Who's the Boss? Intrahousehold Valuation, Preference Heterogeneity, and Demand for an Agricultural Technology in India

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Abstract

Both women and men in a household have a potential role in adoption of labor-saving technologies, particularly when the decision influences their labor allocation. Mechanical rice transplanting (MRT) is a technology that reduces labor in transplanting, which is a task primarily reserved for women in India. I examine the influence of intrahousehold heterogeneity in demand for MRT on the household's technology adoption decision. I elicit stated willingness to pay for MRT from women and men belonging to same households, and measure the household's willingness to pay for the technology by using a village-level experimental auction. Women value MRT more than men, and this difference is not driven by their individual characteristics. However, household demand is a reflection of men's valuation and women's bargaining power does not influence the adoption decision.

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1 Introduction

In many developing countries, agricultural policies focus on improving the productivity and profitability of farmers – both women and men – who either single-handedly manage all farm activities or engage in specific farm activities and perform specialized roles. Most of these policies, especially those accelerating the adoption of new agricultural technologies, treat the household as a single decision-making unit. However, when the technology influences the household's labor arrangements – particularly the household's female and male labor allocation decisions differently – the assumption of a unitary household may be misleading when examining the household's technology choices. When such an agricultural decision has welfare consequences for the household's gendered division of labor, examining the internal household dynamics that guide the decision becomes central to analyzing the key determinants and effects of technology adoption.

This study closely examines such a gendered agricultural choice made by rural households in India – the decision to adopt a labor-saving rice transplanting technology. In many parts of India, manual rice transplanting in puddled conditions tends to be a task primarily reserved for women and is highly labor-intensive and arduous. Depending on the household's family and hired gendered labor allocation on the farm for transplanting, the decision to adopt mechanical rice transplanting (MRT) influences the labor arrangements and welfare of both female and male members of the household. Consequently, the household members involved in transplanting may participate in the bargaining processes guiding the household's technology adoption decision. Understanding how household members value the technology differently and how these valuations influence household technology adoption are crucial dimensions for agricultural policy design. More importantly, these intrahousehold dimensions are important for development policy aiming to improve the welfare of all people who constitute the household.

I ask whether household members, particularly the male and female agricultural decision-makers in the household, value the transplanting technology differently, and whether this difference in valuation arises from having different preferences or varied individual characteristics. I also seek to understand how these valuations influence the household's overall technology adoption decision. Masked behind this joint technology adoption decision are hidden, unobserved parameters of bargaining power or "voice" of these household members that may influence the household's overall decision. Ultimately, the linkages between who decides and who gets affected within the household is not only tied to household welfare but also to the distribution of welfare amongst individual household members.

To untangle the unobserved individual valuation of the technology from the observed household's demand, I use a combination of stated and experimental elicitation techniques. Setting-up intrahousehold incentive compatibility is controversial in the case of this technology because successfully cultivating rice is a critical component of a household's livelihood and food security. To circumvent this issue, I elicit stated valuation for MRT from men and women belonging to same households using framed elicitation techniques proposed in the valuation literature. I measure the household's revealed demand for MRT using an incentive-compatible, experimental auction. Having these three measures – female valuation, male valuation, and household demand – allows me to examine the influence of individual valuation on household demand. I use the unobserved parameters of bargaining power of household members to characterize the household demand of MRTs. The analysis is embedded in the household's female and male labor arrangements for transplanting and illuminates the key role such allocations play in individual valuations of this technology and the household's adoption decision.

I find evidence of heterogeneous valuations amongst women and men for agricultural decision-making in a predominantly patriarchal setting in rural India. Because valuations of an individual embody both their preferences and endowments, I apply the Oaxaca-Blinder decomposition to divide the stated valuation into two components: difference in valuation arising from women and men having different individual characteristics and agricultural access (*endowment difference*), and the unexplained difference (*preference difference*) in valuation conditional on women and men having same individual characteristics. Women value mechanical rice transplanting more than men not only when comparing the stated difference in valuation, but women value MRTs even more when comparing the *preference difference*. In households where only the female and male members of the family transplant, women value the technology more than men by Rs. 154 on average, which corresponds to a fifth of the average valuation of these households.

Even though women value MRTs more than men, their valuation – including their bargaining power – have little bearing on the household's demand for the technology. This finding is stronger for households where only the family members transplant – the difference in intrahousehold valuation is biggest in these households but women have very little "voice" vis-à-vis men in influencing the household's adoption decision. Measuring voice or bargaining power of women is a critical component of this analysis. However, bargaining power in a household is an unobserved parameter and is often difficult to capture in its entirety. I use Sen's (1987) framework of combining the asset-based exit options available to women in case of conflict, women's degree of influence in household decisions, and their contribution to income to capture women's bargaining power. Measuring bargaining in this way fits the study's context in which the seeming dichotomy in unobserved individual valuation (the exit option view of bargaining) is mixed with an observed cooperative household decision (the individual influence and contribution view of bargaining).

This study places technology adoption within the broader familial and social labor arrangements in which such decisions are made. The diffusion of the technology shifts the gendered labor arrangements within and outside the household. What kind of labor arrangements within households makes them adopt a technology has consequences not just for household's farm profitability, but also for the household's resulting gendered labor allocations. Such technology decisions have ramifications for perpetuation of gendered norms in labor division – particularly women's work within and outside the household – and are closely tied to women's bargaining power and the asymmetry in division of welfare and access that women and men enjoy. I contribute to the literature on linkages between mechanization and gendered household labor allocation.

The second contribution of this work is methodological. The study is based at the intersection of intrahousehold decision-making literature and market valuation methods. The research design expands on the way intrahousehold preferences have been examined before. It provides another mode of measuring heterogeneity parameters within the agricultural production domain where direct testing of intrahousehold model assumptions may not be feasible, but still critical from a policy standpoint. Conversely, using stated and experimental elicitation methods to capture intrahousehold heterogeneity extends the use of market and non-market techniques to another application.

2 Methodological Motivation

In this study, I use stated and revealed demand elicitation methods from market valuation literature to examine intrahousehold heterogeneity in valuation of mechanical rice transplanting. Previous empirical work on intrahousehold differences in preferences and allocation decisions has relied on either experimentally switching the gender of the treatment recipient within the household or using natural variation in influence by household members for the same activity. In this section, I explain the reasons for not using such direct methods to examine intrahousehold bargaining dynamics, and elaborate on the relevance of experimental and quasi-experimental market valuation methods for studying this topic.

2.1 Empirical Tests of Intrahousehold Decision-making Models

The underlying dynamics for intrahousehold decision-making are hard to untangle because the decisions seemingly appear to be cooperative even if differences in welfare and preferences exist amongst household members behind the veil of this cooperation (Sen, 1987). The adoption of mechanical rice transplanting depicts such a situation where divergent objectives may exist amongst household members. Previous empirical work on testing the validity of intrahousehold bargaining models has relied on testing the income pooling assumption embedded in the unitary household model (Manser and Brown, 1980; McElroy and Horney, 1981; Lundberg and Pollak, 1993; Carter and Katz, 1997). In a standard household model, individual members pool their income and a more or less altruistic dictator allocates resources to household members, thereby allowing the household to reach Pareto optimal allocations (Becker, 1981). However, studies have shown that these allocations are made differently by women and men in the household. For example, Thomas (1990) finds that transfers have a higher effect on family's health outcomes when given to women instead of men. A study on examining the benefits of child welfare in the United Kingdom shows that making women the recipient of children's welfare shifts the demand towards children's and women's clothing relative to men (Lundberg et al., 1997). Duflo (2000) also shows that the recipient's gender in South African social pension program has significant consequences for children's health. Most of these studies have examined outcomes related to the consumption decisions made by household members. Testing intrahousehold heterogeneity by switching the gender of the decision-maker for adopting MRTs is controversial for this study because rice is a critical crop for household food security and agricultural technology adoption is primarily considered a man's sphere of influence in a male-headed household in India.

