1) information, education, and communication (IEC) activities related to stove benefits and use; 2) a choice of two improved stoves, including an electric G-Coil and natural draft Greenway biomass stove; 3) an installment plan option, wherein households spread out stove payments over three visits; and, 4) a randomly assigned rebate offer, which reduced the price of the stove by one of three-levels, and was contingent upon stove use.

Sales results indicate a high demand for ICS among households offered the stove sales intervention. In the entirety of the treatment group, 51% of households purchased a stove. Of the stove types offered, demand for the electric Gcoil stove was highest, encompassing 70% of the stoves sold. Of the group that purchased a stove, 20% purchased a biomass Greenway stove and 10% purchased one of each type of stove. Following the intervention, 65% of treatment households owned any kind of improved stove, compared with 31% owning an improved stove at baseline.

The randomized rebate offer shows a positive and highly significant effect on household ICS purchase. In all models, the percentage of households purchasing stoves increased as the rebate increased (and price paid decreased). At the highest rebate level, 72% of households purchased an ICS, with 54% and 27% of households purchasing at the middle and lowest rebates, respectively. Further, average marginal effects of the rebate offer on the type of stove purchased indicate that assignment to one of the two higher rebate levels causes a household to be more likely to purchase a Gcoil electric stove over their traditional stove.

A number of community and household characteristics are significantly correlated with stove purchase, giving insight into types of households that may be more likely to adopt ICS. Examination of the role of local NGOs in a community introduces a nearly 16% increase in stove purchase suggesting the importance of understanding local institutions in ICS service delivery. Additional analyses demonstrate the influence of a household's use of savings and credit, finding that rebate's effect on stove purchase is significantly higher among households that lack experience with savings.

This analysis finds that there is a high demand for improved stoves, especially with substantial 'use-related' rebates. Deliberate experimentation with various rebates provides further understanding of price elasticities, which may guide planning and marketing. However, further focus is needed in building a reliable supply of ICS, especially given the challenging environments that small market-based approaches to ICS distribution face in developing countries. When further challenged with low ICS demand and a market distorted by subsidies, local market-based supply chains may flounder. This study's findings suggest that NGOs may serve as an important institutional complement to market-based supply that leverages local networks of trust and contextual knowledge.

I. INTRODUCTION

Over one half of the world's population uses solid and biomass fuels, such as wood and crop residues, for cooking and heating (Legros, et al., 2008). Inefficient combustion from solid fuel use leads to emission of smoke, particulate matter, and black carbon and is associated with increased health risks (Bonjour et. al., 2013), local and global environmental degradation (Grieshop et. al. 2011; Ramanathan & Carmichael, 2008), and barriers to household economic development (Wilkinson et. al. 2009).

Solid fuel use contributes to Household Air Pollution (HAP), which represents the third largest contributor to the global burden of disease worldwide (Lim, et al. 2012). HAP exposure is higher among women and children (Bates, 2013) leading to increased negative health outcomes, including Acute Respiratory Infection (ARI), Chronic Obstructive Pulmonary Disease (COPD), and cardiovascular diseases (Kurmi, et. al. 2010). Disease incidence from solid fuel use is occurs in high solid fuel use regions, concentrated in developing countries of the world (Figure 1) where access to and experience with modern fuels is limited (Legros et. al., 2008).

Community, regional, and global environmental costs result from reliance on biomass fuel use (Wilkinson, et al., 2009). Collection of biomass induces local deforestation, loss of biodiversity (Grieshop, 2011) and contributes to outdoor air pollution (Ramanathan & Carmichael, 2008). Burning solid fuels, even at a household level, contributes to ozone depletion and global climate change through emission of greenhouse gases (Ramanathan & Carmichael, 2008). Further, black carbon emissions, which absorbs UV light, can lead to solar heating and glacial melt at high elevations (Ramanthan & Feng, 2008), as well as decreased agricultural yields (Venkataraman, 2010).

Dependence on solid fuels for cooking also elicits time and monetary costs. The burden of solid fuel collection falls on women and children, who often must divert involvement in other activities that could enhance economic livelihoods or social growth, such as education (Kohlin et al, 2011). Further, fuel collection may occur over significant distances, exposing household members to increased personal safety risks. Additionally, households face growing monetary costs if purchasing fuel (Dalberg, 2013), which further constrains already limited household budgets.

Thus, improved cookstoves (ICS) represent a compelling option for decreasing the health, environmental, and economic costs associated with solid fuel use (GACC, 2012).[1] Improved stoves draw on clean energy sources or improve combustion of solid fuels, which limited evidence suggests decreases exposure to HAP in households and may limit the negative health outcomes in women and children, as well as reducing emissions that contribute to climate change (Ramanathan & Carmichael, 2008). Improved fuel efficiency suggests that smaller quantities of wood are required for cooking and heating, thus reducing each household's time spent collecting wood and decreasing local deforestation.

However, the challenge in realizing the potential gains from ICS lies in encouraging both initial investment and sustained use of ICS technology (Jeuland & Pattanayak, 2012, Ruiz-Mercado et al., 2011). Households in rural, low-resource settings, where solid fuel use is high, are often budget constrained and have exhibited low demand for ICS and other preventative health technology (Hanna et al., 2012, Levine & Cotterman, 2012, Lewis & Pattanayak, 2012, Dupas, 2011). Previous studies

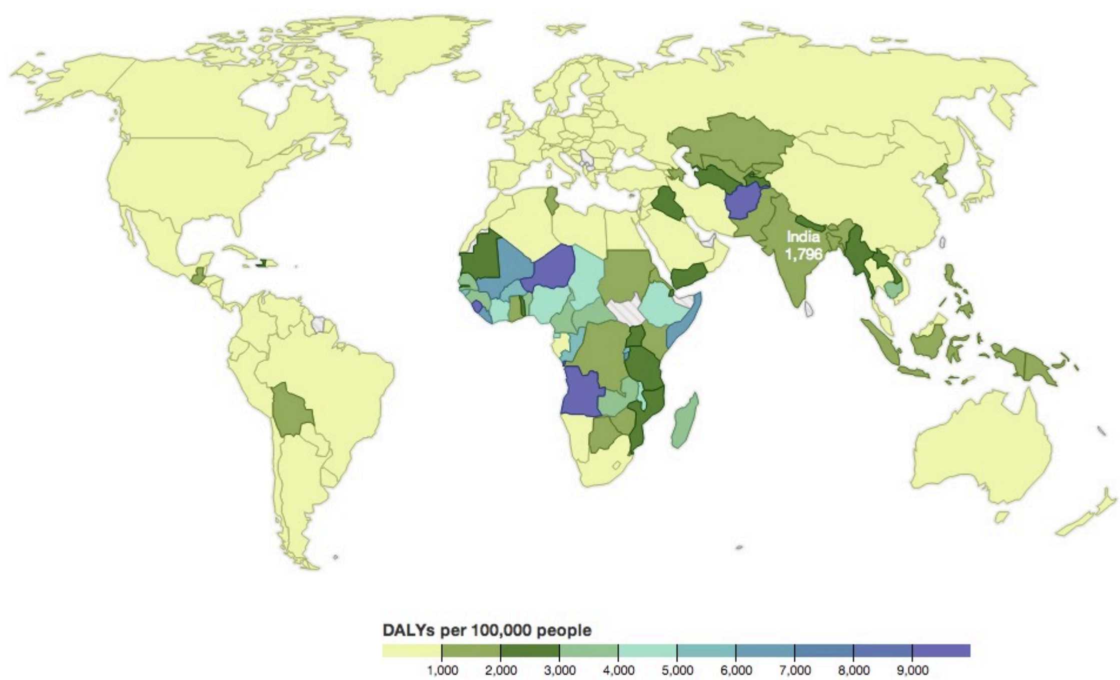
[1] ICS, as defined in this analysis, includes any improved clean stove, including kerosene, LPG, and electric. Cleaner burning stoves using, such as those that use LPG and kerosene, offer air quality benefits beyond stoves that burn biomass and solid fuels (Grieshop et al., 2011). Electric stoves also represent a clean-burning option, though accrue additional energy costs (Lewis and Pattanayak, 2012) that may incur increased household fuel costs, as well as additional environmental costs associated with electricity generation.

suggest that the low demand for ICS may be the result of a range of barriers, including inability to pay or low willingness to pay for ICS (Levine & Cotterman, 2012), as well as a lack of understanding of ICS benefits and use (Shell Foundation, 2013), low trust in new technologies (Miller & Mobarak, 2011), and poor cultural acceptability (Tronsoco et al., 2007).

