Learning from Unincentivized and Incentivized Communication: A Randomized Controlled Trial in India*

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Abstract

In order to understand the extent of the information barrier to adoption of a household technology, we designed a randomized controlled trial on willingness to pay (WTP) for solar lanterns in India. We gave high quality solar lanterns to randomly selected 'seed' households in a non-electrified region of the state of Uttar Pradesh. Three friends of the seed were randomly assigned to one of the following three groups: control, unincentivized network and incentivized communication. We elicit WTP from the control group immediately after the seed receives the solar lantern. We elicit WTP from the friends in the unincentivized and incentivized communication groups thirty days after the seed receives the solar lantern and the friend in the incentivized communication group attends a presentation of the lantern by the seed. We show that unincetivized communication increases WTP by 90% and incentivized communication by 145% relative to the control group. We also show that learning from others is the mechanism that drives the observed WTP by peers.

JEL: D83, O33, Q21, Q42

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1 Introduction

Economic growth theories portray technological progress as the engine of economic development and prosperity. The recent version of this theory uses endogenous growth models to highlight the important role of social learning in technology diffusion (Acemoglu, 2009; Aghion and Howitt, 1997; Barro and SalaiMartin, 2004; Lucas, 1988; Romer, 1986). Economic growth in this set-up is characterized as endogenously driven through investment in human capital, knowledge and innovation. Profit maximizing firms invest, learn by doing and learn from each other through knowledge spillovers; these processes induce smooth technological diffusion in the economy. The theory was later applied to understand technological innovation and diffusion in agriculture in developing countries (Bandiera and Rasul, 2006; Bardhan and Udry, 1999; Conley and Udry, 2010; Foster and Rosenzweig, 1995). Using credible empirical strategies, this strand of literature identifies the role of social networks in promoting social learning, adoption and diffusion of new agricultural technologies.

We collaborated with a local organization and distributed a new solar-powered lantern to households in Gonda district, in the Uttar Pradesh state of India. The solar lanterns are durable, multipurpose, and convenient to use. They sold for 1,200 rupees (USD 18.5) in Lucknow, the capital of Uttar Pradesh state at the time of the fieldwork (Fall, 2015)[1]. Notably, the lanterns have a mobile-charging feature which allows the user to charge a mobile phone. The study area is still non-electrified and households did not have knowledge about the solar lanterns prior to the study. We randomly selected 200 "seed" individuals, half of them male and half of them female, to whom we offered the solar lantern for participating in the study. Each seed household gave three names of close peers (friends or relatives) whom they regularly interact with, and these were randomly assigned into an "unincentivized network treatment", an "incentivized communication treatment" and a "control group". We elicited willingness to pay for the solar lanterns from the control group immediately after interviewing the seed household, using the Becker-Degroot-Marschak (BDM) method (Becker, Degroot, and Marschak, 1964). In the unincentivized network treatment group, the subjects, who were designated as friends by the seed, were interviewed 30 days after the seed received the solar lantern to elicit their willingness to pay. We refer to the learning captured through this process as "learning from unincentivized communication". In the incentivized communication group, the 30-day delay was followed by a tea meeting at which the seed presented the solar lantern and shared his or her experience with the friend, in return for a payment of 100 rupees (USD 1.54).[2] We refer to the learning captured through this process

[1] As a point of comparison, in our sample, households spent on average about 42 rupees on lighting needs per month (either kerosene or batteries). That corresponds to about 500 rupees per year. Hence, if households paid the market price of the solar lantern, they would ammortize it in about two years and a half.

[2] At the time of the survey, 1 USD = 65 rupees.

as "learning from incentivized communication".

The results show that peers who very likely learned about the solar lantern through their relationship with the seed household (the unincentivized network treatment group) are on average willing to pay 120 rupees more than the control group a month after the lanterns were distributed. Peers who were invited to a demonstration tea meeting by the seed households a month after the lanterns were distributed (the incentivized communication treatment group), on the other hand, are willing to pay 190 rupees more than the control group. With a mean WTP of 134 in the control group, the proportional treatment effects are 90% and 145%, respectively. Both treatment effects appear to be large. It is notable that the unincentivized network treatment effect almost doubled WTP, whereas incentivized communication added another 55 percentage points increase in the treatment effect.

This paper is broadly related to a body of research in economics on the impact of peers on outcomes. This strand of literature, focusing mostly on developed countries, investigates the impact of peers or friends on several outcome variables of interest, including educational achievement (e.g., Angrist and Lang, 2002; Figlio, 2005; Hoxby, 2000; Sacerdote, 2001; Zimmerman, 2003), market and health outcomes (e.g., Kling and Liebman, 2007; Munshi, 2003), and, labor productivity and consumption (e.g., Mas and Moretti, 2009; Mobius, Niehaus, and Rosenblat, 2005). The extent of peer effects has also been examined in the development economics literature of social-learning, largely to explain agricultural technology adoption (Bandiera and Rasul, 2006; Bardhan and Udry, 1999; Conley and Udry, 2010; Foster and Rosenzweig, 1995).[3] A particularly important observation in this literature is that modern agricultural technologies significantly improve agricultural output and welfare, but their adoption or uptake rate has been disappointingly low. It demonstrates that farmers engage in learning-by-doing and learning from others. Thus, adoption of a new agricultural technology by a farmer is therefore a social process because it generates knowledge to all her peers and increases their expected yield Bardhan and Udry (1999); Foster and Rosenzweig (1995). More recently, BenYishay and Mobarak (2018) extend the theory of social learning in agriculture by introducing provision performance-based rewards to information communicators about new technologies and argue that the power of social networks in diffusion of new technologies could be enhanced by incentivizing information communication by peers who share the same identity.

We use a novel technology (solar lantern) and disentangle the impact of learning through incentivized and well-targeted communication from learning through unincentivized and regular communication of peers

[3] The only exceptions to this are the studies by Oster and Thornton (2012) and Jain and Kapoor (2015), which investigate the impact of peers on adoption of menstrual cups by school girls in Nepal and academic achievement by university students in India respectively.

on adoption and willingness-to-pay for the technology. Solar lantern is a superior lighting technology which has the potential to improve the welfare of all members of the household. Unlike agricultural technologies which involve significant uncertainty, require specific agro-ecological conditions, a long time to learn about and capture their payoff; the solar lantern we consider in this study is easy to use, multi-purpose, and is easy to assess its payoffs with greater certainty in a short time. Our design also allows us to aggregate revealed WTP, a figure important for policymakers and other stakeholders to design optimal subsidy and cost reduction strategies to encourage diffusion of the technology in cases when average WTP is lower than average cost.

The major challenge in identifying the impact of peers on adoption of new technologies, even after tackling identification issues through a randomized assignment,[4] is understanding the mechanisms that drive the observed results. It may be that peers imitate each other rather than learning from each other about the benefits of the new technology or learning how to operate the technology (Oster and Thornton, 2012). In order to shed light on the possible mechanisms, we collected detailed information on familiarity with solar lanterns, perception about their benefit, estimated market value, etc. As expected, we find that both the unincentivized network and the incenvitized communication groups are likely to have seen a solar lantern before the date of the WTP experiment, and they are much more likely to know someone who owns a lantern, compared to the control group. We also find that, compared to the control group, subjects in both treatment groups believe that the solar lantern needs proper maintenance in order to function properly and they estimate its market price to be higher. Subjects initially don't seem to think that solar lanterns are worth more than kerosene lamps, which are the most common sources of lighting in the study area. However, as they see a friend taking care of the solar panel through which the lantern is powered, the power of the light coming out the lantern, and the mobile phone charging function, they estimate the market price of the lantern to be higher. Consequently they are willing to pay more for the lantern. These results suggest that learning both how to operate the technology and the benefits provided by the technology drive the high WTP the treatment groups reveal, notably to a larger extent that of the incentivized communications group's.