Another way research studies have determined intrahousehold differences in the production decisions of the household is based on examining outcomes for the same activity managed separately by women and men in the household. Udry's (1996) seminal study on gender differences in agricultural productivity shows that plots controlled by women and growing the same crop have lower productivity as compared to those managed by men in Burkina Faso. In Northern Kenya, McPeak and Doss (2006) find that when pastoralist households are presented with new market opportunities for selling milk, husbands make migration decisions that do not favor the wives' ability to sell milk. Similarly, Duflo and Udry's (2004) work in Côte d'Ivoire suggests that income from farm plots is allocated differently based on the gender of the household member cultivating the plot and generating the income. Such studies on production choices made by household members are still few because situations where these assumptions can be tested are rare and context-specific. Household members in India jointly cultivate farm plots and division of labor is segregated by agricultural tasks, thereby making it difficult to test differences in technology adoption by varying the gender of the farm plot manager.

2.2 Experimental and Non-Experimental Market Valuation

Because a direct test of intrahousehold demand heterogeneity is not possible, I rely on a combination of stated and revealed experimental elicitation methods. Economists increasingly use experimental and quasi-experimental tools to capture consumer's willingness to pay for goods and services (Alfnes and Rickertsen, 2003; Lusk and Schroeder, 2004; Norwood and

Lusk, 2011; Demont et al., 2013; Dupas, 2014; Lybbert et al., 2013). When possible to establish experimental markets for goods, such as food and health products, economists rely on experimental valuation techniques. I use experimental auctions to elicit household's willingness to pay for custom-hire mechanical rice transplanting services as it is possible to establish such a market.

Measuring intrahousehold valuation for the technology is difficult because the decision is made jointly and it is not possible to switch spheres of influence within a household to market the technology only to individuals. In such a scenario, economists rely on using stated preference elicitation techniques (Aadland and Caplan, 2003; Cummings and Taylor, 1999; Champ et al., 1997). For example, environmental goods such as improved water quality and preserving wildlife species are difficult to value experimentally because the good either already exists or is not possible to market (Loomis, 2014). Measuring intrahousehold valuations is fraught with similar issues as environmental goods' valuation. Specifically, I combine monetary and non-monetary stated demand elicitation techniques to capture individual consumer preferences for MRTs. Economists have been increasingly relying on insights from behavioral economics to improve the validity of these stated measures, and I use *ex ante* framing techniques and cheap talk methods to obtain valuations that are consistent with observed consumer behavior (Norwood and Lusk, 2011).

Particularly, the research method I use to measure intrahousehold valuations is similar in spirit to Norwood and Lusk's (2011) work on combining hypothetical attribute-based stated elicitation with an experimental auction to value eggs and pork obtained from different production systems. Individuals are asked to iteratively adjust their willingness-to-pay for a production system by adjusting their attribute ranking of the product. Such methods have been employed for valuing products with a complex attribute structure and where monetary valuation is not immediately clear such as for valuing environmental goods (Gustafson et al., 2016; Norwood and Lusk, 2011). I ask study participants to elicit their non-monetary valuation for different technology attributes of traditional and mechanical transplanting and combine this non-monetary measure with their stated valuation for the technology for each of their plots. Section 3 describes the methodology in greater detail.

3 Empirical Design

3.1 Village, Household, and Individual Member Selection

The study was implemented in the north Indian state of Bihar, which is one of the poorest states in the country with a poverty headcount of 33.8 percent (Reserve Bank of India, 2013). The primary crops cultivated in Bihar are rice, wheat, and maize. The research was implemented in 28 villages spread across 13 districts in the state.

Since MRTs are a relatively new agricultural technology in Bihar, few farmers owned the machine in 2014. The research team conducted a census of MRT owners in the entire state in early 2015. Amongst the 93 service providers interviewed, 28 service providers were identified for collaboration with the research team to provide machine transplanting services in the 2015 *kharif* (monsoon) season. These service providers owned less than 15 acres of land, had excess capacity with which to provide transplanting services to other clients, and were willing to provide MRT services in a neighboring village on the conditions established by the research team. After identifying these service providers, a random village was selected from the surrounding ten villages closest to the service provider?s village. Because neither the seedling nursery nor the machine can travel long distances, these villages were chosen such that they were in close proximity to the service providers' villages. These were also villages in which mechanical transplanting had not been undertaken before.

In each sample village, rice-cultivating households with both an adult male and adult female were randomly selected, with the study sample consisting of 965 households. The sample in each village was chosen such that it represented about a quarter of the village?s qualifying population, with a maximum of 65 households selected in a village. After identification of sample households, I conducted a household survey to collect detailed information about labor and capital needs in different activities during rice cultivation. The field activities began in March, 2015 when farmers were cultivating wheat and finished the last research activity by May, which is when farmers make their rice transplanting decision. A timeline of research activities along with the agricultural season calendar is shown in Appendix A.

Along with collecting household level information, I also implemented a separate male and female survey to understand individual differences in physical and human capital assets, employment and earnings, and social and familial backgrounds. I collected recall information on these indicators dating back to the time of individuals' marriage because the present value of these variables is endogenous to joint decision-making within the household.

3.2 Intrahousehold Stated Valuation Elicitation

In the next phase of the study, I designed two sets of hypothetical exercises to elicit individual valuation for mechanical rice transplanting services from the women and men. The women and men were individually introduced to the new technology through a brief verbal introduction, followed by a short informational video on how MRTs operate in the field. They were shown an additional video of the MRT service provider assigned to the village for providing custom-hire services. Each individual was also read a set of frequently asked questions to provide further clarification on the nature of nursery planting and MRT service provision. Care was taken to give complete, accurate, and same information to both individuals within a household. These individual interviews were conducted simultaneously but separately, with female enumerators interviewing female respondents and male enumerators interviewing male respondents.

After providing information about the technology, each participant was asked to state his or her non-monetary valuation for different attributes of MRT and manual transplanting (see Appendix B). Each participant was allocated ten tokens and after an explanation of each attribute, they were asked to allocate ten tokens between MRTs and manual transplanting based on how much they liked the attribute for the alternative transplanting technologies in relative terms. A practice round for eliciting attribute-based valuation for two soap dishes with a different shape and color allowed the participants to understand the elicitation process. Framing techniques were also used throughout the exercise to emphasize that the participants state their preferences for each attribute by thinking exclusively of their preferences. I elicited the non-monetary valuation for six different transplanting technology attributes – use of female family labor, use of male family labor, use of hired labor, technique of nursery cultivation, timeliness of transplanting, and speed of transplanting. After the product attribute-based elicitation, individuals were asked to rank the six attributes in the order of importance they give to each of the the attributes when deciding about the transplanting technology.

In a manner similar to Norwood and Lusk (2011), I combine the non-monetary elicitation with the monetary valuation of mechanical rice transplanting. I elicited hypothetical willingness to pay for each farm plot the household cultivates as a dichotomous choice question for 14 price values (see Appendix C). Throughout the valuation exercise, I used framing techniques and "cheap talk" to minimize hypothetical bias (Cummings and Taylor, 1999; Lusk, 2003; Shogren, 2006). Each individual was asked to state his or her willingness to pay for transplanting by "thinking of only his or her likes and dislikes and by thinking of themselves as the household head making the decision about transplanting." However, the methodology diverges from Norwood and Lusk's (2011) work in two ways. First, the individual valuation measures are not incentive compatible because introducing intra-household incentive compatibility at the individual level is controversial in the case of rice transplanting technology. Second, I did not iteratively adjust attribute rankings with monetary valuation estimates to obtain measures that consistently align with individual preferences. At the end of the individual elicitations, participants were informed that the study team will return again to actually provide MRT services to those interested, and that the participants can use this time to interact with other members of the household and make their final decision.