In this analysis, I incorporate a household adoption framework to understand a household's decision to purchase ICS, a key precursor to long-term sustained use of clean cooking technology. This framework models a household's decision to purchase ICS through a calculus of marginal benefits and costs (Pattanayak & Pfaff, 2009). Budget-constrained rural households may weigh time, monetary, and knowledge costs against the potential long-term health and time-savings benefits of ICS, all of which depend on a household's heterogeneous experiences, perceptions, and characteristics. Using data from a stove sales randomized control trial that includes a novel financing offer in rural India (Pattanayak et al., 2012), I use this framework to specifically examine the effect of a rebate offer in incentivizing ICS purchase. Additionally, I consider the influence of local institutional, community, and household-level factors associated with a household's stove purchase decision.

India presents an important context in which to understand ICS demand. With a very large population that relies on solid-fuels and suffers from HAP-related illness, the potential for gains through widespread ICS adoption are large (Legros et al., 2008). In India, roughly 400 million people are exposed to indoor air pollution associated with solid fuel use, causing over 875 thousand deaths annually (Dalberg, 2013). Further, recent policy changes signal India's readiness to embrace clean energy development; The Indian Biomass Cookstove Initiative, enacted in 2009, aims to provide low-income households with access to clean cooking options on a national scale (Venkataraman, 2010).

Figure 1. Global Incidence of Acute Respiratory Illness (DALYs per 100,000 people)



(World Health Organization, 2010)

II. LITERATURE

Given the low demand for ICS and other environmental health technologies, targeting a wide variety of price and non-price household barriers to purchase, as well as stimulating demand may be necessary to encourage uptake and sustained use (Meredith, et al., 2013; Dalberg, 2013). For example, a recent systematic review shows that the effectiveness of social marketing strategies that target the four "Ps" of price, place, product and promotion for improving demand for water and sanitation products in developing countries (Evans et al., 2014). Bailis et al. (2009) contend that the few, large-scale successful ICS dissemination programs currently in existence have all leveraged business principles and market-based approaches to solving ICS challenges.

Costly investments in ICS present a challenge to budget constrained households (Pattanayak & Pfaff, 2009). Given these constraints, stove price may play a large role in a household's initial decision to replace a traditional mud or three-stone stove, a "free" technology, and invest in a more expensive stove option (Jeuland & Pattanayak, 2012, Rehman, et al., 2008). Evidence suggests price changes may stimulate household purchase of ICS technology, as demand for environmental health technology in low-resource countries is highly price-elastic (Dupas, 2011; Miller & Mobarak, 2011; Beyene, et al., 2012).

Table 1. Existing ICS-specific adoption studies using novel finance offers to promote technology purchase

Author/Year	Location	Rural/ Urban	Design	Sample size	Finance offer	Adoption rate
Miller & Mobarak, 2011	Bangladesh	Rural	Experimental	2280 households	Subsidy: 50% stove price	7%
Levine & Cotterman, 2012	Uganda	Rural	Experimental	355 households	Free trial & installments (3)	46%
Silk, et al., 2012	Kenya	Rural	Experimental	5868 households	Subsidy: ~25%	8%

Subsidized prices, such as rebates or other novel financing, target this price sensitivity and encourage household investment in environmental health products (Lagarde, et al., 2012; Cole et al, 2012). However, few studies have generated nuanced preventative health or ICS-specific findings related to subsidies' effects on stove purchase (Table 1). The few existing ICS studies demonstrate low demand for ICS in a variety of contexts and limited efficacy of finance offers to stimulate adoption of improved cookstoves, with household adoption rates varying between seven and 46 percent. Several studies further suggest that without subsidized ICS dissemination, the poorest households would not adopt clean stove technology, as other household needs are often prioritized (Rehfuess, 2014).

A household's time preferences can also impact investments in preventative health technologies (Rehfuess, 2014). For example, "impatient" households who prefer immediate outcomes may be unwilling to purchase ICS because some returns on investment, such as health or environmental benefits, are realized many years in the future, or are not always apparent (Atmadja et al., 2012). Further, time preferences may also determine household liquidity and savings, which affect a household's ability to purchase an improved cookstove. Individuals who prefer to spend money on consumption or leisure spending today are likely to lack cash-in-hand for relatively large purchases, such as improved cookstoves, in the future. Therefore, spreading payments out over time through installments may increase some households' ability or willingness to pay for ICS.

Households may additionally be reluctant to invest in new technologies, such as ICS, if they are inexperienced or have a low level of trust in the stove's benefits or the sales offer. Thus, most demand promotion campaigns try to give households information with different combinations of education, information, and communication strategies (Hamoudi et al., 2012). Specifically, receiving information from a trusted local community institution, such as a local grassroots NGO, may influence reluctant households to invest in ICS and other similar products like pit latrines (Pattanayak et al., 2009). For example, Cole et al. (2012) and Levine & Cotterman (2011) test the notion that that ‘trust matters’ and find that when endorsed by a local institution or village leader, preventative services and products are significantly more likely to be purchased.

Local grassroots NGOs, institutions which work closely in and with local communities to further development, enable the service delivery of community programs and may play a key role in facilitating adoption of improved cookstoves. Firstly, local NGOs build influence in a community through establishing social trust (Islam, et al. 2011) and may improve long-term sustainability of an intervention, particularly if the organization has held a long-standing presence in the community (Alsop, 2005). Secondly, NGOs hold great contextual knowledge of local practices (Watkins, 2012, Alsop, 2005, Islam, 2011) enabling them to position behavior change in a way that a more distant government agency (Devi, 2013). Though empirical studies relating NGO and CBO implementation to cookstoves and environmental health interventions are rare, growing evidence of NGO implemented health programs shows the promise of NGOs in facilitating successful interventions (Watkins et al., 2012). Quasi-experimental studies show improved equity and coverage of government-sponsored health programs when implemented through contracted NGOs by delivering improved decentralized access (Bhushan, et al., 2002) and increased training and oversight (Baqui et al., 2008). Finally, heterogeneity of NGO visions and approaches may lead to different strategies and outcomes for ICS promotion (Troncoso et al., 2011). Understanding the nuances of NGO implementation is critical to understanding optimal service delivery, as well as strengthening social capital and community empowerment (Islam et al., 2011).

There are many community-level context and household-specific characteristics that may be influential in driving purchase of cookstoves (Lewis & Pattanayak, 2012, Refuess, 2014). Higher socio-economic status, which is often measured using household head’s education level and household wealth (or assets), have been and continue to be important characteristics of likely cookstove adopters (Rehfuess et al., 2014, Miller & Mobarak, 2011). Household income and proxies for wealth, such as household size, are often correlated with ICS purchase (Levine et al., 2010). Presence of other health-risk avoidance technologies, such as water filters or improved toilets, may signal a willingness to invest in additional risk avoidance (Pattanayak & Pfaff, 2009). Access to credit and banking services may be an additional determinant of cookstove adoption based on household ability to pay for a stove, or willingness and comfort to engage in a financing offer (Alem, et al. 2013).

III. EXPERIMENT & DATA COLLECTION

I use experimental data to test some of the theories of demand promotion discussed in the previous section. Specifically, the data used in this analysis comes from an experiment and two rounds of surveys that were part of Duke University’s TRAction study on adoption of ICS in rural India (Pattanayak et al., 2012). The baseline survey data were collected in July and August 2012 by trained enumerators. The intervention was carried out from August to December 2013 (some intervention activities are ongoing) with a group randomly selected from the survey sample in the state of Uttarakhand in the lower Himalayas.

As previous exposure to institutional NGO intervention is a key interest of the study, communities in the two districts of Bageshwar and Nanital were stratified by the presence of a local, grassroots NGO (Chirag). Therefore, villages were selected into the survey sample by considering villages with Chirag presence that could be matched to villages without Chirag presence along several census characteristics. Nearest-neighbor propensity score matching was used to match “Chirag villages” with “non-Chirag villages”, similar to previous studies using pre-evaluation matching to examine water interventions in low-resource settings (Pattanayak et al., 2010). Village sub-clusters were delineated as small, medium or large population size. Of the 38 cluster communities identified, 106 geographically distinct sub-cluster hamlets or villages were identified, from which 1050 households were surveyed.