The paper also speaks to the emerging literature on electrification in developing countries (Dinkelman, 2011; Dugoua and Urpelainen, 2014; Furukawa, 2014; Grimm, Munyehirwe, Peters, and Sievert, 2014; Lee, Miguel, and Wolfram, 2016; Lee, Brewer, Christiano, Meyo, Miguel, Podolsky, Rosa, and Wolfram, 2016), an

[4]Previous studies that used the method of randomization to tackle the identification challenge in measuring the impact of peers on one's outcome include (Duflo and Saez, 2003; Duflo, Kremer, and Robinson, 2011; Godlonton and Thornton, 2012; Kremer and Levy, 2008; Kremer and Miguel, 2007; Miguel and Kremer, 2004; Oster and Thornton, 2012; Rao, Mobius, and Rosenblat, 2007; Sacerdote, 2001).

area of research that overlaps with development and energy economics. The current level of electrification in developing regions such as Sub-Saharan Africa, South Asia, and Latin America remains low (International Energy Agency, 2014) and households very often use kerosene lamps for lighting. Kerosene lamps have been documented to generate indoor air pollution and adversely affect health outcomes of members, pose a risk of burns and fires, emit hazardous greenhouse gases, and require rural households to regularly travel long distance to buy kerosene (Lam, Smith, Gauthier, and Bates, 2012). Extending the grid to the most rural regions requires high levels of investment that are often difficult to secure by governments. Solar power serves as a decentralized solution to the problem of energy poverty, and is slowly diffusing throughout rural Africa and rural South Asia (Sandwell, Wheeler, and Nelson, 2017). However, tight household budget constraints, poor product quality and little local expertise in photovoltaic technologies have been hindering faster adoption.[5] In addition, given the increased need to reduce greenhouse gas emission from the energy sector, exploring the role of solar-powered lighting equipment, which emits no greenhouse gas, reduces indoor air pollution, and helps children allocate more time to studying would have large benefits to society at large. From a public policy point of view, the findings from this paper will provide useful information on willingness to uptake such technologies and the factors that drive their quick diffusion.

The rest of the paper is organized as follows. Section 2 lays out the conceptual framework and our key hypotheses about willingness to pay for solar lanterns. Section 3 describes the design and procedure of the randomized controlled trial, with results of the randomization checks. Section 4 presents the key empirical results. Section 5 concludes the paper.

2 Conceptual Framework

Drawing on Bandiera and Rasul (2006); Bardhan and Udry (1999); BenYishay and Mobarak (2018); Conley and Udry (2010); Foster and Rosenzweig (1995), we now lay out a brief motivating framework for interpreting the main results from our randomized controlled trial. We begin by defining the following treatments:

- In the *unincentivized network treatment* group, subjects observe the use of a new technology by others without incentivized and tailored communication. Thus, learning from others is a result of the natural interaction through social networks.
- In the *incentivized communication treatment* group, subjects both observe the use of new technology by others and receive direct communication about the properties of the new technology just before WTP is elicited. Thus, learning from others is considered to be ‘active’.

[5] See Karakaya and Sriwannawit (2015) for a recent systematic review of the literature on barriers to the adoption of photovoltaic technologies in developing countries.

To test the presence of social learning – that is, learning from others – in agriculture, these studies make use of the "target-input" model proposed by Wilson (1975) and Jovanovic and Nyarko (1994). According to this model, the farmer knows the basic form of the new technology (e.g., an improved seed) with certainty, but does not know the target level, which is assumed to be random. Farm profit is inversely related to the difference between the actual level of input applied and the target level. The farmer realizes what the actual level of input should have been only after the input has been applied and output has been realized. As a result, the farmer learns about the new technology over time through learning-by-doing. In this model, individuals can also learn from each other's experience when they share similar distribution of the input target. Assume that two farmers belong to a certain social network and share information with each other or costlessly observe each other's input choice. In each period, farmers use Bayes' rule to update their prior belief on the variance of the optimal input level, making use of information from their own experience and the experience of their network members. Thus, adoption of a new technology in this model is a social process because its adoption by an individual generates information spillover to all her peers, which increases their expected welfare in the future (Bardhan and Udry, 1999).

Diffusion of solar lanterns can be modelled using an extended version social learning framework because, through their regular interaction with the seed, peers learn about the service provided by the lanterns without cost and immediately update their belief about the quality of the lanterns. Consequently, these individuals would be willing to pay more than those who did not have prior information about the lanterns. Our experimental design allows for a period of one month for information to diffuse, that is for households in the "unincentivized network" group to learn about the solar lantern.[6] In our context, one month seems sufficient because; 1) the technology is easily observable, and 2) we offer the technology to one of their closest friends who is expected to interact with them regularly. We will show later that, indeed, all "unincentivized network" households report knowing what a solar lantern is, indicating that one month was sufficient to ensure respondents in the treatment groups were exposed to solar lanterns through their friend.

Hypothesis 1. *The unincentivized network treatment increases willingness to pay.*

An important extension of the 'target-input" model by BenYishay and Mobarak (2018) is that the member of the social network who communicates information about the new technology, i.e., the "communicator" knows the optimal level of the technology. However, it would be costly to transfer her knowledge about the new technology to other farmers. If there is an intervention that rewards the information communicator based on what proportion of farmers adopted the new technology as a result of the communicator's efforts,

[6] Allowing for longer than a month would increase the probability of other confounders.

diffusion of the technology may occur much faster. As a result, others will learn about the new technology and adopt it much more quickly than the case of unincentivized communication through ordinary social networks. In our case, rewarding seed households to invite one of their randomly selected peers for a tea meeting after the seed household used the solar lanterns for a month is expected to result in transmission of more accurate information than in the case of unincentivized regular interaction. As a result, peers who have been provided detailed information about the attributes of the solar lanterns in such a way are likely to pay more for the lanterns than peers who were not invited for the tea meeting (the unincentivized network group).

Hypothesis 2. *The incentivized communication treatment increases willingness to pay more than the unincentivized network treatment.*

Another aim of our RCT is testing the role of gender in communication about a new technology. Early studies from industrialized countries (Bourguignon, Browning, and Chiappori, 2009; Browning and Chiappori, 1998; Chiappori, 1992; Chiappori, Fortin, and Lacroix, 2002) show that, although members of a household (most importantly, couples) often have different preferences and intra-household bargaining power, they still achieve Pareto-efficient outcomes in household decision-making. Studies in developing countries, on the other hand, document rejection of Pareto-efficiency in household decision-making, most importantly because of differences in preferences and intra-household bargaining power between husbands and wives. Udry (1996) documents that total yield by farm households in Burkina Faso could be improved by relocating inputs from male-cultivated plots to female-cultivated plots.[7] Schaner (2015) provides evidence indicating that households in Kenya make sub-optimal saving decisions as a result of differences in discount rates of couples. More recent studies (Alem, Hassen, and Köhlin, 2017; Miller and Mobarak, 2013) show that improved cookstoves, which enhance the quality of life of all household members, are valued at significantly higher levels by women than men, but could not be adopted optimally because women have low decision-making power (autonomy).

Hypothesis 3. *Learning through male social networks increases willingness to pay by a greater amount than learning through female social networks.*

[7] A related study, Robinson (2012), documents that the response in private consumption to an exogenous shock is significantly different between wives and husbands in western Kenya, implying that informal risk-sharing mechanisms within households are not Pareto-efficient.

3 Experimental Design

To test our hypotheses, we conducted a WTP experiment in 200 unelectrified habitations of Gonda district in the state of Uttar Pradesh, India.[8] Habitations (also called sub-villages or hamlets) are the lowest administrative units in India. The subjects were given an opportunity to purchase a solar lantern in a BDM game. We compared the effects of a network treatment and a communication treatment using randomly assigned male and female contacts. The experiment was conducted in two rounds between the end of July and the beginning of October 2015. The study area was chosen because it had a low electricity access rate, with many unelectrified habitations close to Gonda City, the district capital. To avoid data mining and bias from multiple comparisons, a detailed pre-analysis plan (PAP) listing all research hypotheses and our key empirical specifications was registered with Evidence in the Governance and Politics website.[9]

The primary specification equation can be written as follows:

$$WTP_{ij} = \alpha + \beta_1 N_i + \beta_2 N_i F_i + \gamma_1 C_i + \gamma_2 C_i F_i + \mu_j + \epsilon_{ij}, \tag{1}$$

where WTP_i is the willingness to pay for a solar lantern by household i within habitation j; N_i is a dummy variable coding for whether household i is in the "unincentivized network" treatment group, that is household i knows a lantern user through its social network (either through the social network of the head or that of the spouse); F_i is a dummy variable coding for whether the lantern user is known through the social network of the female spouse; C_i is a dummy variable coding for whether the household is in the "incentivized communication" treatment group, that is the household engaged in active communication with the lantern user of his network; μ_j is a vector of habitation fixed effects ($N = 200$); ϵ_{ij} is a random error term. A term for F_i does not appear in the equation because, by design, habitation fixed effects accounts for it. Our objective is to estimate $\beta_1, \beta_2, \gamma_1, \gamma_2$. Throughout, we cluster standard errors by habitations. In this empirical framework, the hypotheses can be expressed as follows. Hypothesis 1 is equivalent to $\beta_1 > 0$ and $\beta_1 + \beta_2 > 0$; Hypothesis 2 to $\gamma_1 > 0$ and $\gamma_1 + \gamma_2 > 0$; Hypothesis 3 to $\beta_2 < 0$ and $\gamma_2 < 0$.

3.1 Outcome Variable

In the experiment, subjects were given the opportunity to purchase a solar lantern. Photos of the lantern can be found in the appendix. At the time of the experiment, the retail price of the lantern was 1,200 rupees (USD 18.5). The product features included a 3-watt solar panel, a 6V 4.5Ah battery, a 3-watt, 24-piece

[8] Before implementation, the experiment was reviewed and approved by the internal review board (IRB) of Columbia University.