3.3 Household Revealed Demand Elicitation

The study culminated in village-level experimental auctions. Household heads from sample households were asked to participate in a collective exercise where they would have an opportunity to actually custom-hire MRT services on their fields. On the day of the auction, the service provider associated with the sample village visited the village along with the research team. After the research team informed the auction participants about the terms of the MRT services, I implemented the auction and elicited WTPs for different farmer plots in a manner similar to the Becker et al. (1964) bidding mechanism.[1] Because of the possibility that farmers would actually custom-hire MRT services if their WTP is greater than or equal to the price drawn in the village for the services, the WTP estimates obtained are revealed measures of household demand.[2]

4 Data and Descriptive Evidence

I combine heterogeneity in socio-economic characteristics within and across households to examine heterogeneity in individual and household demand for the technology. In this section, I characterize and formalize these differences, which subsequently forms the backbone of the analysis.

4.1 Within and Across Household Demographic Differences

Table 1 provides a snapshot of the sample households. Generally, majority of the households are headed by men (97 percent), who are on average 48 years old. The female decisionmakers selected for the study are primarily wives of these household heads. A little less than half of the household members, in a six-member household, are involved in agricultural activities on average. Specifically, for transplanting, women in these households spend three labor days per acre whereas men spend approximately five labor days. In addition to using family female and male labor for transplanting, the household hires seven female laborers per acre and only about two male laborers. The average cost of transplanting alone to the household

[1]The terms of MRT custom-hire services offered to households included providing nursery cultivation and transplanting services. Service providers were responsible for raising nursery for farmers using the seed variety of the farmer?s choice, but the farmers were responsible for bearing the costs of nursery cultivation. Transportation costs from the service provider?s village to the farmer?s field for the purposes of the study were borne by the research team. The farmers were responsible for paying the per acre price announced at the auction for mechanical transplanting to the service provider.

[2]Because the auctions were organized at the village-level, attrition during this phase of the study was high. Only 608 households attended the auction from the original sample of 965 households. A vast majority (92 percent) of those attending the auctions were men. Sample attrition appears to be random as there is no significant difference in individual hypothetical valuation between those who attended the auction and those who did not. There is also no significant difference in the wealth index of the two samples.

is Rs. 615, which only includes the cost of hiring laborers.

The average cost of transplanting per acre increases as the household shifts away from using family labor to using higher levels of hired labor. I divide the sample households into three labor-use categories: households that use only family female and male labor for transplanting, households that employ both family (female and male) and hired labor, and households that use no female family labor and rely on hired female labor for transplanting. As Table 2 suggests, average transplanting costs are approximately Rs. 826 if the household uses both family and hired labor, and increases by roughly Rs. 85 if the household does not use any female family labor. Households that use hired labor also cultivate more plots as compared to those using only family labor. I construct a factor analytic household wealth index as an indicator of family's asset levels. [3] Households using higher levels of hired labor also rank higher on the wealth index than if the household only uses family labor – an important dimension to consider for adoption of mechanical rice transplanting because women in households who may be most influenced by adoption of the technology may not be able to afford paying for the technology.

Behind the veil of this household heterogeneity in transplanting activities, the women and men belonging to the same household also differ significantly on several key characteristics (Table 3). These demographic and agricultural involvement dimensions of heterogeneity contribute to individual differences in valuation of mechanical rice transplanting. For instance, whereas 93 percent of the sample household men are involved in agriculture, only 67 percent are involved in agricultural activities. Women have significantly less access to extension, with a 17 percentage point difference. I construct a composite index of technological know-how and women rank lower on the index as compared to men.[4] Although the overall access to agricultural extension is low for the entire sample, it is lower by 18 percentage points for women vis-à-vis men. Despite having access to the same household assets, women consider their average creditworthiness to be less than men by Rs. 20, 000.

4.2 Within and Across Household Differences in Willingness to Pay for Mechanical Rice Transplanting

The distribution of individual stated valuation of men and women provides the first evidence of potential heterogeneity in demand for the transplanting technology. Figure 1 shows

[3]Wealth index is calculated as a factor analytic index using these components: number of cellphones, motorcycle, and television units, whether household had cable television, transport and education expenditure of the household, donations for festivals, diesel pump, rotavator, knapsack, and tractor ownership, and size of land owned.

[4]Agricultural technology index is created as a simple summation of all the agricultural technologies that the men and women know about amongst a set of 18 agricultural technologies widely used by Indian farmers.

the distribution of plot-level stated female and male valuation after differencing it with the transplanting cost. The figure shows two types of variation in valuation measures. First, responses in the first and fourth quadrant suggest that the male and female stated bids that were greater or lesser than the transplanting cost. The second type of variation is evident from the extent of deviation from the 45 degree, perfect homogeneity, line. Even if both members stated positive or negative bids (second and third quadrant), bids further away from the homogeneity line suggest that one member valued the technology for that plot proportionately more or less than the other. Across the three bins of transplanting labor-use households, I see that women value the technology more than the men in the household (Table 4). The difference in magnitude between women's and men's valuation is highest for households that only use family labor for transplanting. However, in the auctions, households that use only family labor have the lowest revealed demand of Rs. 710 ($N = 182$ plots). Households that use both family and hired labor have an average willingness to pay of Rs. 785 ($N = 440$ plots) and those not using female family labor have the highest average willingness to pay of Rs. 797 ($N = 512$ plots).

When comparing across villages, I find significant differences in distribution of willingness to pay (see Figure 2). The proportion of plots in the village distribution where the household's revealed valuation is equal to zero is particularly relevant for the analysis. Of interest are also jumps in valuation from zero individual to non-zero household or vice-versa. Because I am interested in analyzing the contribution of men's and women's individual valuation to the household's demand measure, I focus on characterizing three particular cases.

- **Case 1 - All zero:** When the revealed household demand and the stated individual valuation of both the woman and man is equal to zero. Of the 888 plots where data for all three measures is available, there are 64 plots where all three measures are zero. Because the individual and household's responses did not change throughout the elicitation processes, the zero WTP measures suggest that perhaps this set of plots were not considered by the household for mechanical transplanting and was not subject to the intrahousehold bargaining dynamics. A characterization of these plots on few transplanting observables, as shown in Table 8, suggests that these plots were different from the rest in their soil type, in using significantly less hired female labor for transplanting, and in being transplanted 22 percent points more by the female family labor. I do not include these plots in the analysis on intrahousehold bargaining and household demand.
- **Case 2 - Auction zero:** When the revealed household demand is zero but the stated individual valuation of both the woman and man is not equal to zero. There are 144 plots that belong to this category. Statistically speaking, there is no difference on any observable characteristics of plots where households gave zero versus non-zero bids. I also do not include these plots in the analysis on intrahousehold bargainig dynamics because I want to examine movements in household's revealed demand within the

intensive margin.

- **Case 3 - Individual valuation zero:** When the revealed household demand is not zero but the stated individual valuation of both the woman and man is zero. There are 45 plots such plots, and are plots where family female labor is more involved in transplanting as compared to hired female labor. Because of the initial zero valuation by both household members, it is quite likely that these plots were also not subject to bargaining processes in the household.