Households in each village were randomly selected at baseline using the right hand rule and by counting off every *n*th household. The *n*th number was established by village size, dividing the population by 13, but not exceeding every 8th household. Additional divisions were made in each sub-cluster to ensure spatial variation. Small, medium, and large sub-clusters received 20, 30, and 40 surveys, respectively. In the case where a household was unavailable, a neighboring household was randomly selected.

Table 2. Descriptive Statistics, Intervention group (N=771)

	N	Mean	Standard Deviation	Median	Min	Max
Household size	771	4.78	2.07	5	1	14
Total # rooms in house	768	4.70	2.48	4	1	22
Monthly HH expenditure (Rs.)	749	5729	5124	5000	0	70,000
Improved primary water source	771	.63	.48	1	0	1
Presence of toilet	771	.84	.37	1	0	1
Household owns mobile phone	771	.83	.38	1	0	1
Owns/leases agricultural land	753	.98	.125	1	0	1
Education, Head of HH (years)	757	4.85	4.53	6	0	18
Education, Primary Cook (years)	752	4.65	4.46	5	0	18
Minutes per day spent cooking (traditional stove)	771	287.09	146.34	240	0	1440
Minutes per day spent cooking (improved stove, including LPG)	771	47.26	95.06	0	0	600
Household owns improved stove (not including LPG)	753	.32	.47	0	0	1
HH has taken loan in past year	771	.16	.37	0	0	1
HH saved money at MFI or bank in past year	771	.11	.31	0	0	1
Hours of electricity per day	740	16.99	7.27	20	0	24
HH believes ICS has medium or better impact	771	.30	.46	0	0	1
% of HH sick in past 2 weeks	771	.08	.19	0	0	1
Presence of transit facilities	764	.57	.50	1	0	1
Presence of NGO	771	.53	.50	1	0	1

The baseline survey was conducted with the primary cook or head of household. The survey instrument asked respondents about perceptions, existing knowledge, and use of cookstoves (improved and traditional) including relevant fuels; household members' demographics including education, health, previous illness and experience with respiratory diseases; and household socioeconomic characteristics. An additional community questionnaire that was administered to the village leader or *pradhan* in each Gram Panchayat's revenue village collected information on community characteristics, such as infrastructure, organizations, and demographics.

The intervention, implemented approximately 15 months after baseline, was offered to 771 households in the treatment group, all of which had been surveyed at baseline in 70 sub-cluster hamlets.[2] The randomization was successful; key household characteristics were balanced (statistically insignificantly different) across different arms of randomization (see Appendix, Table A.2).

Table 3. TRAction Intervention: Stove Costs and Rebate Offers

Stove Type	Traditional	Greenway (biomass fuel)	G-Coil (electric)
Stove Cost (INR/US$)	Rs. 0 $0	Rs. 900 $18	Rs. 1300 $26
Stove cost as % of average monthly household expenditure	0%	15.7%	22.7%

Rebate level	Rebate 1	Rebate 2	Rebate 3
Subsidy (INR)	Rs. 25	Rs. 200	Rs. 320 or Rs. 460 (1/3 of stove cost)
Subsidy (US$)	US$ .50	US$4	US$ 6.50 or US$ 8.75

TRAction intervention activities were informed by baseline survey analysis, existing literature and empirical evidence, as well as a series of carefully designed pilot interventions. Elements targeting key barriers to ICS adoption were tested in small-scale pilot programs in eight villages in three different Indian states, including Uttarakhand (Lewis et al., 2014). Inclusion of information, education, communication (IEC) activities, such as viewing a stove use demonstration and intensive social marketing, led to significant increases in household purchase of ICS. Experimentation of stove sales offers including stove return, installment plans, and rebate offers showed highest uptake by combining installment and rebate offers. Finally, several models of manufactured ICS were additionally offered in pilots, with results indicating greatest interest in electric stoves over natural draft biomass-fueled stoves, when they were offered together.

Households in villages randomly selected for intervention received stove sales offers comprised of four main components targeting known barriers to ICS adoption (Figure 2).

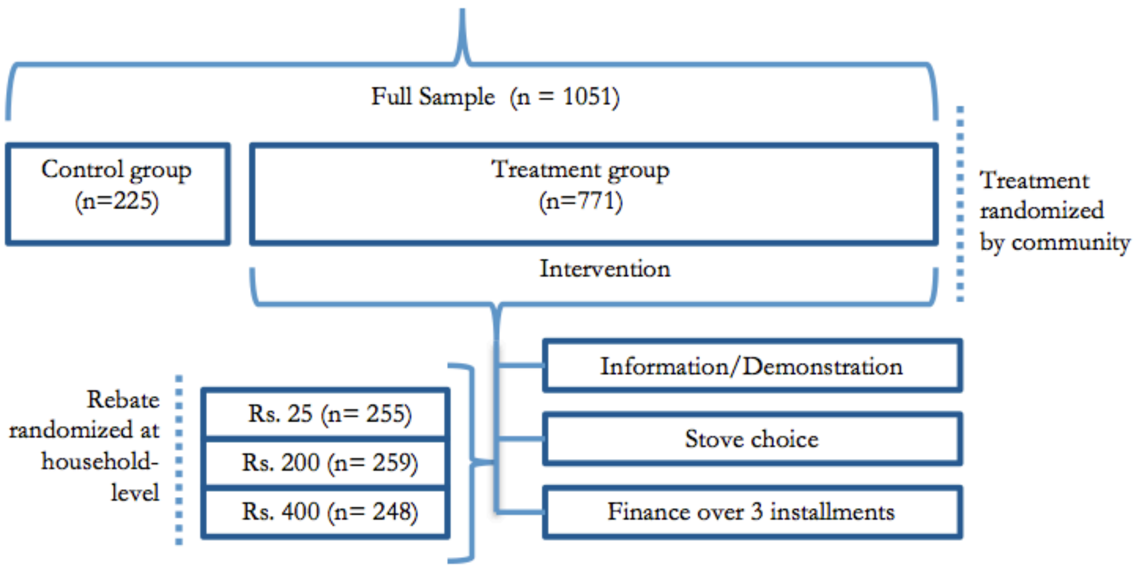
1. Households received a promotional pamphlet detailing attributes of improved stoves and features, including fuel and time-savings, costs of operation, and costs of stoves, as well as a demonstration of use of improved stoves.
2. A choice of two stoves was offered to households, a natural-draft, improved biomass stove, the Greenway Smart Stove, and the G-Coil electric stove. Households were permitted to buy up to two stoves and were able to purchase one of each, if desired.
3. Households were given an installment plan option, wherein they spread out stove payments over three visits, making payments smaller and further apart.

[2] It is important to note that 128 households in the treatment group were not offered the rebates because they either refused to participate in the sales offer or the dwelling was empty. Of the households that refused the offer, 43 households were in communities with an NGO presence. Rebates have been randomly assigned to these households for this analysis. As with the overall randomization, we assume a similar random distribution for the households that refused the offer.

4. Households were randomly assigned one of three rebate offers, reducing the cost of the stove by 25 INR (US$.50), 200 INR (US$4), or one-third of the cost of the stove, referred to as an average discount of approximately 400 INR (US$8).

Households purchasing more than one stove used the rebate offer only once. Trained stoves sales teams, recruited and trained through NGO partner, Chirag, collected all data on stove purchases. At the time of intervention, treatment households were given brief surveys that asked respondents about stoves in use and reasons for purchasing or not purchasing the stoves being sold. Table 2 shows the stove costs and subsidies given at each rebate level during the intervention.

Figure 2. Features of stove sales intervention



III. ESTIMATING MODELS

Because rebates were randomly assigned at the household level, I assume that rebate levels are uncorrelated with characteristics of the household, which allows for a causal estimation of the treatment effect. I conduct balance tests to compare means of several variables for treatment and control groups (and rebate-levels), using a normalized difference metric. As shown in Table A1 and A2 (Appendix), the sub-samples in each group are balanced; i.e., the normalized difference for each of the key variables is less than the threshold of |0.25|. The only exception is a variable measuring transit facilities, which does not present a great concern, but may indicate a small degree of community-level access differences. Households included in this sample received an approximately equal distribution of each rebate level, as demonstrated by Table A3 (Appendix).