[9] The PAP is publicly available at http://egap.org/registration/1420.

surface-mounted-device LED, and a mobile charging socket. We chose the product based on a review of solar lanterns available among Uttar Pradesh distributors. We confirmed the performance of the lanterns - in terms of the quality and duration of the lighting, and the charging power - by using them with the survey team for about a week.

The outcome variable is the subject's WTP measured in the BDM game. As Becker, Degroot, and Marschak (1964) show, the BDM game recovers the subject's true preference by removing incentives to misrepresent WTP for strategic reasons. In the game, the subject is requested to provide his or her highest WTP for an item, and the price of the item is then drawn from a random distribution. If the price is below the stated WTP, the subject pays the *randomly drawn price*, not the stated WTP. Therefore, the subject has no incentive to understate WTP to obtain a better bargain. This method has been widely applied in development economics to measure WTP (e.g., Guiteras, Levine, Polley, and Quistorff, 2013; Hoffmann, 2009; Levine, Beltramo, Blalock, and Cotterman, 2012) because it is incentive-compatible and provides a continuous demand curve, as opposed to demand estimates for a discrete number of price points (as is the case in a typical randomized-price WTP measurement).

The game was played in the field as follows. Each household is requested to announce their maximal willingness to pay on a 0-1,200 rupee scale, and the actual price is determined by a random draw from a bag which contains 21 balls, each one of them with a number written on it. The number goes from 0 to 1,200 rupees in increments of 100 rupees. The respondent first makes a bid and then randomly draws a ball. If the price on the ball the respondent draws is higher than the bid, the respondent is not allowed to purchase the lantern. If the price on the ball is lower than the bid, the respondent must purchase the lantern at the price that was drawn. As a result, when the respondent makes a bid, he must make sure he has access to the funds. The respondent has only one chance to play, and he cannot change his bid after drawing a ball. Before the respondent played for 'real', the game was played with a bar of soap to make sure the respondent fully understood the rules.

Figure 1 displays the distribution of the bids: we see that most subjects made a positive bid, but no subject offered the non-subsidized market price of the lantern. We also note that the willingness to pay displays important variation across individuals, spanning from 0 to 1200, with mean 239 and standard deviation 266. At the end, a total of 160 respondents (42 in the control group, 55 in the unincentivized network group and 63 in incentivized communication group) ended up purchasing the lantern because their bid was higher or equal to their draw.

[Figure 1 about here.]

In measuring WTP, we paid particular attention to training the enumerators so that they explained the procedure to the subjects carefully enough and always conducted the practice round with soap. Based on our observation of the WTP measurement, the subjects understood the rules of the game. No subject complained afterwards or refused to pay in case she or he won the solar lantern. The subjects were sometimes disappointed if they did not win the lantern, but in that case they also did not have to give any money.

3.2 Sampling and Treatments

The data collection began with a mapping of 200 primary habitations and 25 replacement habitations around Gonda City. The enumerators approached the habitations in expanding circles, with habitations near Gonda City visited first and those further away visited later. If a habitation was excluded because of safety concerns or because it had access to grid electricity, a randomly drawn replacement habitation was used instead. Overall, we had to exclude and replace five habitations. The map of the study area and habitations is shown in Figure 2.

[Figure 2 about here.]

Within each habitation, the enumerators approached a randomly chosen "seed" household and, depending on the treatment, interviewed either an adult male or female member. The seed was requested to provide names of three friends with whom he or she interacts on a regular basis, and the three friends were then randomly assigned to three groups: control, unincentivized network, and incentivized communication. The control group was interviewed on the same day and the unincentivized network and incentivized communication groups approximately 30 days after the initial interview.[10] If the chosen friend was not the household head, we interviewed the head of the household to which that friend belongs. Households in the three groups were offered the possibility of buying a solar lantern through a BDM game.

The timeline of the experiment is summarized in Figure 3. The experiment began with sampling and the interviews of the control group in July-August 2015. In each habitation, the unincentivized network and incentivized communication groups were interviewed approximately one month after sampling. We surveyed the unincentivized network group at the same time as the incentivized communication group to avoid treatment spillovers. Table 1 summarizes the size of the different treatment groups. We visited a total of 197 habitations, 98 assigned to the male seed treatment and 99 to the female seed treatment. Three

[10] We decided to conduct the solar lantern purchase experiment with the network and communication groups 30 days after the seed received them, because the solar lantern is a simple technology, which one can learn about in a short time. Thirty days appeared to be reasonably long enough time for information about the lantern to flow from the seed to the two treatment groups. This is exactly what we document and discuss in the "Mechansims" section of the paper.

habitations were dropped because the network and communications friends were no longer living in the surroundings, and hence could not be surveyed.

[Figure 3 about here.]

[Table 1 about here.]

The male-female treatment was randomized at the habitation level. One of the researchers drew a random number for each habitation and assigned the highest 100 numbers to the female treatment. We gave all seed households a solar lantern and 100 rupees in exchange for taking part in the survey and inviting one of the three friends for a tea meeting. Our survey team, consisting of enumerators who spoke the local dialect, attended all tea meetings. They specifically told the seed households that their goal was not to convince their friend to buy a lantern but only to share stories about their experience and the performance of the lanterns.

In order to minimize the likelihood that seeds felt unfairly privileged from receiving a solar lantern plus 100 rupees, we phrased the experiment to them that they won a lottery which awarded a solar lantern for participating in the study and 100 rupees conditional on meeting again with the survey team in the presence of one of their three best friends. We also informed them that their friends would also participate in a lottery, without more information about the nature of the lottery. Hence, the seeds did not know ex-ante that they would be getting 100 rupees more than their friends[11], and they also did not know that their friends would play a BDM game. In this context, seed households likely felt just as lucky and privileged as their friend for participating in a lottery.

Within each habitation, the three friends named by the seed were randomly assigned to the control or to the unincentivized network or incentivized communication treatment. The household of the friend in the control group was visited and asked for WTP immediately after the seed household provided the name of three friends. The procedure for the households of those in the unincentivized network and incentivized communication groups was similar, except for the two following differences. First, the visit to the unincentivized network and incentivized communication households took place about a month later. A one-month lag is a way to ensure that knowledge about the lantern can naturally diffuse from the seed household to peer households. Second, before playing the BDM game with the incentivized communication household, the seed invited his/her communication friend over to a tee meeting to discuss his/her experience of the lantern.

[11] Their friends also did not know that the seed was getting 100 rupees more.

3.3 Covariate Balance and Power Analysis

The balance table for the information treatment is shown in Table 2. As the table shows, the treatment groups are balanced across most covariates, with a few exceptions: gender of the respondent, savings and indebtedness. The control group has significantly more female heads of household and about 450 rupees less in savings compared to the unincentivized network and incentivized communication groups. This is a potential source for concern given households with more savings would be in a better position to bid higher prices. For this reason, as a robustness check, we include these variables in additional regression analysis.

[Table 2 about here.]

The balance table across the seed gender treatments is shown in Table 3. As could be expected, within each information treatment group the households referred by the female seeds are more likely to be headed by a female, while the households referred by the male seeds are usually headed by a male. It follows that the different groups display significant differences for variables such as education, consumption expenses or literacy.

[Table 3 about here.]

Standard power analysis shows that the experiment can identify plausible treatment effects. Using the control group's mean and standard deviation (134 and 181 respectively), a standard deviation's uniform increase (to 315, with a standard deviation of 362) would be detected with an $\alpha = 0.95$ probability if the control and treatment group each had at least 65 participants. In our setting, each group has 200 subjects, and, we cluster standard errors at the habitation level ($N = 200$). We also control for habitation fixed effects, which enables us to estimate the treatment effects more precisely.

4 Results

4.1 Main Estimates

Figure 4 shows the distribution of bids across treatment groups. There is a noticeable change in the distribution between the control group and the network group, and between the network group and the incentivized communication group: the distribution becomes flatter and displays a much fatter left tail. This likely indicates that our treatments have positive effects on WTP. We hardly notice important differences, however, when comparing the distribution across gender of the seed; this indicates that our gender treatment is not likely to have any effect.

We display box plots of WTP for the different treatment groups in Figure 5. We also show the value of the mean WTP across treatments in the Appendix. We find that the mean WTP in the network and incentivized communication treatments is significantly higher than in the control, and we also find a significant difference between the network and incentivized communication treatments when the sample is not split by gender[12]. However, when looking only at the sample with female seeds, there is no significant difference between the means of the network and incentivized communication treatments. Box plots on Figure 5 seem to indicate that there is a difference between Male and Female in the control group, but less so in the treatment groups. We find that, indeed, the difference in the control group is significant at the 5%. However, we note that the difference is not significant any longer when using the rank-sum test.