4.3 Bargaining Power of Women: Theoretical Foundation and Empirical Construction

The extent of influence in decision-making exercised by household members is a crucial component of untangling the intrahousehold processes that guide the household's technology adoption decision. This degree of influence – bargaining power – represents the "voice" an individual member has in influencing joint household decisions (Carter and Katz, 1997). These bargaining parameters are often unobserved and difficult to identify within a household. Most studies on intrahousehold dynamics have relied on either the *cooperation* or *exit option (non-cooperative)* based approach to measure bargaining (Manser and Brown, 1980; McElroy and Horney, 1981; Doss et al., 1996; Quisumbing et al., 2003; Zepeda and Castillo, 1997; Kabeer, 1999). In *cooperative* models, bargaining power specifies the sharing rule of individual members' contribution to the overall household welfare. Examples of proxies that have been used in these models include whether a woman works for cash income, share of non-land assets and household's land area under the woman's control, wage rates, and non-labor income (Smith, 2003; Briere et al., 2003; Gilligan et al., 2014). In the *non-cooperative* model approach, bargaining power represents an individual's options for exiting the household should a conflict arise. Most of the parameters used to capture bargaining power to represent exit options when leaving the household use variables that are exogenous to the formation of the household, such as age at marriage, education gap between husband and wife, husband and wives' familial background, and dowry size.

When household decision-making pertains to adopting mechanical rice transplanting that may disproportionately influence certain members of the household, the decision embodies both cooperation and conflict simultaneously – both individuals want to cooperate to maximize household welfare by optimizing on the technology choice yet decide on their labor allocation towards transplanting such that it maximizes their individual welfare. Sen (1987) posits that bargaining in these "cooperative conflicts" is a combination of how much an individual member contributes to the household or their level of *percieved contribution*, their exit options, and their *percieved interest* in decisionmaking. Even if these measures are endogenous to household formation, the"perceived" individual role in decision-making does play a role in influencing the actual outcomes a household achieves. I use proxies for each of these three aspects of bargaining to compute a bargaining power index using principle component analysis. For each of these categories of bargaining, I use the following variables.

- **Perceived contributions:**[5] To capture the level of *percieved* contributions, I use the following variables: Having a bank account jointly or alone, taking out a loan jointly or alone, group membership and the extent of participation in it, whether the woman is satisfied with the amount of leisure time she currently has, and the level of work satisfaction (based on the actual hours that the woman works and if it exceeds 1.5 times the median hours worked in the sample).
- **Exit options:** These include demographic factors that contributed to a woman's bargaining power at the time of joining the household, that is, at the time of marriage. Variables used include the woman's age and education level at the time of marriage, her father's caste, and the value of silver, bedding, and cash that she brought as dowry.
- **Perceived interests:** These variables capture a woman's perceived influence in household decisions related to agricultural, productive assets, and income spending. One of the proxy variables includes the proportion of agricultural decisions she contributes to from a list of 15 agricultural decisions such as selecting crop variety, selling product to market, and choosing inputs. Another variable was constructed similarly to capture the proportion of decisions she makes pertaining to making capital investments, buying livestock, or spending remittances. I also used variables that capture whether the woman feels she has ownership of assets like land, livestock, house, and capital equipment and whether she feels she has the freedom to sell, rent, or buy any of these assets.

Figure 3 shows the distribution of the constructed bargaining index for the three labor-use categories. The bargaining index of women in households where they are not involved in transplanting is higher than in household where they are involved in transplanting. This difference not only appears to be driven by the fact that women in these households may have better exit options but also is possibly because these women may *perceive* their degree of influence and contribution to be higher in various household activities. In the next section, I see how bargaining power influences the household's technology adoption decision.

[5] The Women's Empowerment Index in agriculture is a composite index designed to measure the influence and role of women in agriculture and comprises of five key components: role in decisions regarding agricultural production, decisionmaking power in regards to productive activities, decisionmaking about use of income, participation and leadership in community, and labor and leisure allocation Alkire et al. (2013). Because these components include notions of perceived role and contribution, the variable choice was heavily influenced by the kind of variables used in constructing the index although the empirical approach is different.

5 Intrahousehold Preference Heterogeneity

Individuals value goods based on their preferences and individual characteristics. Even though women value the technology more than men based on their stated valuation, it is quite possible that this difference is primarily due to a difference in their individual *endowments.* A key dimension of understanding the difference between women's and men's valuation is examining if these differences are due to heterogenous preferences of women and men. In this section, I focus on decomposing the *stated difference* between women and men into the *endowment difference* and *preference difference.*

Embedded in the *stated difference* are differences in characteristics of women and men (*endowments*), the *hypothetical decision bias* of not participating in the technology adoption decision as a sub-sample of women are not involved in transplanting, and the *hypothetical elicitation bias* that results from non-incentive compatibility in the stated elicitation exercise. The study design used three *ex ante* elicitation strategies to minimize hypothetical elicitation bias that have been widely used in stated preference valuation studies (Aadland and Caplan, 2003; Cummings and Taylor, 1999; Jacquemet et al., 2013). First, I employed honesty priming repeatedly to inform the subjects that they would not gain anything by lying to us about their valuation (Jacquemet et al., 2013). Second, I used "cheap talk" measures and told both women and men to state their valuations as if they were the household heads responsible for making the transplanting decision for their household (Cummings and Taylor, 1999). Third, I elicited individual valuations and household WTP as a dichotomous choice question for each price value. Under the assumption that these three strategies reduce the size of the *hypothetical elicitation bias* and the assumption that the size of this bias is same for women and men, I specifically focus on parsing out the *stated difference* in women's and men's valuation from their individual characteristics *endowments* and *hypothetical decision bias.*

Econometrically, I formalize the identification issues in estimating the *preference difference* in individual stated valuation in section 5.1 and estimate the *preference difference* using decomposition methods. Economically, both the *stated* and *preference* difference hold meaning – the *preference difference* gives evidence of preference heterogeneity amongst women and men whereas the individual members negotiate over their *stated differences* in valuation. Over the course of the household bargaining process, it is quite possible that individuals update their individual valuation, which could still be different from the household willingness to pay. However, I do not observe the revised individual valuation. The revised valuation difference could still be different from the *preference difference* as the *preference difference* assumes that individuals have the same set of endowments, which is not the case in most households.

5.1 Conceptual Framework

I use a simple framework to understand the differences in valuation between women (f) and men (m). Suppose that individual i's utility depends on the consumption of transplanting technology (t) and a composite numeraire good (z). Individuals have a set of heterogeneous observable and unobservable characteristics represented by the vector X and ε, respectively. Individual utility can be represented as $U_i(t, z, x_i, \epsilon_i)$. Each individual maximizes utility subject to his/her budget constraint where p represents the cost of the transplanting technology.

$$\begin{aligned} &\underset{z,t}{\text{Max}}\ U(t, z|x_i, \epsilon_i) \\ &Subject\ to\ y_i \geq z + p.t \end{aligned} \tag{1}$$

I assume that the price of the numeraire good is normalized to one. Under the assumption that individual i has a reference level of utility, u_i^0, from traditional transplanting services defined as $U_i^0(t = 0, z|x_i, \epsilon_i)$, I can write a value function (v_i) for individual i's willingness to pay (WTP_i) for mechanical rice transplanting as:

$$v_i(t|y_i, x_i, \epsilon_i, u_i^0) \equiv WTP_i \tag{2}$$

For simplicity, I re-write the WTP_i above as a function $W_i(\cdot)$ of the observable X and unobservable ϵ characteristics. Let D_i denote an indicator function such that $D_i = 1$ if individual i is male (m) and 0 if female (f). I elicit the valuation (WTP_i) for individual i during the study. Specifically, I observe:

$$WTP_i = W_i(D_i) \tag{3}$$

Let $\theta(WTP_i|D_i)$ represent the distributional statistic of interest, such as the mean, from the WTP distribution of women and men. The individual valuations allow me to compute the *stated difference* in the distributional statistic (the first moment differences are shown in Table 4).

$$\begin{aligned} \Delta_{stated} &= \theta(WTP_i|D_i = 1) - \theta(WTP_i|D_i = 0) \\ \Delta_{stated} &= \theta(W_i(1)|D_i = 1) - \theta(W_i(0)|D_i = 0) \end{aligned} \tag{4}$$

Equation 4 suggests that I only observe the valuations conditional on the characteristics of men and women. However, I am interested in obtaining the unconditional difference, or the *preference difference* in valuation. Intuitively, this difference implies that both men and women are alike on their observable and unobservable characteristics and differ only in W_i specification. The *preference difference* is shown in Equation 5.

$$\Delta_{preference} = \theta(W_i(1)) - \theta(W_i(0)) \tag{5}$$

In Section 5.2, I describe the estimation methods I use to separate the *preference difference* from the *stated difference*.