To examine the treatment effect of the rebate offer on probability of stove purchase, I use probit regressions. First, I use a simple specification linking exogenous rebate assignment to probability of ICS purchase, where *Rebate2* represents the payment of Rs. 200 and *Rebate3* represents one-third of the cost of the stove (Rs. 300 – Rs. 460), compared to receiving the nominal rebate of Rs. 25 (1.1). In this and following models, each rebate level is represented by a binary indicator variable.

$$Y_i = \beta_0 + \beta_1 Rebate2_i + \beta_2 Rebate3_i + \varepsilon_i \qquad (1.1)$$

Second, I examine if specific baseline household characteristics (W) are correlated with the probability of ICS purchase.

$$Y_i = \beta_0 + \beta_1 Rebate2_i + \beta_2 Rebate3_i + \beta_3 W_i + \varepsilon_i \qquad (1.2)$$

Third, I consider the effect of rebate assignment on the choice of stove type purchased (Gcoil or Greenway) using multinomial logistic regression. Whittington et al. (2002) provide an example of using such models to examine rural household choice between different kinds of environmental health technologies in the South Asian context.

$$Y_{ij} = \beta_0 + \beta_1 Rebate25_{ij} + \beta_2 Rebate200_{ij} + \varepsilon_{ij} \qquad (1.3)$$

To examine the role of local grassroots NGOs I first examine the role of a local grassroots NGO presence independently.

$$Y_i = \beta_0 + \beta_1 NGO + \varepsilon_{ij} \qquad (2.1)$$

Incorporating a vector of baseline household characteristics, V, I examine correlations of household and community-level factors, and NGO presence with probability of ICS purchase.

$$Y_i = \beta_0 + \beta_1 NGO + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 V_i + \varepsilon_i \qquad (2.2)$$

Further, I examine the joint influence of rebates and NGO presence by including interaction terms.

$$Y_i = \beta_0 + \beta_1 NGO + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 Rebate2_i * NGO + \beta_5 Rebate3_i * NGO + \varepsilon_i \qquad (2.3)$$

$$Y_i = \beta_0 + \beta_1 NGO + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 V_i + \varepsilon_i \quad P(Y|NGO) \qquad (2.4)$$

I use multinomial logistic regression to estimate the effect rebate assignment and NGO presence in a community on purchase of stove type.

$$Y_{ij} = \beta_0 + \beta_1 NGO_{ij} + \varepsilon_{ij} \qquad (2.5)$$

Next, given the potential importance of credit and liquidity constraints, I consider the impact of two household financial decisions in the past year: (a) saving in a financial institution, and (b) taking a loan. First, I examine the independent influence of households saving and credit use on probability of stove purchase (3.1).

$$Y_i = \beta_0 + \beta_1 Save + \beta_2 Credit + \varepsilon_i \qquad (3.1)$$

Second, I include a vector of household characteristics, T.

$$Y_i = \beta_0 + \beta_1 Save + \beta_2 Credit + \beta_3 Rebate2_i + \beta_4 Rebate3_i + \beta_5 T_i + \varepsilon_i \qquad (3.2)$$

Third, I examine the impact of household saving in the past year jointly with the exogenous rebate assignment using interaction terms (3.3) and again with those households that have using credit in the past year (3.4).

$$Y_i = \beta_0 + \beta_1 Save + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 Rebate2_i{*}\, Save + \beta_5 Rebate3_i{*}Save + \varepsilon_i \quad (3.3)$$

$$Y_i = \beta_0 + \beta_1 Credit + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 Rebate2_i{*}Credit + \beta_5 Rebate3_i{*}Credit + \varepsilon_i \quad (3.4)$$

Fourth, I conduct sub-sample analyses of vectors of HH characteristics, *P* and *Q*, and their influence on stove purchase in sub-populations conditioned by saving in the past year (3.5) or taking a loan in the past year (3.6).

$$Y_i = \beta_0 + \beta_1 Save + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 P_i + \varepsilon_i \quad P(Y \mid Save) \quad (3.5a\text{-}b)$$

$$Y_i = \beta_0 + \beta_1 Credit + \beta_2 Rebate2_i + \beta_3 Rebate3_i + \beta_4 Q_i + \varepsilon_i \quad P(Y \mid Credit) \quad (3.6a\text{-}b)$$

Finally, I again use multinomial logistic regression to model the association of savings and loan behavior on the choice of stove type.

$$Y_{ij} = \beta_0 + \beta_1 Save_{ij} + \beta_2 Credit_{ij} + \varepsilon_{ij} \quad (3.7)$$

For all regression analyses, I used clustered standard errors at the sub-cluster, or village, level, as treatment assignment was determined at this administrative level.

IV. RESULTS & DISCUSSION

Sales results indicate a high demand for ICS among households offered the stove sales intervention. In the entirety of the treatment group, 51% of households purchased a stove. Of the stove types offered, demand for the electric Gcoil stove was highest, encompassing 70% of the stoves sold. Of the group that purchased a stove, 20% purchased a biomass Greenway stove and 10% purchased one of each type of stove. Following the intervention, 65% of treatment households owned any kind of improved stove, compared with 31% owning an improved stove at baseline.

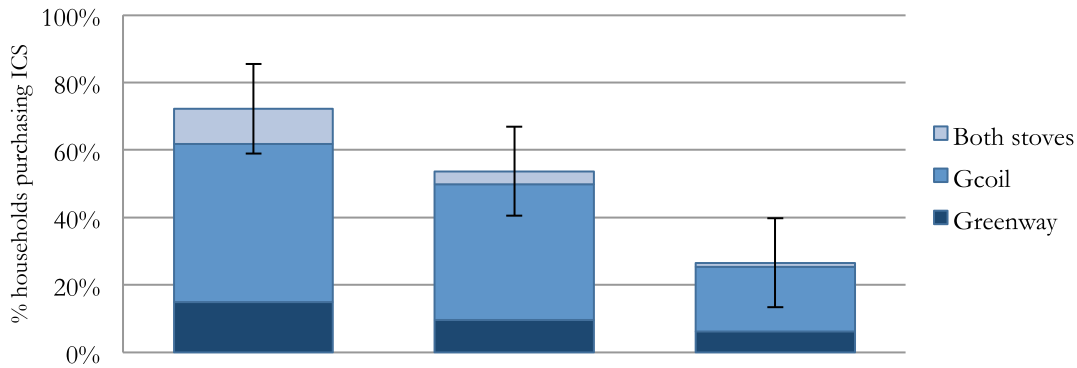
Rebates

The randomized rebate assignment allows me to causally link the rebate offer and a household's probability of purchasing ICS. As Figure 3 demonstrates, the percentage of households purchasing stoves increased as the rebate increased (and price paid decreased). At the highest rebate level, 72% of households purchased an ICS, with 54% and 27% of households purchasing at the middle and lowest rebates, respectively. The sales at each price allow us to trace out a demand curve for ICS (Figure 4). Multivariate regression results show that the average marginal effects of the rebates exhibit a similar pattern (Table 4, models 1.1-1.2); the regression coefficients of the second and third highest rebate levels are statistically significantly correlated with a higher probability of ICS purchase.

The rebate offered in the sales intervention effectively gave households a delayed subsidy, which both induced a price shock to households, such that the cost of the stove decreased, and encouraged households to experiment and become familiar with the stove, as the rebate offer was contingent upon observable use on the third visit. In the context of the household production framework previously described, the rebate offer's positive effect on ICS adoption is as expected. That is, rebates promote experimentation, which reduces knowledge costs associated with use of ICS, and larger rebates substantially decrease the monetary costs of purchasing the health-risk avoidance technology, proportionally inducing ICS adoption.

As additional household level controls are added (Table 4, model 1.2), the magnitude and significance of the rebate becomes stronger, further highlighting the effect of the rebate offer. By controlling for household characteristics associated with ICS adoption, I am likely accounting for factors negatively associated with household purchase. For example, an increase in percentage of household members sick in the past two weeks with cough or cold is negatively associated with ICS purchase.