[Figure 4 about here.]

[Figure 5 about here.]

Mean comparisons, however, do not control for unobserved heterogeneity across habitations and for correlation between observations within the same habitation. We therefore proceed to using regression analysis with fixed effects and clustered standard errors at the habitation level. The main results from regression analysis are shown in Table 4. In all regressions, the standard errors are clustered at the habitation level. Habitation fixed effects are not included in the second column because the gender treatment was randomized across habitations. Results show that the network treatment increased WTP by almost 120 Rupees compared to the control group. Given the mean WTP of the control group was 134 Rupees,[13] this corresponds to a 90% increase. Furthermore, compared to the control group, the incentivized communication treatment increased WTP by 195 Rupees which corresponds to a 145% increase. These findings have important implications on social-learning about new technology. After investigating the robustness of our findings, we will investigate the mechanisms and shed light on these implications.

The gender treatment, however, does not appear to have a statistically significant effect. We hypothetize a possible gender effect to play a role because of women's low decision-making autonomy, *male* household heads might discount women's words and experience of a new technology and might therefore not be as convinced to bid a higher price. Some of the friends chosen by the female seed were in fact female household heads. We expect the gender effect not to be at play in those cases, since female household heads, as opposed to male, are less likely to discount another woman's word. Hence, in column 3 of Table 4, we run a regression

[12] We performed both t-tests and rank-sum tests.

[13] Similarly, the value of the intercept in model 1 of Table 4 is 134.5 Rupees.

specification similar to column 2 but excluding households headed by women. If there is gender effect, it should be stronger in that sub-sample. Although the point estimate is indeed negative, overall, the effect is not statistically significant. This excludes the possibility that the absence of a strong effect of the gender treatment results from a composition effect. Instead, it indicates that the mechanism we hypothesised and discussed earlier might not be in place.

[Table 4 about here.]

4.2 Robustness Checks

In Table 5, we include controls for monthly savings, one of the imbalanced covariates. We see that the treatment effects coefficients slightly decrease from 120 to 108 Rupees in the network group and from 195 to 184 Rupees in the incentivized communication group. Yet, the effects remain robust. The coefficient for monthly savings is significant at the 5% level but the magnitude is small: every additional Rupee in savings correlates with a WTP increase of 0.026 Rupees. Given the imbalance of savings across treatment groups, this represents an average contribution to the WTP of about 6 Rupees in the control group and 17 to 18 Rupees in the network and incentivized communication groups. The contribution of savings to the WTP is therefore an order of magnitude lower than the contribution of our information treatments. In fact, the raw correlation coefficient between WTP and savings is only 0.15. This can be visualized on the scatter plot of WTP for the entire sample, with amount of savings shown in the Appendix: those who had the highest amount of savings are not those who revealed the highest WTP. In regression 2, we interact monthly savings with the treatment dummies. The coefficient for the interaction term is negative and significant at the 10% level, indicating that savings and WTP correlate even in this treatment group. We also re-run the regression using monthly savings in logs instead of levels and find similar results. Specifically, we note that the estimated treatment effects decreases slightly, from 120 to 103 Rupees in the network group and from 195 to 177 Rupees in the communication group, but, overall, the effects remain large and significant at the 1% level. Finally, regression 5 estimates the treatment effects for the sub-sample of respondents who declared having zero savings. This regression therefore includes only about half of the observations. We see that the treatment effects found within this subsample are very similar to those found for the whole sample. This confirms that monthly savings are not the main driver of our treatment effects.

[Table 5 about here.]

In Table 6, we add other control variables. In column 1, we control for whether the household head is female because this was the other unbalanced variable. Treatment effects for both the network and communication groups change little. In column 2, we control for both whether the household head is female and for the amount of monthly savings. The main treatment effects are slightly reduced but remain large and significant at the 1% level. In column 3, we control for the date when the household was surveyed. Harvesting of maize and rice in the study area started at the end of September and early October respectively. This timing partly coincided with our survey of the network and incentivized communication groups: about 20% of our treated households were interviewed after September 25[14],[15]. If those sampled households began selling their harvest, they would likely have been able to afford greater expenditures, and consequently have a higher WTP for the solar lanterns. We therefore investigate the robustness of our treatment effect to this possible "wealth effect".

In order to investigate the possible role of a wealth effect, we control in our regression for the date of interview. Specifically, the variable "Date" is the month and day of the month on which the respondent was interviewed. If there is a wealth effect due to the sale of crops, respondents interviewed toward the end of the experiment are more likely to have access to cash and bid a higher price. The coefficient on 'Date' then should be positive. Results show that the coefficient is not significant and leans toward negative values.[16] This shows that respondents interviewed last were no more likely to bid higher amounts, which provides supporting evidence against a wealth effect from the harvest season. In column 4, our main results remain robust to the inclusion of seven additional control variables. Most variables, such as the level of education, expenditures, whether or not the respondent is in debt, and household size, display small and insignificant coefficients. The number of children going to school shows a slightly larger coefficient; the variable is statistically insignificant. Only the number of kerosene lamps displays a coefficient that is significant at the 10% level: households owning many kerosene lamps also bid slightly higher WTP. Intuitively, households with a greater number of kerosene lamps are likely to be households with a greater need for lighting products, which should translate into higher WTP.

[Table 6 about here.]

[14] Rice Knowledge Management Portal, maintained by the Indian Council of Agricultural Research (http://www.rkmp.co.in/content/rice-growing-seasons-of-uttar-pradesh) indicates that in Uttar Pradesh summer rice is harvested in April-May and Kharif rice in November-December. On the other hand, wheat is harvested around March-April in the eastern part of Uttar Pradesh, and around mid-April in the western part (see http://www.archive.india.gov.in/citizen/agriculture/index.php?id=11). Our local team, however, indicated that a reasonable estimate for the first day of harvest in the region around Gonda City was September 25 for Maize and October 5 for rice, and we use these more conservative dates for our robustness check.

[15] We also checked for other campaigns promoting solar lanterns in the sample habitations, which are likely to be correlated with our treatments. There were none.

[16] Standard errors and coefficients are very large in this case due to the collinearity between our treatment dummies and the date variable.

4.3 Mechanisms

In this section, we investigate the possible mechanisms to explain why our treatments are effective. Table 7 displays the mean response to various survey questions for each treatment group. The exact phrasing of the questions can be found in the appendix. First, we note that almost every respondent, across groups. thought that a solar lantern was *definitively* an innovative product, *definitively* a product superior to a kerosene lamp, and would *definitively* recommend it to others. However, we note that, compared to the control group, respondents in the network and incentivized communication groups are much more likely to have seen a solar lantern before and they are much more likely to know someone who owns a lantern. This is fully consistent with our experimental design and provides evidence that our treatments were properly implemented. Furthermore, close to 90% of the respondents in the network and incentivized communication group stated that they had conversations with that person more than three times a week. Hence, the major factor explaining the difference between the network and the incentivized communication groups is unlikely to be the level of interactions with a friend who owns a solar lantern. The last two variables in the table provide some insights as to why WTP has increased. Contrary to the control group, most people in the network and incentivized communication groups now believe that, to function properly, a solar lantern needs proper maintenance. They also estimate the cost of such a product at a higher level than the control group. This might seem counterintuitive at first that perception of higher cost and higher maintenance is a positive thing when it comes to evaluating a technology. However, this is fully consistent with discovering how sophisticated the product really is. It very likely indicates that the respondents learn about the technical quality of the lantern from their friend's experience. At first, villagers might expect that solar lanterns are nothing more sophisticated than basic lamps, like kerosene lanterns. They then observe their friend taking care of it; they note the photovoltaic panel that is connected to the lamp, which allows the battery to be charged. As a result, they perceive the product as a sophisticated item that requires careful maintenance and are therefore willing to pay a higher price.

[Table 7 about here.]

In one of the survey questions, we asked respondents how much they thought the lantern cost. The mean estimate approximates 730 Rupees with a standard deviation of about 500. Interestingly, the correlation between cost estimates and the willingness to pay is small in magnitude. Regression 1 in Table 8 shows that every 100 extra Rupees in cost estimate correlates with an increase in willingness to pay of only about 8 Rupees. In column 2, we investigate the treatment effects on the estimated cost. We note that both the network and incentivized communication groups display higher estimated costs compared to the control group. In particular, respondents in the network group estimated the lantern at a higher cost than did respondents in the incentivized communication group. Yet, they bid lower prices in the BDM game on average. This indicates that the main mechanism through which the tea meetings affect willingness to pay is not through increasing respondents' perception of the product's cost. It is rather very likely through improving knowledge about the attributes of the solar lantern technology.

[Table 8 about here.]