5.2 Empirical Framework

I use two approaches to decompose the *stated difference* in valuation: Oaxaca-Blinder decomposition and hedonic decomposition using transplanting attribute elicitation (Fortin et al., 2011; Oaxaca, 1973; Gustafson et al., 2016).

5.2.1 Oaxaca-Blinder Decomposition

Oaxaca-Blinder decomposition approach is widely used in the labor economics literature to disaggregate differences in mean outcomes (Fortin et al., 2011; Oaxaca, 1973).

Suppose that the WTP_i function $W(D_i)$ is assumed to be a linear and separable function in observable X and unobservable ε characteristics.

$$WTP_i = W(D_i) = X\beta_i + \varepsilon_i \qquad for\ D\ \epsilon\ (0,1) \tag{6}$$

I re-write Equation 4 as a difference in mean WTP of women and men. Let $D_m = 1$ denote an indicator for being a man and 0 if a woman.

$$\begin{aligned}
\Delta_{stated} &= E[WTP_m|D_i = 1] - E[WTP_f|D_i = 0] \\
\Delta_{stated} &= E[X\beta_m + \epsilon_m|D_i = 1] - E[X\beta_f + \epsilon_f|D_i = 0] \\
\Delta_{stated} &= (E[X|D_i = 1]\beta_m + E[\epsilon_m|D_i = 1]) - (E[X|D_i = 0]\beta_f + E[\epsilon_f|D_i = 0])
\end{aligned} \tag{7}$$

Assuming that the average unobservable characteristics, $E[\epsilon_m|D_i = 1]$ and $E[\epsilon_f|D_i = 0]$, are constant and equal in magnitude, and after adding and subtracting the average effect of men's observable characteristics under the women's distribution $E[X|D_i = 1]\beta_f$, the *stated difference* can be written as follows.

$$\begin{aligned}
\Delta_{stated} &= (E[X|D_i = 1]\beta_m - E[X|D_i = 1]\beta_f) + (E[X|D_i = 1]\beta_f - E[X|D_i = 0]\beta_f) \\
\Delta_{stated} &= E[X|D_i = 1](\beta_m - \beta_f) + (E[X|D_i = 1] - E[X|D_i = 0])\beta_f \\
\Delta_{stated} &= \qquad \Delta_{preference} \qquad\qquad + \qquad \Delta_{endowments}
\end{aligned} \tag{8}$$

Equation 8 gives us the proportion of *stated difference* that results from a difference analogous to the unconditional difference in $W_i(\cdot)$ (*preference effect*) and a difference in observable characteristics (*endowment effect*). *Preference difference* gives the difference in WTP that would have resulted if women and men were exactly similar in their observable and unobservable characteristics. In the potential outcomes framework literature, decomposing the *stated* *difference* into the *preference* and *endowment* effect is similar to separating true treatment effect and selection bias in the observed stated difference (Fortin et al., 2011).

5.2.2 Hedonic Valuation Decomposition of Transplanting Attributes

I use hedonic valuation decomposition as another way of examining preference heterogeneity in stated valuation. Hedonic valuation is a method of estimating willingness to pay for different attributes embedded in a product. During the study, I elicited non-monetary valuation for six attributes of mechanical and traditional transplanting, represented by a vector of T attributes. The willingness to pay for the attributes embedded in traditional rice transplanting at the reference level of utility is represented as a value function, similar to equation 2.

$$WTP_i \equiv v_i(T|y_i, x_i, \epsilon_i, u_i^0) \tag{9}$$

For N such attributes, the marginal willingness to pay for the kth attribute for mechanical transplanting as compared to traditional transplanting and while keeping all else constant is represented as follows.

$$v_i(t_1 \cdots t'_k \cdots t_n|x_i, \epsilon_i, u_i^0) = WTP'_{i(k)} \tag{10}$$

Using the simplified notation as before, let $W(\cdot)$ now represent willingness to pay for transplanting as a summation of marginal willingness to pay for each attribute where θ is the marginal willingness to pay for each attribute.

$$WTP_i = W_i(D_i) = T\theta_i \tag{11}$$

Differences between men and women for the marginal willingness to pay for an attribute reveals the unconditional difference in $W_i(D_i)$, provided the observable and unobservable characteristics do not bias the valuation of their estimates. In the hedonic valuation literature, the notion that these observable and unobservable characteristics make consumers value product attributes differently is classically known as consumer sorting (Gustafson et al., 2016). In order to account for consumer sorting, I re-write Equation 11 as follows.

$$WTP_i = T\theta_i + X\beta_i + +\varepsilon_i \tag{12}$$

Here X and ε represent the vector of observable and unobservable characteristics influencing marginal willingness to pay for transplanting attributes. Using Equation 12, I can represent the *stated difference* in WTP using the equations below. The assumption that the effect of unobservable characteristics is constant and same for both women and men also applies here.

$$\Delta_{stated} = (E[W|D_i = 1]\theta_m - E[W|D_i = 0]\theta_f) + (E[X|D_i = 1]\beta_f - E[X|D_i = 0]\beta_f)$$
$$\Delta_{stated} = (E[W|D_i = 1] - E[W|D_i = 0])(\theta_m - \theta_f) + (E[X|D_i = 1] - E[X|D_i = 0])(\beta_m - \beta_f)$$
$$\Delta_{stated} = \Delta_{preference} + \Delta_{endowment} \tag{13}$$

Thus, using the non-monetary attribute elicitation allows me to separate the *preference difference* from the *stated difference* in an indirect manner.

5.3 Results

5.3.1 Oaxaca-Blinder Decomposition

The *stated difference*, as shown in Table 4, is negatively significant – that is, women value the technology more than men – for the entire sample. This difference is biggest for households that use only family labor for transplanting. Using a vector of demographic and agricultural involvement observable differences of women and men, I decompose this *stated difference* in individual valuation of MRT for each of farm plot into the *preference effect* and *endowment effect* difference. Women and men in the sample differ on these individual characteristics that I use in the decomposition (see Table 3).

When I use these characteristics, the *stated difference* is now significant for the entire sample and for those using only family labor for transplanting. Table 5 illuminates the differences in valuation due to individual observable differences and individual preferences. For all households, men value the technology more than women when viewed from the *endowment* perspective whereas women value the technology more than men from the *preference* lens (see Figure 8). Although the *endowment effect* difference is statistically insignificant for all kinds of households, the *the preference effect* is significant for the entire sample and for households using family labor. In households that use only family labor for transplanting, women value the technology by Rs. 154 per acre more than men and this difference is higher than their *stated difference* and driven by having different preferences. Not only is the *preference effect* difference highest for the family labor use group amongst the three different labor-use classifications, this group also has the lowest average individual valuation as compared to the others – the average individual valuation is Rs. 705 per acre, so the *preference effect* difference is approximately one-fifth of this valuation.