Figure 3. Stove purchase by rebate



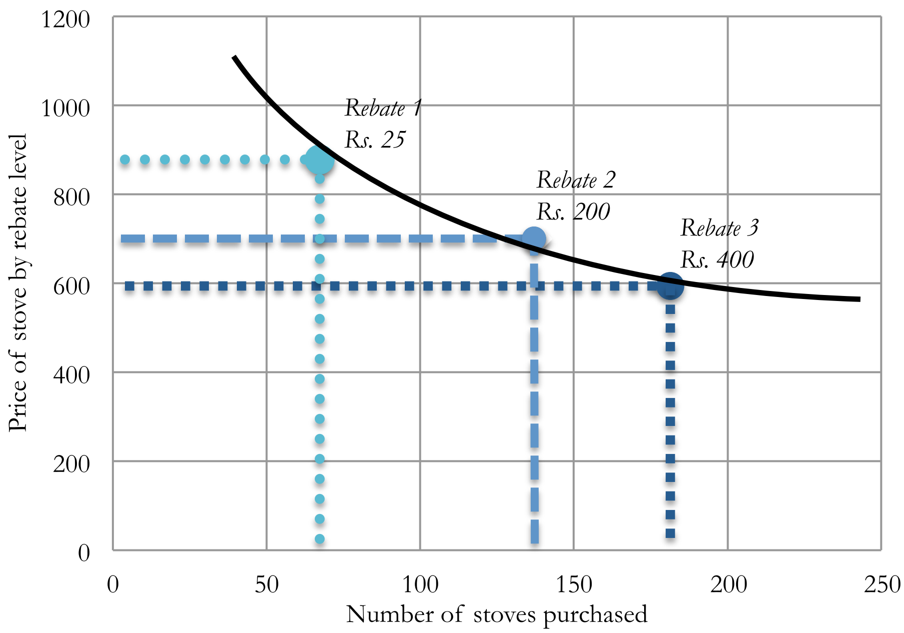
Rebate	Rs. 400[3]	Rs. 200	Rs. 25
Stove price[4]	Rs. 600	Rs. 700	Rs. 875

A number of community and household characteristics are significantly correlated with stove purchase, giving insight into types of households that may be more likely to adopt ICS. For example, households that owned improved stoves at baseline and those using improved water sources show a positive and significant probability of stove purchase, suggesting that houses that have made investments in air and water quality are more likely to invest in additional environmental health-risk avoidance by purchasing ICS. Additionally, households with constant access to electricity are significantly associated with probability of ICS purchase; 43% of treatment households with constant access (n=177) purchased a Gcoil electric stove. However, electricity access is significantly correlated with household expenditure, suggesting that its relationship with increased ICS purchase may also be accounting for high SES households (Table A4, Appendix).

Average marginal effects of the rebate offer on the type of stove purchased indicate that assignment to one of the two higher rebate levels causes a household to be more likely to purchase a Gcoil electric stove over their traditional stove (Table 6, model 1.3). This effect grows in strength and significance as the rebate level increases from Rs. 200 to Rs. 400. This result suggests that households receiving the higher rebate may be likelier to purchase Gcoil stoves because, while less expensive than the Greenway stove, they may perceive that higher initial subsidies will help to allay electricity costs of Gcoil use. Note, all households were told that the energy bill will increase because of the electric stove use.

[3] Highest rebate level (Rs. 400) reflects an average rebate based on one-third of stove cost for stoves of different prices (Greenway biomass: Rs. 1300 and Gcoil electric: Rs. 900).
[4] Stove prices reflect purchase of Gcoil electric stove.

Figure 4. Demand curve for ICS purchase by stove price/rebate level[5]



NGO Presence

As Figure 5 demonstrates, the role of local NGOs in a community introduces a nearly 16% increase in stove purchase. However, the role of NGOs may hold further importance when considering whether households entertained the stove sales offer, that is, opened their doors and heard out the sales team. Among households that refused to participate in the stove sales offer (N=128), 65% were in communities without NGO presence. Thus, the NGO may have played a role in encouraging households to be open to the stove sales offer initially. Among households who agreed to hear the stove sales offer, 56% were in communities with an NGO presence.

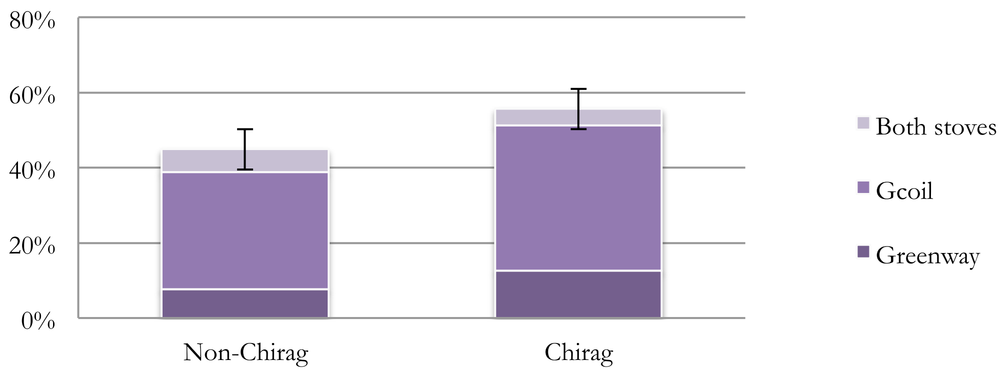
Results from Model 2.1 show that the presence of a local grassroots NGO increased the probability of stove purchase (Table 4, model 2.1). However, when interacting NGO presence with rebate level (Table 4, model 2.2), the joint effect is not statistically significant. This suggests that the NGO did not alter how price sensitive or insensitive the households were, or at least the sample was not powered to detect that effect. In the multinomial logit model for stove choice (Table 6, model 2.5), the presence of an NGO shows a highly significant and slightly positive effect of NGO presence on purchase of both Greenway and Gcoil stoves, as compared with traditional stove ownership. This result supports the notion that households with a trusted NGO may trust the sales offer and promise of stove benefits.

To gain further insight into the role of a local NGO, I conduct sub-sample analyses of the treatment group by presence of an NGO (Table 4, model 2.4a-b). As in other models, the positive sign and significant effect of the rebate on stove purchase increases proportionally as the stove price decreases, however, at the highest rebate level it has a 20% larger effect in communities with an NGO presence than those that do not have an NGO present. Additionally, the effect of the rebate is slightly smaller for the medium rebate level in communities that have an NGO present. The striking differences between communities at the highest rebate level suggest that NGOs may engender a

[5] Stove prices reflect purchase of Gcoil electric stove.

higher trust or willingness to engage in a financial offer when it represents a substantial decrease in price. Households in communities with NGOs may be accustomed to sales offers of social goods and are therefore only willing to accept those that offer them the best deal available, with the understanding that this may not be their only opportunity to invest in household health technology, if not offered the highest discount.

Figure 5. Stove Purchase and Stove Type by presence of NGO



In the group that does not have an NGO present (40% of sample), improved water source, use of credit in past year, and ownership of an improved stove at baseline are all positive and significant predictors of improved stove purchase. Among this group, the percent of household members experiencing cold or cough in the past two weeks at baseline, is also significant. In areas where the NGO is present, villages of larger populations and constant access to electricity are positive and significantly related to ICS purchase.

Characteristics associated with stove purchase in villages without an NGO present shed light on factors that may be important to household investment decision-making in the absence of trust in a sales offer. The significance of previous experience with respiratory sickness and environmental health technology among villages with no NGO presence indicates that households may be balancing the perceived risks of investment in a new preventative health technology with the known risks of household sickness or known benefits of technology investment. Thus, households may be making decisions based on experience where trusted informants' advice on purchase decisions is not available. Ownership of improved stove is a particularly strong predictor of ICS purchase (99% confidence interval) suggesting that direct experience with ICS may dramatically increase probability of purchasing additional ICS. Finally, household use of credit in the past year is strongly and highly significantly associated with stove purchase, suggesting that when a trusted institution is lacking, previous experience with credit and payments over time may make a household more willing to engage in a similar finance offer, such as the rebate and time payment components of the intervention.

This sub-sample analysis, first, demonstrates that different factors may be influential in encouraging stove uptake when a trusted local institution is promoting ICS, and second, suggests more about the role of an NGO in a community. Where NGOs are present, the significance and positive association with larger villages suggests that villages with greater numbers of households may rely more heavily on institutions as sources of trust when investing in health technology than smaller villages, which may rely upon tightly-knit social networks.

Savings and Credit

Household savings and credit can be significant potential factors in predicting stove purchase. In theory, household savings and credit access should decrease liquidity constraints, a hypothesized barrier to ICS purchase. Results of Model 3.1 show that both household savings and credit use in the past year were positively and significantly correlated with ICS purchase (Table 5, model 3.1). Introduction of the rebate offer, along with other household characteristics (Table 5, model 3.2), decreases the strength of the positive association between the effect of savings and credit on ICS purchase, but remains significant at the 85% confidence level.