Finally, in an attempt to explain why men did not discount female seeds in our setting, Table 9 looks at indicators of women's status. Our survey included a series of questions about gender norms in the villages. In the first set of questions, we asked respondents whether they believed a woman should ask permission from her husband or a family member before going out. Almost all household heads said that women should ask for permission to go to the health center, to visit a friend or to go to the market. On the other hand, answers to other questions reflect more egalitarian views. Only about 5% of the sample said that they never talked with their spouse about what to spend income on, and about two-thirds of the sample said they often had such discussions. In addition, virtually all households thought that women should have a say in how income is spent. Most respondents thought that it was definitively important that girls go to school. They further expressed the view that beating a woman was rarely justified. Finally, most respondents thought that women were as able as men to use new technologies. It appears that gender norms in our context give women some say in purchasing decisions, as well as when it comes to using new products. This might therefore explain why our gender treatment had little effect on willingness to pay.

[Table 9 about here.]

5 Conclusion

[Figure 6 about here.]

Adoption and diffusion of new technologies is crucial to improve the livelihood of poor communities. One important factor that promotes this process is information sharing through social networks. Adoption of a new technology is a social process because its adoption by an individual creates positive information externality to peers and this increases their expected welfare (Bardhan and Udry, 1999). Does rewarding individuals who make a conscious effort to communicate information about new technologies increase willingness to pay (WTP) by members of a social network? Whose social network in the household matters for the flow of information about new technologies? In this paper, we attempted to answer these questions by crafting a randomized controlled trial which involves distribution of multi-purpose solar lanterns under different treatments.

We collaborated with a local institution in rural India and assigned three peers of randomly recruited seed individuals (half of them male and half female) into a "network treatment", an "incentivized communication treatment" and a "control group". We elicited WTP for the solar lanterns from the control group right after interviewing the seed household, using the Becker-Degroot-Marschak (BDM) method (Becker, Degroot, and Marschak, 1964). We elicited WTP for the lanterns from the "network" group one month after the seed households had acquired the lantern. We also asked the seed households to invite one of the peers (the incentivized communication group) for a tea meeting to demonstrate and share their experience in using the lantern after a month, in return for an incentive payment of 100 rupees. We elicited WTP of the incentivized communication group after the tea meetings have taken place. The study area is non-electrified and households did not have previous knowledge about the solar lanterns. These facts allowed us to explore the flow of information and the value households place on technologies that have large potential to improve quality of life of all members of the household.

Our results show that households, who most likely learned about the solar lantern technology through their normal interaction with the seed (the network treatment group), are willing to pay 120 Rupees more compared to the control group. Given the control group is willing to pay 134 Rupees on average, this corresponds to a 90% increase in WTP. On the other hand, households who attended a demonstration session by their peers (the incentivized communication treatment) are willing to pay 195 Rupees (145%) more than the control group. We do not find a statistically significant difference in WTP between male and female networks in either treatment. In order to shed light on the possible mechanisms that explain the observed outcome (WTP for the solar lanterns), we collected detailed information on peers' previous knowledge of solar lanterns, perception about their benefit, estimated market price, etc. Our results suggest that learning how to operate the technology and observing its benefits, which appeared to be superior to the kerosene lamp that households in the study area use as a source of lighting, are the important factors that drive WTP of both treatment groups.

Our findings have significant implications for policies that aim at promoting adoption and diffusion of new technologies in developing countries. If rewarding information communicator peers promotes information spill-over and willingness to pay, reducing the cost of the technology and allocating resources to communication will have significant welfare impact on society. The revealed willingness-to-pay data generated in this experiment allows us to predict what the adoption rate of the solar lanterns would be under each treatment over varying subsidy rates. A significant proportion of households in developing countries do not have access to electricity and governments lack the required resources to extend the grid. Solar power has a large potential to tackle energy poverty and protect the environment by serving as a decentralized solution. Such a cost-benefit analysis would therefore be useful to governments and other stakeholders that aim at promoting adoption of solar lanterns in unelectrified low-income communities. Figure 6 illustrates the results from this prediction exercise. The results suggest that, covering 20% of the population at the baseline scenario would require subsidy of about 950 rupees per lantern. A lower level of subsidy may be required once information has diffused, as in the network group: in which case, covering 20% of the population would require subsidy of about 700 rupees per lantern. Due to the improved quality of information flow, incentivized communication will further reduce the required level of subsidy to maintain a 20% coverage of the solar lantern technology to XXXX rupees.

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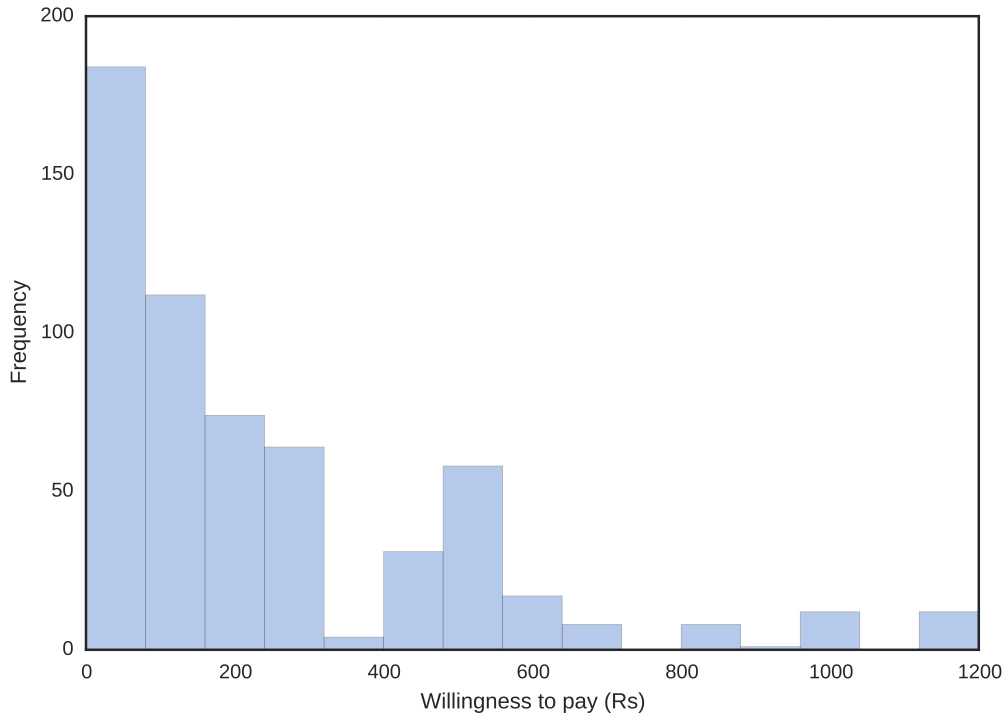

Figure 1: Histogram of bids for the solar lantern. Summary statistics are as follows: minimum = 0; maximum = 1200; mean = 239; standard deviation = 266.

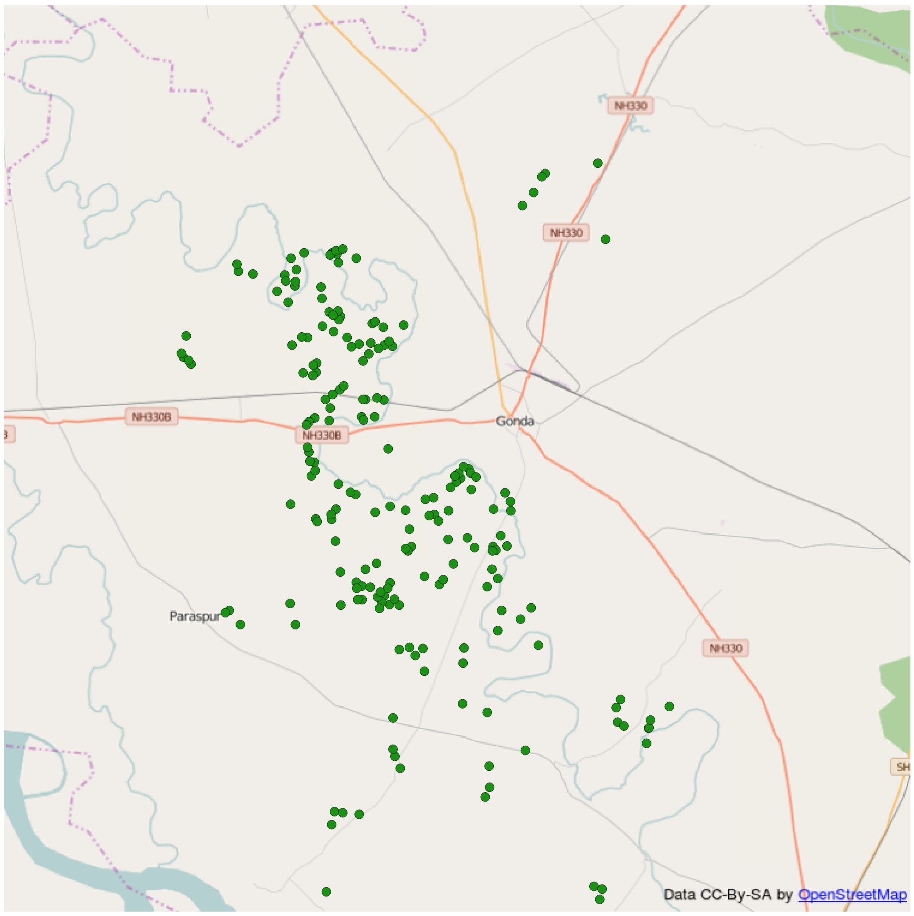

Figure 2: Map of study area around Gonda City. The green dots indicate the study habitations.