When I closely examine the drivers of the two differences, differences in education and extension matter for the *endowment effect* difference. That access to education and extension contribute to a higher valuation for the technology by men matters crucially for agricultural policy as extension in India tends to primarily male-centric. In terms of the *preference effect* difference, differences in risk preferences of women and men contributes by Rs. 140 per acre. For households using family labor only, differences in age and involvement in agriculture contributes significantly to the *preference effect* difference. When both women and men are involved in agriculture, women tend to value the technology "preferentially" more than men by Rs. 351 per acre.

5.3.2 Hedonic Valuation Decomposition

Examining differences in valuation of transplanting attributes is another way of understanding differences in the monetary valuation of the technology by women and men. Table 6 shows the differences in token allocation for the six attributes involved in transplanting by women and men. For the overall sample, women value the MRT technology more in terms of nursery cultivation method and the delay in transplanting caused due to the inability to find laborers. Men value the technology more because it uses less hired labor and allows them to transplant their fields faster than traditional transplanting methods.

When I use a household-level random effects model to estimate the hedonic marginal valuation of these transplanting attributes, I find that the difference in how women and men value the attributes of nursery cultivation, delay in transplanting, and speed of transplanting is significant in the difference between their individual monetary valuation. None of the three categories of households differ in their valuation for using family and hired labor for transplanting. The fact that the labor attributes are not significant for their overall valuation difference perhaps suggests that the big differences in nursery, delay, and speed of transplanting appeal to them as attributes in mechanical transplanting as compared to traditional transplanting. The results do not change when I add the same vector individual characteristic differences as those in the Oaxaca-Blinder decomposition implying that these individual characteristics do not bias the hedonic valuation of attributes for women and men.

6 Intrahousehold Bargaining and Household Demand

To characterize how intrahousehold bargaining dynamics influence the household's adoption decision, I conceptually layout and empirically test the role of women's bargaining power, information exchange within the household, and the household's labor allocation in transplanting.

6.1 Conceptual Framework

In this section, I illustrate the effect of bargaining between household members on household's demand for the technology. Suppose that the household's demand for the technology is influenced by the information exchange between the man (m) and woman (f) within the household and exchange of information about the technology with others o outside the household. Let WTP_m and WTP_f represent the man's and woman's valuation of the technology, and WTP_o capture the valuation of others outside the household. Let the function $\gamma_f(\cdot)$ represent the weight a woman's valuation – her "voice" – in the household's demand for the technology. Similarly, $\gamma_m(\cdot)$ denotes the weight of man's valuation in the overall household demand. When $\gamma_f = 0$ and $\gamma_m \neq 0$, only the man's valuation of the technology plays a dominant role in the household's demand for the technology, with the woman's valuation having no weight in the decision.

The overall household demand for the technology, as captured by the household's willingness to pay (WTP_{hh}), is

$$WTP_{hh} = \gamma_f(\cdot)WTP_f + \gamma_m(\cdot)WTP_m + \gamma_o(\cdot)WTP_o \tag{14}$$

Suppose B_f represents the bargaining power of the woman and forms a key component of the woman's weighting function – $\gamma_f(\cdot)$ – in household decisions. While $\gamma(\cdot)$ is a function of the bargaining power of the woman in the decisions that the man and woman jointly make in the household, the role of bargaining power comes into play especially in the context of this gendered technology. Depending on the level of a woman's involvement in the household's transplanting activities (denoted by T), she may be disproportionately vested in the household's decision to adopt the technology and exercise her bargaining power when she transplants. In the Indian context, agricultural technology adoption decisions fall predominantly under the man's sphere of influence in a male-headed household. Even when the woman has information about the transplanting technology (because of the information treatment given to the woman and man in the household), if she does not participate in transplanting, she may not be inclined to participate in the adoption decision and exert her bargaining power in altering the household's demand for the technology.

$\gamma_f(\cdot)$ is a linear function of the extent of her having an opinion on the decision and the degree of influence she exercises in the decision when she does have an opinion. In a general household decision, $\gamma(\cdot) = (\gamma_0 + \gamma_1 \cdot B_f)WTP_f$, where γ_0 represents the degree of her involvement in the decision based on whether the task falls under her sphere of influence and $(\gamma_1 \cdot B_f)$ captures the weight her of influence in the decision. Because in the context of the study, all women have formed an opinion about the technology, $\gamma(\cdot)$ is also a function of the bargaining power of women based on their degree of involvement in transplanting.

This composition of $\gamma_f(\cdot)$ ties in closely with the concept of bargaining I described in Section 4.3 where bargaining power of a woman comprises of her exit options (analogous to γ_0), her *perceived contributions* that capture the weight of her opinion (γ_1), and her *perceived interests* that capture whether transplanting falls under her domain of interest (γ_2).

I re-write $\gamma(\cdot)$ as a linear and separable function of these three components.

$$\gamma_f(\cdot) = (\gamma_0 + \gamma_1 \cdot B_f + \gamma_2 \cdot B_f \cdot T)WTP_f \tag{15}$$

Because technology adoption decisions are presumably made by men regardless of their transplanting labor allocation, I write $\gamma_m(\cdot)$ as a single weighting parameter γ_m, and $\gamma_o(\cdot)$ as γ_o. Equation 14 is then re-written as follows.

$$WTP_{hh} = (\gamma_0 + \gamma_1 \cdot B_f + \gamma_2 \cdot B_f \cdot T)WTP_f + \gamma_m WTP_m + \gamma_o WTP_o \tag{16}$$

Equation 16 shows the conduits through which information exchange within a household and with others outside the household influences the household's demand for the technology. Particularly, the relative magnitudes of $\gamma(\cdot)$ allow us to test the degree of influence a woman has in household decisionmaking for mechanical rice transplanting with respect to her bargaining power and labor allocation in transplanting.

6.2 Econometric Specification

Equation 16 forms the basis of the econometric estimation. During the auctions, the male household head elicited the household's demand for the technology, which could be different from his previously stated individual valuation due to temporal and methodological differences in the two elicitation procedures. Temporally, this difference could have been because of interactions within or outside the household in the period between the two elicitation activities. While I know the valuation of individuals within the household, I do not know the exact valuation of the individuals each participant interacted with outside the household. I use an indirect approach to capture the influence of information acquisition outside the household. I know the number of interactions each individual had about mechanical transplanting prior to the auction (denoted by $OtherHHs$). I also know the relative rank of the male household head's individual valuation in the village's distribution of individual valuation ($Rank$). The joint effect of the two allows us to indirectly proxy for the effect of outside interactions on the revealed household demand during the auctions.

Methodologically, individual and household demand elicitation were different on three key fronts. First, the service provider was present during the auctions and not during the individual elicitations. Second, auctions were held in the presence of other study participants and followed a different method than individual elicitations, even though I elicited the household demand by asking the same question. Third, individual elicitations were hypothetical, so the members may have not fully internalized their household's income constraints. These three differences could have also made the men change their valuation during the auction from their previously stated response, and hence form the vector of characteristics that influence the household's overall demand. Barring these temporal and methodological shifters, any remaining difference is due to bias in elicitation of the stated individual valuation.

I estimate the following equation.

$$\Delta WTP_{hh} = [\gamma_0 + \gamma_1 \cdot B_f + \gamma_2 \cdot B_f \cdot T] WTP_f + \gamma_m WTP_m + \gamma_o \, OtherHHs \cdot Rank + X'\alpha + \epsilon \quad (17)$$

Here X represents the vector of methodological factors that influenced the household demand and other control factors such as caste, and ϵ captures the hypothetical bias embedded in the elicitation.