Interaction of the rebate offer and household savings (Table 4, model 3.3) demonstrates that the joint effects of the highest rebate offer and savings is significant and negatively associated to ICS purchase. A post-estimation test suggests that inclusion of interaction terms for both rebate levels is significant (99% confidence level), suggesting that joint inclusion adds explanatory strength to the model. The negative and significant correlation of the savings and rebate interaction term may indicate that households who are engaged in savings may be less affected by monetary incentives, given that their household access to cash is presumably greater than those who do not save.

In a sub-sample analysis of households that did not report saving money at a bank or formal financial institution in the past year at baseline (89% of the sample), the rebates are strongly correlated with ICS purchase and increase at each rebate level. This finding builds upon that found in model 3.3, demonstrating that *non-saver* households who receive a higher rebate are highly likely to purchase an ICS, whereas *saver* households are less likely to purchase ICS simply due of the rebate. The idea that a house with no savings history and that may lack cash-on-hand may be more likely to take advantage of the subsidized price of the rebate offer supports findings in other environmental health technology studies, which suggest the importance of targeting household liquidity constraints.

Households that did save in the past year do not yield significant rebate estimates, which may in part due to low sample size and statistical power. However, in households that save, those that identify as scheduled castes and scheduled tribes[6] (SC/ST) are significantly less likely to purchase improved stoves. This result may be due to the strong ties to traditional behaviors, such as cooking practices, making ICS adoption a highly challenging adjustment to a long-standing cultural practice. Additionally, in households that report saving in the past year, years of head of household education becomes significant (99% confidence level), suggesting that increased education, which may facilitate increased knowledge of health and improved understanding of ICS benefits, may improve a household's likelihood to purchase ICS.

A sub-sample analysis of households that took a loan in the past year and those who have not (Table 5, model 3.6a-b) reveals that household use of credit and receiving a high rebate offer makes a large difference in increasing probability of ICS purchase. Households that use credit may be more trusting or comfortable with engaging in a finance offer with an external institution, such as our partner NGO, Chirag. Further, households that do not use credit also show significant positive association of large household size with ICS purchase. The significance of the number of household members may be capturing an income effect, as large households often reflect a household's greater economic capacity to care for many people. Households that do use credit show a positive and significant association of primary cook education with ICS purchase, signifying that increased exposure and knowledge of the household's female leader may also contribute to ICS adoption. As past studies have shown, women traditionally prioritize household purchasing decisions to improve household health over those decisions made by men.

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[6] Scheduled caste and scheduled tribal populations are historically disadvantaged and isolated groups that may still have low socio-economic and educational statuses (Government of India, 2014).

Table 4. Average Marginal Effects on Probability of Stove Purchase

	1.1	1.2	2.1	2.2	2.3	2.4a	2.4b
						No NGO	NGO
Rebate 2	0.71***	0.79***		0.72***	0.79***	0.80***	0.74***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)
Rebate 3	1.20***	1.33***		1.04***	1.33***	1.22***	1.43***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)
Village Size		0.14			0.13	0.11	0.18
		(0.14)			(0.15)	(0.54)	(0.09)
Improved water source		0.28*			0.30*	0.54*	0.05
		(0.03)			(0.02)	(0.02)	(0.70)
Household has saved in past week		0.28			0.26	0.20	0.17
		(0.12)			(0.14)	(0.51)	(0.45)
Household has taken loan in past year		0.20			0.21	0.45*	0.01
		(0.15)			(0.14)	(0.02)	(0.94)
SHG		0.17			0.13	0.19	0.17
		(0.25)			(0.37)	(0.42)	(0.33)
Improved Stove (non-LPG)		0.82*			0.80*	1.36**	0.49
		(0.03)			(0.03)	(0.01)	(0.31)
Household has constant access to electricity		0.26*			0.26*	0.16	0.36*
		(0.03)			(0.03)	(0.30)	(0.04)
SC/ST		-0.07			-0.09	-0.01	-0.21
		(0.55)			(0.45)	(0.98)	(0.19)
Total Monthly Expenditure		-0.00			-0.00	-0.00	0.00
		(0.85)			(0.87)	(0.51)	(0.48)
Number of household members		0.06*			0.05*	0.05	0.04
		(0.03)			(0.04)	(0.22)	(0.26)
% of household sick in past two weeks		-0.43			-0.43	-0.75*	-0.10
		(0.08)			(0.09)	(0.02)	(0.83)
Years of Education, Household head		0.01			0.01	0.00	0.02
		(0.27)			(0.26)	(0.85)	(0.19)
Years of Education, Primary Cook		-0.01			-0.01	-0.01	-0.01
		(0.42)			(0.40)	(0.68)	(0.63)
NGO			0.26	0.16	0.15		
			(0.07)	(0.48)	(0.31)		
NGO*Rebate 2				-0.02			
				(0.93)			
NGO*Rebate 3				0.31			
				(0.23)			
Constant	-0.62***	-1.53***	-0.13	-0.70***	-1.57***	-1.57**	-1.43***
	(0.00)	(0.00)	(0.28)	(0.00)	(0.00)	(0.00)	(0.00)
Joint test (Chi)				5.10			
				(0.17)			
Observations	771	722	771	771	722	338	384

Robust pval in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Table 5. Average Marginal Effects on Probability of Stove Purchase (Savings/Credit)

	3.1	3.2	3.3	3.4	3.5a	3.5b	3.6a	3.6b
					save	no save	credit	no credit
Rebate 2		0.79***	0.75***	0.67***	0.24	0.86***	1.21**	0.78***
		(0.00)	(0.00)	(0.00)	(0.60)	(0.00)	(0.00)	(0.00)
Rebate 3		1.33***	1.27***	1.14***	0.38	1.43***	1.80***	1.28***
		(0.00)	(0.00)	(0.00)	(0.42)	(0.00)	(0.00)	(0.00)
Village Size		0.14			0.15	0.15	0.02	0.15
		(0.14)			(0.46)	(0.12)	(0.89)	(0.15)
Improved water source		0.28*			0.50	0.30*	0.58	0.23
		(0.03)			(0.17)	(0.04)	(0.10)	(0.13)
Household has saved in past week	0.41**	0.28	0.88**				0.55	0.20
	(0.01)	(0.12)	(0.00)				(0.35)	(0.28)
Household has taken loan in past year	0.29*	0.20		-0.01	0.83*	0.16		
	(0.02)	(0.15)		(0.98)	(0.05)	(0.27)		
SHG		0.17			-0.26	0.29	-0.38	0.29
		(0.25)			(0.54)	(0.08)	(0.33)	(0.09)
Improved Stove (non-LPG)		0.82*				0.70		0.78*
		(0.03)				(0.09)		(0.04)
Household has constant access to electricity		0.26*			0.54	0.25*	0.54	0.23
		(0.03)			(0.13)	(0.04)	(0.12)	(0.06)
SC/ST		-0.07			-1.15**	0.07	-0.05	-0.09
		(0.55)			(0.01)	(0.59)	(0.86)	(0.50)
Total Monthly Expenditure		-0.00			-0.00	0.00	-0.00	0.00
		(0.85)			(0.55)	(0.90)	(0.31)	(0.78)
Number of household members		0.06*			0.12	0.04	-0.09	0.08**
		(0.03)			(0.22)	(0.08)	(0.13)	(0.00)
% of household sick in past two weeks		-0.43			0.14	-0.50	-1.95***	-0.24
		(0.08)			(0.86)	(0.07)	(0.00)	(0.43)
Years of Education, Household head		0.01			0.10**	0.01	-0.00	0.02
		(0.27)			(0.01)	(0.40)	(0.92)	(0.24)
Years of Education, Primary Cook		-0.01			-0.02	-0.01	0.06	-0.02
		(0.42)			(0.57)	(0.39)	(0.06)	(0.13)
Save*Rebate 2			-0.61					
			(0.14)					
Save * Rebate 3			-0.78*					
			(0.05)					
Credit * Rebate 2				0.26				
				(0.45)				
Credit * Rebate 3				0.34				
				(0.36)				
Joint test (Chi)			11.46	3.44				
			(0.01)	(0.33)				
Constant	-0.08	-1.53***	-0.70***	-0.62***	-1.33	-1.60***	-0.66	-1.60***
	(0.33)	(0.00)	(0.00)	(0.00)	(0.12)	(0.00)	(0.32)	(0.00)
Observations	771	722	771	771	80	641	118	603

Table 6. Average Marginal Effects on Probability of Type of Stove Purchase (multinomial logit regressions)