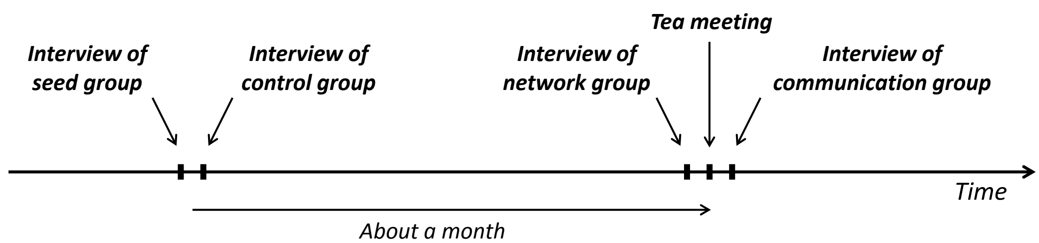

Figure 3: Timeline of the experiment.

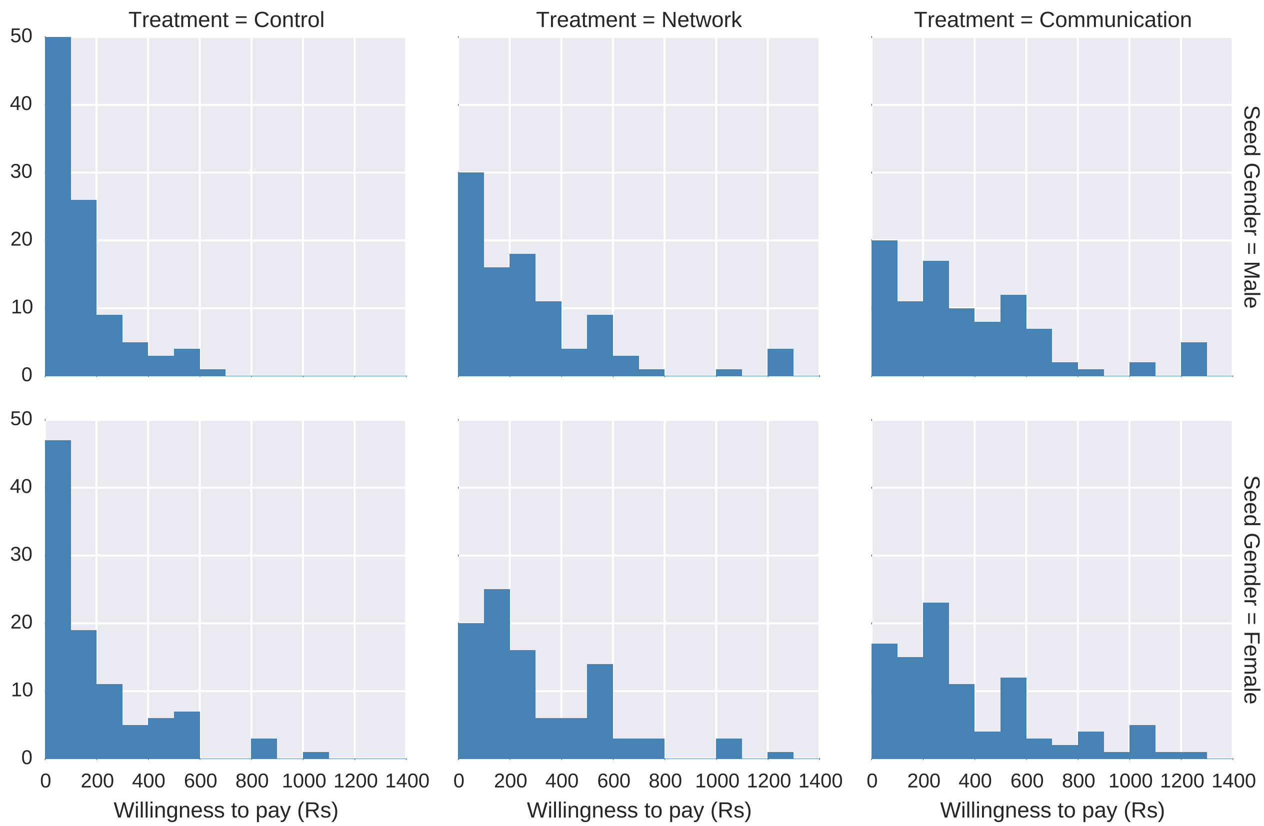

Figure 4: Faceted histogram of bids for the solar lantern.

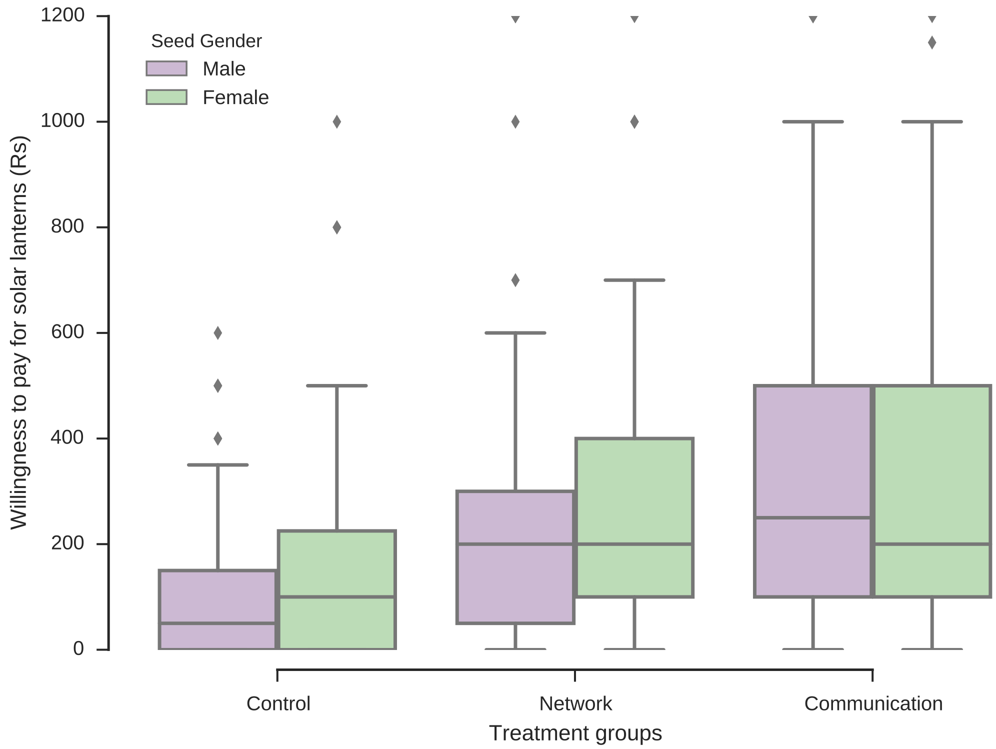

Figure 5: Boxplots of bids for the solar lantern.

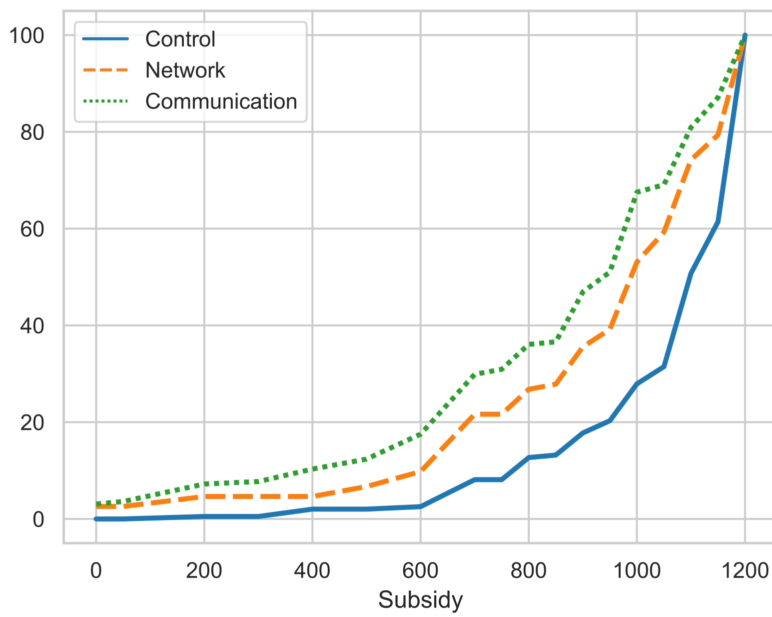
Control
Network
Communication
100
80
60
40
20
0
0
200
400
600
800
1000
1200
Subsidy

Figure 6:

	Total number of habitations		
	Control	**Network**	**Communication**
Male Seed	98	98	98
Female Seed	99	99	99

Table 1: Size of treatment groups. In all treatments, the sample household's head is interviewed. The gender treatment is randomized across habitations; the information treatment is randomized within habitations.