6.3 Results: Bargaining and Household Demand

I estimate the basic household bargaining model specified in Equation 14 first. Table **??** shows the simple linear regression estimates for the pooled sample and for the three categories of labor-use households. The pooled sample estimates suggest that the weight γ_m of the male valuation in the household demand is more than double the women's weight (γ_f). When I compare these estimates with the results from the full model specified in Equation 17, I find that only γ_m for male valuation is significant with no significant weight attached to the women's valuation (see Table 10).

Another key insight pertains to the magnitude and significance of the role of outside information. As the simple pooled model estimates suggest, discussing about mechanical rice transplanting increases the willingness to pay for those in the lower quartile of the village-level male individual distribution. However, the net effect is negative – that is discussing with others lowers household WTP – as individuals move to a higher rank in the quartile distribution. These estimates are statistically insignificant in the full model, although the message remains unchanged in terms of the magnitudes.

When I look at the estimates in the simple and full model for the three different labor categories, I find three interesting differences. First, although I am not powered to comment on the validity of the estimates for households that only rely on family labor, I find that γ_f is not significantly different from zero in households that use both family and hired labor whereas the weight of the male valuation is positive and significan. γ_f is significant and slightly higher in magnitude from γ_m for households that do not use any female labor for transplanting. In the full model estimates, both the weighting parameters are insignificant for households using both family and hired labor. γ_{f0} is significant and higher than γ_m, which is insignificant, for households that use no female family labor. Second, bargaining power of women does not play any role in influencing the household's willingness to pay for the technology for any labor-use category. Third, the magnitude of γ_m is highest for households that use only family labor and decreases progressively as households substitute away from using family female labor.

7 Conclusion

By combining hypothetical and experimental measures of willingness to pay, I elicit intra-household valuation for a new agricultural technology that may potentially influence both women's and men's household labor allocation in transplanting. Women value mechanical rice transplanting more than men, and this difference is not driven by their observable characteristics. Women value the technology even more in households where only family labor is involved in transplanting. However, in these households, women have the lowest relative weight in the household's overall demand for the technology. Women in these households may value MRTs disproportionately more than men but may not have other options other than to be involved in transplanting.

The perceptions of individual and household welfare is closely tied to women and men's valuation of the technology. Women's perceived notion of individual welfare may be analogous to the household's welfare, in which case, she may not exert any influence on the household demand's for the technology. Yet, this perception of individual welfare may be different from actual individual welfare. The actual household adoption decision may thus appear to be a natural one for both women and men in the household, and may not be about whose decision dominates. Instead, the heterogeneity in valuation signals a deeper dynamics in the household about the distinction and link between agency and well-being. Even though women may be better-off without transplanting, this welfare is closely tied to their use of time and availability of other paid work. Being able to achieve these "alternative outcomes" is linked to the notion of agency and is often exerted within the context of familial organization and gender roles. These outside options and household arrangement may overshadow the role of individual agency and result in outcomes that do not appear to be equitable, yet are agreeable to members of the household.

The study has direct relevance for public policy. Extension is typically male-centric in India and throughout the developing world based on the assumption that men are the primary decision-makers for using new technologies. Such a trend has in turn led to women having a smaller participating role in the agricultural decisions and also has an influence on their bargaining power. From an agricultural standpoint, if the goal of policy is to narrow the gap between women and men farmers and their productivity, then extension should aim to provide information about these technologies to both women and men, which can eventually narrow the decision-making gap between women and men. From a development policy standpoint, improving the "voice" of women in households is critical. Ultimately, how households choose technologies in developing countries also shapes important welfare outcomes such as women's and children's well-being, which are central to intergenerational transmission of poverty in many developing countries.

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Figure 1: Intrahousehold Heterogeneity in Distribution of Individual Willingness to Pay

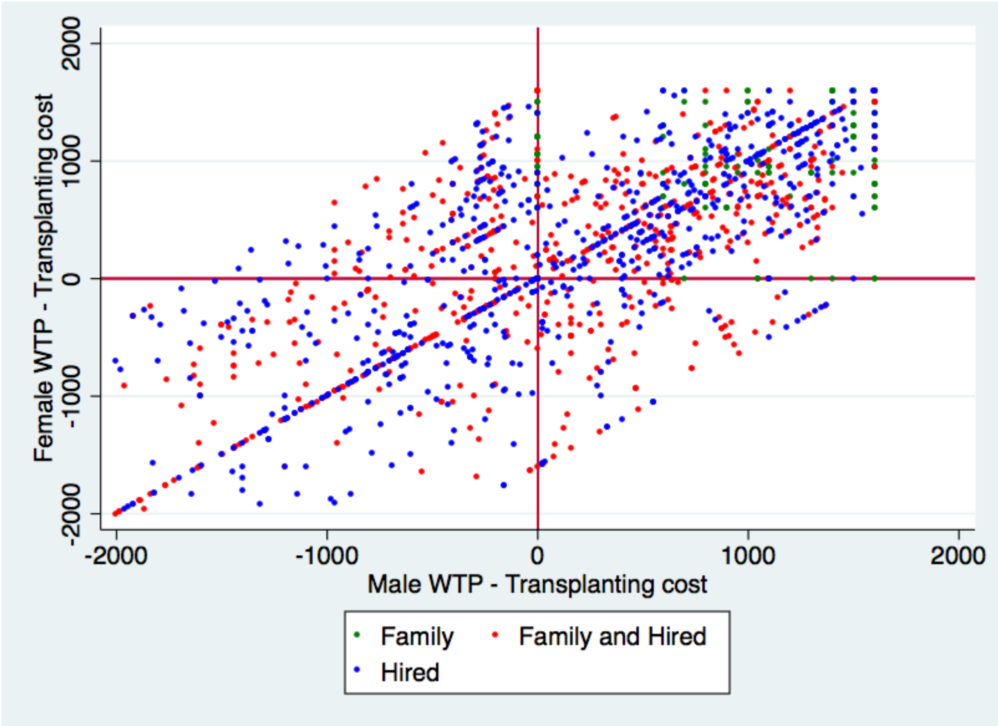

Figure 2: Heterogeneous Distribution of Experimental Willingness to Pay Across Villages