Dependent variable	Stove Type	dy/dx	P-value
Rebate level (1.3)	Greenway		
	Rebate 2	-0.02	0.89
	Rebate 3	0.04	0.72
	Gcoil		
	Rebate 2	0.29*	0.01
	Rebate 3	0.36***	0.00
	Both stoves		
	Rebate 2	-0.07	0.49
	Rebate 3	-0.01	0.95
NGO presence (2.5)	Greenway	0.05**	0.03
	Gcoil	0.07**	0.04
	Both stoves	-0.02	0.32
Save / Credit	Greenway		
	save	0.04	0.21
(3.7)	credit	0.05***	0.09
	Gcoil		
	save	0.10*	0.06
	credit	0.08*	0.07
	Both stoves		
	save	0.02	0.32
	credit	-0.02	0.54

V. POLICY IMPLICATIONS & LIMITATIONS OF ANALYSIS

In this section I consider some potential limitations of this analysis and important policy considerations. First, ICS purchase does not immediately entail realization of ICS benefits; sustained use is an additional challenge with other, complex barriers that may differ from those associated with initial adoption. While this analysis examines the effect of rebates (a delayed subsidy) and substantiates their use in promoting ICS purchase, subsidies may not encourage long-term use of health technologies (Cole, et al. 2012, Ashraf, et al, 2007). Preliminary evidence from our study suggests a similar outcome (Figure A5, Appendix). Thus, subsidies may only induce initial willingness to purchase and experimentation, requiring further behavior change programs to encourage long-term adoption.

Second, optimally, market supply must equal demand. While this study focuses on stimulating household demand for ICS, building a reliable supply of ICS is particularly important for rural areas and may require considering customer support and after-sales services programs (Lagarde et al., 2010; Lewis et al, 2014; Rehfuess et al., 2014). As small-scale, market-based supply chains grow, they face a range of challenges. Small emerging social businesses in developing countries encounter challenging environments, facing weak lending markets, high corruption, and low institutional support (Bialis et al., 2009). When further challenged with low ICS demand and a market distorted by subsidies, local market-based supply chains may flounder.

Third, as suggested by this study, NGOs serve as an important institutional complement to market-based supply that leverages local networks of trust and contextual knowledge. Beyond the time limited programs and support of external aid organizations, local NGOs are key to ICS adoption over time. Nevertheless, relying on NGOs for ICS supply over private market delivery brings tradeoffs. In terms of efficiency, private sector service delivery has shown improved performance over public and non-profit supply of water and electricity services (Gassner et al., 2008). Further, NGOs' dependency on donor funding may make them less performance-driven (Edwards & Hulme, 1996) and no longer institutions driving an autonomous development agenda (Townsend et al., 2004). Donors, alternatively, represent potential avenues for supporting subsidy-driven demand interventions, but only if consistent funding can be secured and reporting burdens can be met by NGOs. Implementation itself should be tested in each context to further identify additional barriers to stove purchase and sustained use before a large stove intervention is taken to scale.

Unlike previous ICS promotion studies, I find that there is a high demand for improved stoves, especially with substantial 'use-related' rebates. Deliberate experimentation with various rebates provides further understanding of price elasticities, which may guide planning and marketing. Household-level characteristics, including savings and credit, and community attributes, such as presence of NGOs, may additionally help targeting of future ICS sales campaigns. However, beyond understanding the incentives that drive ICS purchase and use, it is important to consider and build evidence for health and social impacts, delivery, and sustained use of ICS.

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APPENDIX

Table A1. Normal Difference Tests: Randomized Treatment and Control groups

	Mean: Treatment	Mean: Control	Difference: Normalized	N: Treatment	N: Control
Transit Facilities	0.47	0.69	0.31	795	259
Presence of Paved Roads	0.26	0.42	0.24	795	259
Distance to Nearest Doctor	9.43	9.41	0.00	766	230
Presence of Bank Facilities	0.34	0.27	-0.09	795	259
Presence of NGO (Chirag)	0.49	0.53	0.06	793	266
HH owns improved stove	0.28	0.41	0.20	773	261
HH owns improved stove (non-LPG)	0.02	0.05	0.09	795	266
Minutes of use (clean stove) per day	38.19	64.30	0.19	795	266
Fuelwood (kg)	6.92	6.58	-0.04	776	255
HH has taken loan in past year	0.13	0.19	0.11	795	266
Household size	4.80	4.91	0.03	795	266
Female Head of Household	0.26	0.30	0.07	785	263
Hours of Electricity per day	17.22	17.15	-0.01	767	253
Believes Stoves have medium or better impact	0.29	0.30	0.01	795	266
HH owns traditional stove	0.98	0.96	-0.07	795	266
HH uses improved fuel	0.34	0.48	0.21	795	266
HH uses improved fuel (non-LPG)	0.13	0.22	0.17	795	266
Minutes of use (clean stove, non-LPG) per day	2.17	4.29	0.07	795	266
Minutes of use (traditional stove) per day	296.94	286.16	-0.05	795	266
Total Fuel Expenditure (natural log)	5.61	5.82	0.14	348	148
BPL	0.56	0.59	0.05	774	254
Household has saved in the past year	0.10	0.11	0.00	795	266
Presence of improved toilet (own, neighbor, community)	0.84	0.89	0.10	795	266
Owns cellphone	1.27	1.40	0.10	794	266
Total HH expenditure (natural log)	8.40	8.43	0.03	771	258
Self-Assessed wealth (5 point scale)	2.08	2.26	0.15	793	266
HH uses electricity for light	0.93	0.95	0.05	795	266
SCST	0.23	0.32	0.15	795	266
Scheduled Caste	0.22	0.32	0.16	795	266
Scheduled Tribe	0.01	0.00	-0.04	795	266
% of households sick in past two weeks	0.07	0.08	0.02	795	266
HH believes smoke is unsafe	0.50	0.48	-0.04	795	266
Head of Household education (years)	5.84	5.58	-0.04	779	262
Primary Cook education (years)	4.56	4.75	0.03	770	259

Table A2. Normalized difference tests by rebate group

Normalized Differences by Rebate group: Rebate 1 (Rs. 25) vs. Rebate 2 (Rs. 200) & 3 (Rs. 450)	Mean: Rebate 2 & 3	Mean: Rebate 1	Difference: Difference	N: Rebate 2 & 3	N: Rebate 1
HH size	4.72	4.87	0.05	516	255
Head Years of Edu	5.84	5.87	0.00	506	251
Female Head	0.24	0.29	0.07	510	252
HH believes ICS impacts beneficial	0.31	0.29	-0.04	516	255
Cold Cough, 2 wks	0.23	0.20	-0.05	516	255
Total Mins cooking (both stoves)	340.35	332.09	-0.04	516	255
Mins cooking (traditional)	285.84	289.61	0.02	516	255
Mins cooking (ICS)	49.62	42.48	-0.05	516	255
ICS ownership	0.33	0.30	-0.04	501	252
Logged Total Fuel Expenditure	5.67	5.73	0.04	247	114
Hours of Electricity per day	16.66	17.68	0.10	498	242
Chirag – NGO presence	0.54	0.49	-0.07	516	255
Cellphone ownership	0.81	0.87	0.11	516	255
Total rooms in house	4.72	4.68	-0.01	516	252
Presence of toilet	0.84	0.84	0.00	516	255
Owns/leases agricultural land	0.98	0.98	0.00	506	247
Relative wealth	2.14	2.09	-0.05	514	255
Taken loan in past year	0.18	0.12	-0.12	516	255
Saved money in past year	0.13	0.07	-0.12	516	255
Total expenditure (natural log)	8.43	8.40	-0.03	499	248
Most risk-taking respondent	0.44	0.42	-0.02	508	250
Most patient respondent	0.50	0.50	0.00	506	248