	Cont	Net	DIFF	Cont	Comm	DIFF	Net	Comm	DIFF
1) Individual Characteristics:									
Female respondent	0.355	0.198	0.157***	0.355	0.254	0.102**	0.198	0.254	-0.0558
	(0.480)	(0.399)	(3.54)	(0.480)	(0.436)	(2.20)	(0.399)	(0.436)	(-1.32)
Year of birth	1972.1	1971.8	0.239	1972.1	1970.7	1.345	1971.8	1970.7	1.107
	(14.76)	(14.24)	(0.16)	(14.76)	(12.91)	(0.96)	(14.24)	(12.91)	(0.81)
Education	1.944	2.041	-0.0964	1.944	1.893	0.0508	2.041	1.893	0.147
	(1.352)	(1.435)	(-0.69)	(1.352)	(1.255)	(0.39)	(1.435)	(1.255)	(1.08)
Reads Hindi	0.477	0.487	-0.0102	0.477	0.482	-0.00508	0.487	0.482	0.00508
	(0.501)	(0.501)	(-0.20)	(0.501)	(0.501)	(-0.10)	(0.501)	(0.501)	(0.10)
2) Household Characteristics:									
Number of children	3.693	3.918	-0.225	3.693	4.015	-0.323	3.918	4.015	-0.0979
	(2.106)	(2.032)	(-1.07)	(2.106)	(2.085)	(-1.51)	(2.032)	(2.085)	(-0.47)
Number of children in school	1.370	1.412	-0.0426	1.370	1.649	-0.280*	1.412	1.649	-0.237
	(1.550)	(1.562)	(-0.27)	(1.550)	(1.657)	(-1.71)	(1.562)	(1.657)	(-1.45)
Household size	7.310	7.183	0.127	7.310	7.289	0.0203	7.183	7.289	-0.107
	(3.916)	(3.379)	(0.34)	(3.916)	(3.375)	(0.06)	(3.379)	(3.375)	(-0.31)
3) Wealth-related variables:									
Monthly Expenses	4176.6	4376.6	-200	4176.6	4530.5	-353.8	4376.6	4530.5	-153.8
	(2334.3)	(3412.5)	(-0.68)	(2334.3)	(2810.7)	(-1.36)	(3412.5)	(2810.7)	(-0.49)
Amount of Savings	223.4	682.2	-458.9***	223.4	661.4	-438.1***	682.2	661.4	20.81
	(673.8)	(884.1)	(-5.79)	(673.8)	(1038.3)	(-4.97)	(884.1)	(1038.3)	(0.21)
In debt	0.467	0.609	-0.142***	0.467	0.477	-0.0102	0.609	0.477	0.132***
	(0.500)	(0.489)	(-2.85)	(0.500)	(0.501)	(-0.20)	(0.489)	(0.501)	(2.65)
Owns a business	0.0355	0.0660	-0.0305	0.0355	0.0711	-0.0355	0.0660	0.0711	-0.00508
	(0.186)	(0.249)	(-1.38)	(0.186)	(0.258)	(-1.57)	(0.249)	(0.258)	(-0.20)
Amount of land (acres)	1.310	1.443	-0.134	1.310	1.415	-0.106	1.443	1.415	0.0278
	(1.888)	(1.936)	(-0.69)	(1.888)	(1.426)	(-0.63)	(1.936)	(1.426)	(0.16)
Owns cattle	0.873	0.873	0	0.873	0.929	-0.0558*	0.873	0.929	-0.0558*
	(0.334)	(0.334)	(0.00)	(0.334)	(0.258)	(-1.86)	(0.334)	(0.258)	(-1.86)
Owns a phone	0.853	0.838	0.0152	0.853	0.868	-0.0152	0.838	0.868	-0.0305
	(0.355)	(0.370)	(0.42)	(0.355)	(0.339)	(-0.44)	(0.370)	(0.339)	(-0.85)
4) Lighting-related variables:									
Number of kerosene lamps	2.376	2.421	-0.0457	2.376	2.401	-0.0254	2.421	2.401	0.0203
	(1.266)	(1.229)	(-0.36)	(1.266)	(1.043)	(-0.22)	(1.229)	(1.043)	(0.18)
Hours of lighting	5.178	4.782	0.396*	5.178	5.033	0.145	4.782	5.033	-0.251
	(2.368)	(1.814)	(1.86)	(2.368)	(1.766)	(0.69)	(1.814)	(1.766)	(-1.39)
Monthly spending per lamp	39.65	43.85	-4.196	39.65	43.78	-4.122	43.85	43.78	0.0739
	(26.72)	(23.50)	(-1.62)	(26.72)	(34.85)	(-1.30)	(23.50)	(34.85)	(0.02)

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Balance table across treatments and associated t-tests. A rank-sum test (Wilcoxon-Mann-Whitney) was also performed for the variables that do not approximate a normal distribution. The only difference with the t-tests are as follows: 1) The difference between control and communication for the number of children that go to school is significant at the 10% level, 2) The difference between network and communication for hours of lighting is now significant at the 10% level.

	Cont M	Cont F	DIFF	Net M	Net F	DIFF	Comm M	Comm F	DIFF
1) Individual Characteristics:									
Female respondent	0.153	0.556	-0.402***	0.102	0.293	-0.191***	0.153	0.354	-0.200***
	(0.362)	(0.499)	(-6.47)	(0.304)	(0.457)	(-3.45)	(0.362)	(0.480)	(-3.31)
Year of birth	1971.3	1972.8	1.532	1971.6	1972.1	-0.529	1969.7	1971.8	-2.043
	(15.89)	(13.58)	(-0.73)	(15.06)	(13.44)	(-0.26)	(12.82)	(12.97)	(-1.11)
Education	2.051	1.838	.213	2.265	1.818	0.447**	1.980	1.808	0.172
	(1.357)	(1.345)	(1.10)	(1.544)	(1.289)	(2.21)	(1.284)	(1.226)	(0.96)
Reads Hindi	0.541	0.414	0.127*	0.592	0.384	0.208***	0.490	0.475	0.0150
	(0.501)	(0.495)	(1.79)	(0.494)	(0.489)	(2.97)	(0.502)	(0.502)	(0.21)
2) Household Characteristics:									
Number of children	3.543	3.837	-0.294	3.823	4.010	-0.187	3.918	4.113	-0.196
	(2.077)	(2.133)	(-0.97)	(2.026)	(2.043)	(-0.64)	(2.045)	(2.131)	(-0.65)
Number of children in school	1.223	1.510	-0.287	1.417	1.408	0.00850	1.526	1.773	-0.247
	(1.489)	(1.601)	(-1.28)	(1.499)	(1.630)	(0.04)	(1.690)	(1.623)	(-1.04)
Household size	7.357	7.263	0.0945	7.765	6.606	1.159**	7.939	6.646	1.292***
	(3.946)	(3.906)	(0.17)	(3.705)	(2.927)	(2.44)	(3.472)	(3.163)	(2.73)
3) Wealth-related variables:									
Monthly Expenses	3899.0	4451.5	-552.5*	4844.9	3913.1	931.8*	4940.8	4124.2	816.6**
	(2240.9)	(2403.0)	(-1.67)	(4403.4)	(1913.7)	(1.93)	(3206.4)	(2299.6)	(2.06)
Amount of Savings	278.6	168.7	109.9	717.3	647.5	69.87	672.4	650.5	21.94
	(776.2)	(552.7)	(1.15)	(914.5)	(856.1)	(0.55)	(740.3)	(1270.3)	(0.15)
In debt	0.480	0.455	0.0250	0.582	0.636	-0.0547	0.480	0.475	0.00484
	(0.502)	(0.500)	(0.35)	(0.496)	(0.483)	(-0.78)	(0.502)	(0.502)	(0.07)
Owns a business	0.0510	0.0202	0.0308	0.0816	0.0505	0.0311	0.0612	0.0808	-0.0196
	(0.221)	(0.141)	(1.17)	(0.275)	(0.220)	(0.88)	(0.241)	(0.274)	(-0.53)
Amount of land (acres)	1.196	1.422	-0.226	1.431	1.455	-0.0248	1.604	1.228	0.375*
	(1.157)	(2.404)	(-0.84)	(1.678)	(2.170)	(-0.09)	(1.638)	(1.158)	(1.86)
Owns cattle	0.827	0.919	-0.0927*	0.867	0.879	-0.0114	0.918	0.939	-0.0210
	(0.381)	(0.274)	(-1.96)	(0.341)	(0.328)	(-0.24)	(0.275)	(0.240)	(-0.57)
Owns a phone	0.816	0.889	-0.0726	0.806	0.869	-0.0626	0.908	0.828	0.0799*
	(0.389)	(0.316)	(-1.44)	(0.397)	(0.339)	(-1.19)	(0.290)	(0.379)	(1.66)
4) Lighting-related variables:									
Number of kerosene lamps	2.235	2.515	-0.280	2.439	2.404	0.0347	2.541	2.263	0.278*
	(1.250)	(1.273)	(-1.56)	(1.332)	(1.124)	(0.20)	(1.141)	(0.921)	(1.88)
Hours of lighting	5.082	5.273	-0.191	4.806	4.758	0.0485	5.005	5.061	-0.0555
	(2.218)	(2.515)	(-0.57)	(1.892)	(1.743)	(0.19)	(1.709)	(1.828)	(-0.22)
Monthly spending per lamp	38.79	40.48	-1.688	44.92	42.84	2.088	42.30	45.25	-2.952
	(22.00)	(30.64)	(-0.44)	(21.72)	(25.13)	(0.61)	(21.83)	(44.27)	(-0.59)

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Balance table across treatments and seed gender and associated t-tests. A rank-sum test (Wilcoxon-Mann-Whitney) was also performed for the variables that do not approximate a normal distribution. The only difference with the t tests are as follows: 1) The difference in education level is significant at 10% in the control group, 2) The difference in household expenses is not significant in the network group, 3) The difference in savings of the seeds is significant at 10% in the communication group, 4) The difference in irrigated land is not significant in the communication group, 5) The difference in the number of kerosene lamps is not significant in the communication group.

	(1) WTP	(2) WTP	(3) Male head only
Network	119.883***	136.988***	134.586***
	(22.115)	(30.847)	(35.014)
Communication	195.078***	224.416***	224.802***
	(22.925)	(32.086)	(36.442)
Network x Female Seed		-34.067	-10.586
		(44.229)	(62.968)
Communication x Female Seed		-57.749	-63.893
		(45.745)	(65.971)
Habitation fixed effects	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes
R-squared	0.157	0.161	0.165
Observations	585	585	426

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

Table 4: Main results for experimental treatments. In column 1, the coefficients for Network and Communication are different at the 1% level.

	(1)	(2)	(3)	(4)	(5)
Network	107.560***	114.829***	103.161***	119.744***	117.944***
	(22.727)	(28.718)	(25.966)	(33.841)	(36.070)
Communication	183.525***	201.240***	177.301***	229.662***	214.382***
	(23.902)	(25.510)	(27.383)	(39.679)	(43.535)
Amount of Savings	0.026**	0.066**			
	(0.013)	(0.033)			
Network x Savings		-0.037			
		(0.039)			
Communication x Savings		-0.053*			
		(0.031)			
Savings (log)			5.689	19.353**	
			(4.340)	(7.478)	
Network x log Savings				-14.007	
				(8.860)	
Communication x log Savings				-22.412**	
				(9.470)	
Habitation fixed effects	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes
R-squared	0.165	0.170	0.162	0.173	0.180
Observations	585	585	585	585	315

Standard errors in parentheses
Model57 is for the sub-sample of respondents that declare zero savings.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Main results for experimental treatments controlling for amount of savings. We also tested a specification with logarithmic savings, but the coefficient on savings was found insignificant (p-value=0.19).

	(1)	(2)	(3)	(4)
Network	115.107***	103.683***	388.290**	107.417***
	(22.469)	(22.937)	(180.316)	(23.648)
Communication	191.915***	181.072***	470.514***	180.440***
	(23.112)	(24.064)	(180.690)	(25.392)
Female Head	-31.046	-27.911	-29.942	-23.498
	(27.096)	(26.594)	(26.485)	(29.239)
Amount of Savings		0.026**	0.027**	0.025*
		(0.013)	(0.013)	(0.013)
Interview date			-7.698	
			(4.800)	
Education				4.435
				(11.774)
Monthly Expenses				-0.005
				(0.005)
If in debt				-26.111
				(26.150)
Household size				-2.581
				(3.973)
Number of children to school				11.891
				(7.441)
Number of kerosene lamps				19.689
				(11.929)
Hours of lighting				1.419
				(6.538)
Monthly spending on lighting				0.008
				(0.290)
Habitation fixed effects	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes
R-squared	0.160	0.167	0.176	0.181
Observations	585	585	584	574

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

Table 6: Main results for experimental treatments with control variables included.

	Cont.	Net.	DIFF	Cont.	Comm.	DIFF	Net.	Comm.	DIFF
Innovative product	4.939	4.980	-0.0405	4.939	4.970	-0.0305	4.980	4.970	0.0100
	(0.373)	(0.226)	(-1.30)	(0.373)	(0.200)	(-1.01)	(0.226)	(0.200)	(0.47)
Superior to kerosene lamps	4.995	4.980	0.0152	4.995	4.985	0.0101	4.980	4.985	-0.00508
	(0.0714)	(0.174)	(1.13)	(0.0714)	(0.123)	(1.00)	(0.174)	(0.123)	(-0.33)
Will recommend to others	4.995	4.975	0.0203	4.995	4.949	0.0457*	4.975	4.949	0.0254
	(0.0712)	(0.187)	(1.42)	(0.0712)	(0.346)	(1.81)	(0.187)	(0.346)	(0.91)
Seen lantern before	0.244	0.934	-0.690***	0.244	0.949	-0.706***	0.934	0.949	-0.0152
	(0.430)	(0.249)	(-19.49)	(0.430)	(0.220)	(-20.49)	(0.249)	(0.220)	(-0.64)
Know someone with lantern	0.132	0.924	-0.792***	0.132	0.944	-0.812***	0.924	0.944	-0.0203
	(0.339)	(0.266)	(-25.78)	(0.339)	(0.230)	(-27.80)	(0.266)	(0.230)	(-0.81)
Need maintenance function properly	0.533	0.0508	0.482***	0.533	0.0914	0.442***	0.0508	0.0914	-0.0406
	(0.500)	(0.220)	(12.39)	(0.500)	(0.289)	(10.73)	(0.220)	(0.289)	(-1.57)
Cost estimate	627.1	838.7	-211.6***	627.1	736.6	-109.5**	838.7	736.6	102.1*
	(558.7)	(647.9)	(-3.47)	(558.7)	(538.9)	(-1.98)	(647.9)	(538.9)	(1.70)

Table 7: Summary statistics for some key solar lantern related variables highlighting possible mechanisms.

	(1) Estimated cost	(2) Estimated cost
WTP	0.390***	
	(0.091)	
Network		211.589***
		(53.725)
Communication		109.538**
		(53.985)
Habitation fixed effects	No	Yes
Clustered SE	Yes	Yes
R-squared	0.031	0.036
Observations	585	591

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

Table 8: Results with cost estimate of solar lanterns as dependent variable.

	Male Seed Friends	Female Seed Friends
1. Should ask permission to go the health center	0.963	0.963
	(0.190)	(0.189)
2. Should ask permission to go visit a friend	0.980	0.973
	(0.142)	(0.162)
3. Should ask permission to go to the market	0.980	0.983
	(0.142)	(0.129)
4. Talk about what to spend money on with spouse	1.585	1.613
	(0.600)	(0.583)
5. Women should have a say on how to spend income	0.976	0.966
	(0.174)	(0.199)
6. It is importnat that girls go to school	4.980	4.970
	(0.164)	(0.223)
7. Women should work outside home or own a business	3.524	3.805
	(1.787)	(1.647)
8. Beating justified if she goes out without telling	0.500	0.559
	(0.501)	(0.497)
9. Beating justified if she argues with husband	0.592	0.670
	(0.492)	(0.471)
10. Beating justified if suspected of adultery	0.759	0.754
	(0.429)	(0.431)
11. Men are better able to use new technologies than women	3.299	3.128
	(1.713)	(1.714)

Table 9: Descriptive statistics on women's status. Note: Most variables are binary variables where 0 codes for no, and 1 for yes. Answers to question 4 are coded as follows: 0 for "Never", 1 for "Sometimes", 2 for "Often". Answers to questions 6, 7, and 11 are as follows: 1 for "Definitely not", 2 for "Not really", 3 for "Neutral", 4 for "Somewhat" and 5 for "Definitely".