Rebate 2 (Rs. 200) vs. Rebate 1 (Rs. 25) & Rebate 3 (Rs. 450)					
	Mean: Rebate 1 & 3	Mean: Rebate 2	Normalized Difference	N: Rebate 1 & 3	N: Rebate 2
HH size	4.83	4.65	-0.06	512	259
Head Years of Edu	5.72	6.10	0.06	502	255
Female Head	0.28	0.20	-0.13	505	257
HH believes ICS impacts beneficial	0.30	0.31	0.01	512	259
Cold Cough, 2 wks	0.22	0.22	0.01	512	259
Total Mins cooking (both stoves)	337.03	338.78	0.01	512	259
Mins cooking (traditional)	286.24	288.78	0.01	512	259
Mins cooking (ICS)	47.51	46.76	-0.01	512	259
ICS ownership	0.32	0.32	0.01	503	250
Logged Total Fuel Expenditure	5.75	5.58	-0.11	240	121
Hours of Electricity per day	17.25	16.50	-0.07	488	252
Chirag – NGO presence	0.53	0.52	-0.01	512	259
Cellphone ownership	0.84	0.81	-0.06	512	259
Total rooms in house	4.69	4.73	0.01	509	259
Presence of toilet	0.84	0.85	0.02	512	259
Owns/leases agricultural land	0.98	0.98	0.00	497	256
Relative wealth	2.13	2.11	-0.02	511	258
Taken loan in past year	0.16	0.16	0.01	512	259
Saved money in past year	0.10	0.14	0.09	512	259
Total expenditure (natural log)	8.41	8.44	0.03	494	253
Most risk-taking respondent	0.41	0.47	0.09	504	254
Most patient respondent	0.51	0.49	-0.02	501	253

Rebate 3 (Rs. 450) vs. Rebate 1 (Rs. 25) & 2 (Rs. 200)					
	Mean: Rebate 1 & 2	Mean: Rebate 3	Normalized Difference	N: Rebate 1 & 2	N: Rebate 3
HH size	4.76	4.79	0.01	523	248
Head Years of Edu	5.93	5.67	-0.04	515	242
Female Head	0.25	0.26	0.02	518	244
HH believes ICS impacts beneficial	0.29	0.33	0.05	523	248
Cold Cough, 2 wks	0.21	0.24	0.05	523	248
Total Mins cooking (both stoves)	336.12	340.79	0.02	523	248
Mins cooking (traditional)	290.18	280.58	-0.05	523	248
Mins cooking (ICS)	44.33	53.44	0.07	523	248
ICS ownership	0.31	0.34	0.04	511	242
Logged Total Fuel Expenditure	5.64	5.80	0.11	241	120
Hours of Electricity per day	17.03	16.90	-0.01	503	237
Chirag – NGO presence	0.51	0.56	0.07	523	248
Cellphone ownership	0.84	0.82	-0.04	523	248
Total rooms in house	4.71	4.70	0.00	520	248
Presence of toilet	0.85	0.84	-0.02	523	248
Owns/leases agricultural land	0.98	0.98	-0.01	512	241
Relative wealth	2.10	2.19	0.08	522	247
Taken loan in past year	0.14	0.21	0.13	523	248
Saved money in past year	0.11	0.11	0.01	523	248
Total expenditure (natural log)	8.41	8.43	0.02	510	237
Most risk-taking respondent	0.45	0.40	-0.08	513	245
Most patient respondent	0.50	0.50	0.01	510	244

Rebate 1 (Rs. 25) vs. Rebate 2 (Rs. 200)					
	Mean: Rebate 2	Mean: Rebate 1	Normalized Difference	N: Rebate 2	N: Rebate 1
HH size	4.65	4.88	0.08	268	255
Head Years of Edu	6.00	5.87	-0.02	264	251
Female Head	0.22	0.29	0.11	266	252
HH believes ICS impacts beneficial	0.30	0.29	-0.02	268	255
Cold Cough, 2 wks	0.22	0.20	-0.04	268	255
Total Mins cooking (both stoves)	339.94	332.09	-0.04	268	255
Mins cooking (traditional)	290.72	289.61	-0.01	268	255
Mins cooking (ICS)	46.09	42.48	-0.03	268	255
ICS ownership	0.32	0.30	-0.03	259	252
Logged Total Fuel Expenditure	5.55	5.73	0.11	127	114
Hours of Electricity per day	16.44	17.68	0.12	261	242
Chirag – NGO presence	0.53	0.49	-0.05	268	255
Cellphone ownership	0.81	0.87	0.12	268	255
Total rooms in house	4.73	4.68	-0.01	268	252
Presence of toilet	0.85	0.84	-0.01	268	255
Owns/leases agricultural land	0.99	0.98	-0.01	265	247
Relative wealth	2.10	2.09	-0.01	267	255
Taken loan in past year	0.16	0.12	-0.08	268	255
Saved money in past year	0.14	0.08	-0.15	268	255
Total expenditure (natural log)	8.42	8.40	-0.03	262	248
Most risk-taking respondent	0.47	0.42	-0.07	263	250
Most patient respondent	0.50	0.50	0.00	262	248

Rebate 1 (Rs. 25) vs. Rebate 3 (Rs. 450)					
	Mean: Rebate 3	Mean: Rebate 1	Normalized Difference	N: Rebate 3	N: Rebate 1
HH size	4.78	4.88	0.03	257	255
Head Years of Edu	5.58	5.87	0.05	251	251
Female Head	0.28	0.29	0.01	253	252
HH believes ICS impacts beneficial	0.32	0.29	-0.04	257	255
Cold Cough, 2 wks	0.23	0.20	-0.06	257	255
Total Mins cooking (both stoves)	341.93	332.09	-0.04	257	255
Mins cooking (traditional)	282.89	289.61	0.03	257	255
Mins cooking (ICS)	52.50	42.48	-0.07	257	255
ICS ownership	0.33	0.30	-0.04	251	252
Logged Total Fuel Expenditure	5.76	5.73	-0.02	126	114
Hours of Electricity per day	16.82	17.68	0.08	246	242
Chirag – NGO presence	0.56	0.49	-0.10	257	255
Cellphone ownership	0.81	0.87	0.10	257	255
Total rooms in house	4.70	4.68	-0.01	257	252
Presence of toilet	0.83	0.84	0.02	257	255
Owns/leases agricultural land	0.98	0.98	0.00	250	247
Relative wealth	2.18	2.09	-0.08	256	255
Taken loan in past year	0.20	0.12	-0.16	257	255
Saved money in past year	0.12	0.08	-0.10	257	255
Total expenditure (natural log)	8.42	8.40	-0.02	246	248
Most risk-taking respondent	0.40	0.42	0.04	254	250
Most patient respondent	0.51	0.50	-0.01	253	248

Rebate 2 (Rs. 200) vs. Rebate 3 (Rs. 450)					
	Mean: Rebate 3	Mean: Rebate 2	Normalized Difference	N: Rebate 3	N: Rebate 2
HH size	4.78	4.65	-0.04	257	259
Head Years of Edu	5.58	6.10	0.08	251	255
Female Head	0.28	0.20	-0.12	253	257
HH believes ICS impacts beneficial	0.32	0.31	-0.01	257	259
Cold Cough, 2 wks	0.23	0.22	-0.02	257	259
Total Mins cooking (both stoves)	341.93	338.78	-0.01	257	259
Mins cooking (traditional)	282.89	288.78	0.03	257	259
Mins cooking (ICS)	52.50	46.76	-0.04	257	259
ICS ownership	0.33	0.32	-0.01	251	250
Logged Total Fuel Expenditure	5.76	5.58	-0.12	126	121
Hours of Electricity per day	16.82	16.50	-0.03	246	252
Chirag – NGO presence	0.56	0.52	-0.06	257	259
Cellphone ownership	0.81	0.81	-0.01	257	259
Total rooms in house	4.70	4.73	0.01	257	259
Presence of toilet	0.83	0.85	0.03	257	259
Owns/leases agricultural land	0.98	0.98	0.00	250	256
Relative wealth	2.18	2.11	-0.06	256	258
Taken loan in past year	0.20	0.16	-0.07	257	259
Saved money in past year	0.12	0.14	0.04	257	259
Total expenditure (natural log)	8.42	8.44	0.02	246	253
Most risk-taking respondent	0.40	0.47	0.11	254	254
Most patient respondent	0.51	0.49	-0.02	253	253

Table A3. Stove sales by rebate level

	Rebate 1 Rs. 25	Rebate 2 Rs. 200	Rebate 3 Rs. 400
Households purchasing stove(s)	68	139	179
N	255	259	248

Table A4. Pair Wise Correlations, Household expenditure and wealth covariates

	Monthly HH expenditure	Monthly Expenditure (natural log)	Number of household members
Stove Bought	-0.01	-0.00	.09**
Hours of Electricity per day	0.11**	.17***	.10**
Improved water source	-0.02	.03	-.05
Village size	-0.01	0.07*	-.01
Improved stove ownership (non-LPG)	0.54	0.16	.03

Figure A5. Preliminary Results of Follow-up survey (Duke/USAID Randomized control trial): Stove Purchase and Use, Treatment group only