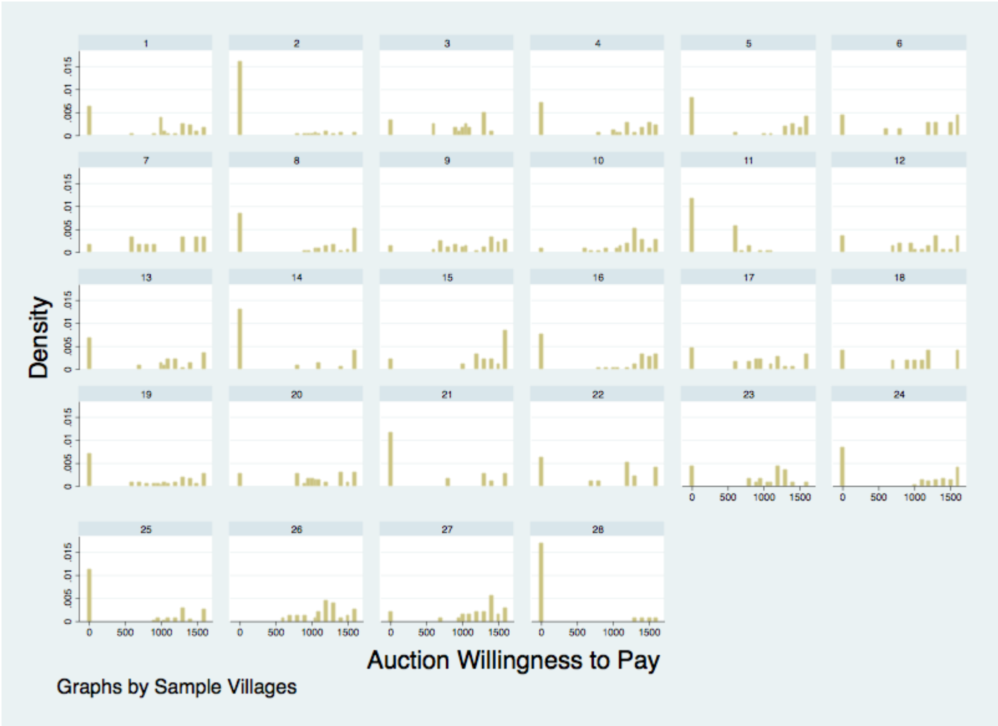

Figure 3: Bargaining Index for Different Labor-use Categories

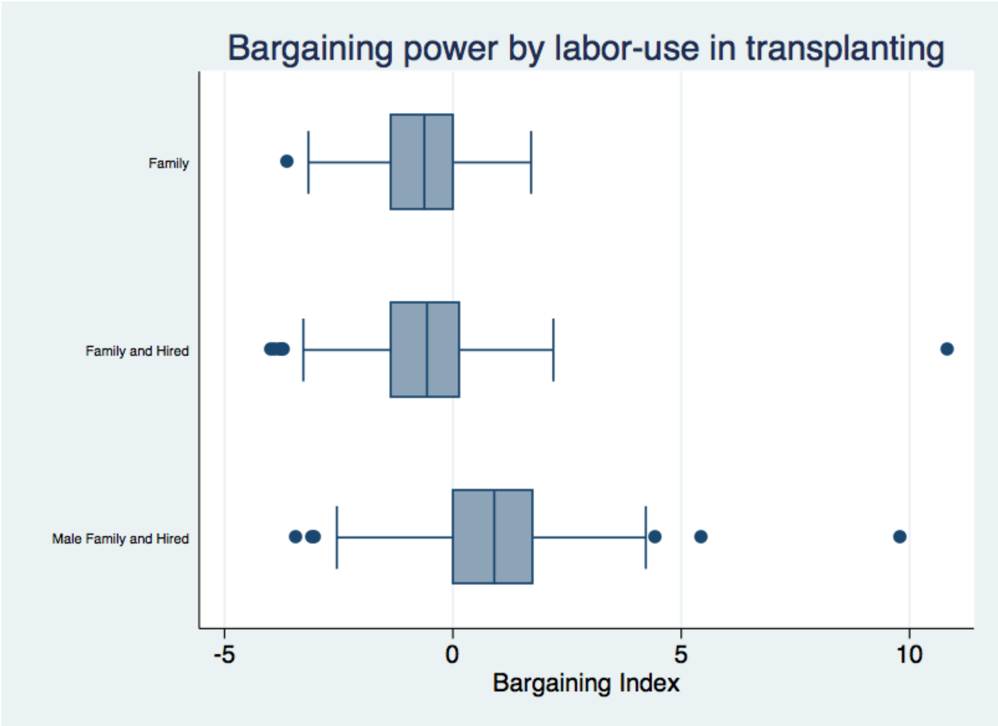

Figure 4: Oaxaca-Blinder Decomposition of Stated Individual Valuation

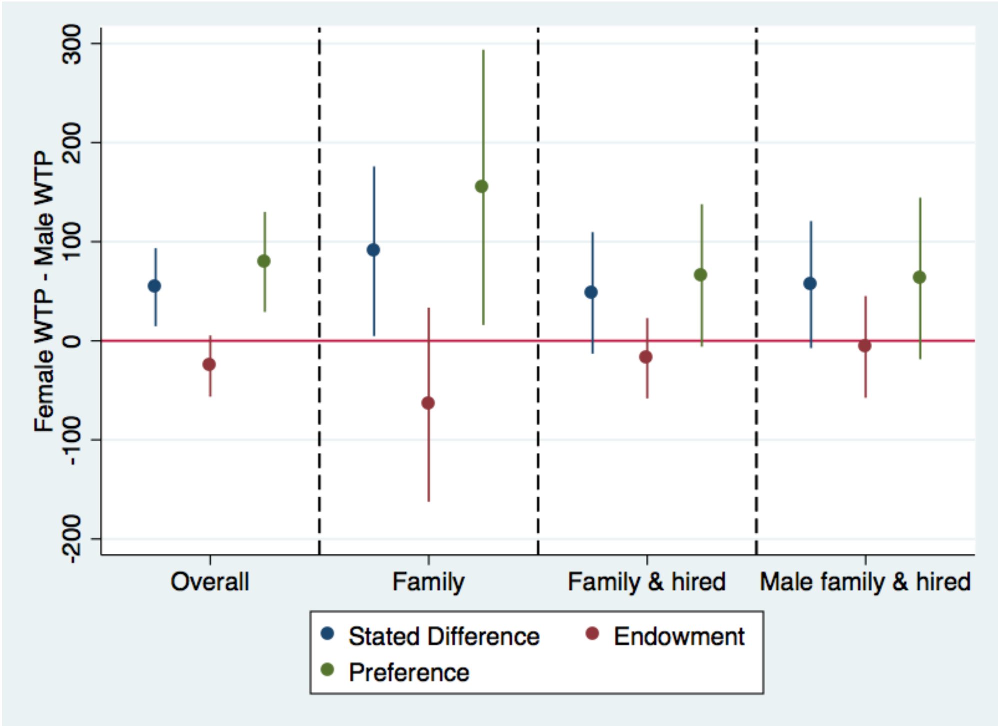

Figure shows 90 percent confidence intervals

Table 1: Summary Statistics: Household Characteristics

Variable	Mean	Std. Dev.
Household Composition		
Age of household head	47.95	13.79
Sex of household head	0.97	0.16
Household size	6.08	2.95
Percent of household in agriculture	0.44	0.24
Household is nuclear	0.74	0.44
Percent husband-wife in sample	0.87	0.34
Household is upper caste	0.25	0.43
Household has Below Poverty Line ration card	0.44	0.5
Agricultural Characteristics		
Household owns agricultural land	0.82	0.39
Area owned (in acres)	1.64	3.89
Area cultivated (in acres)	1.28	2.27
Number of plots	2.7	2.0
Transplanting Cost and Labor-use		
Transplanting cost per acre †	614.92	753.53
Female family labor per acre	3.15	6.04
Male family labor per acre	4.86	6.17
Female hired labor per acre	6.96	12.16
Male hired labor per acre	1.96	6.77
N	965	

† Transplanting cost per acre only includes cost of hiring laborers for transplanting. It does not include any nursery or family labor-use cost.

Table 2: Descriptives: Labor-use in Transplanting

	Family labor only	Family & hired labor	Male family & hired labor
Number of plots	2.33	2.71	4.03
	(1.69)	(1.48)	(17.33)
Plot area (acres)	0.65	0.62	0.83
	(1.75)	(0.53)	(1.17)
Wealth Index	-0.37	-0.19	0.37
	(0.47)	(0.63)	(1.17)
Transplanting cost per acre	0	826.22	910.4
	(0)	(712.62)	(759.61)
Family female labor per acre	9.1	3.89	0
	(8.87)	(5.83)	(0)
Family male labor per acre	8.02	4.28	3.3
	(9.06)	(4.09)	(4.08)
Hired female labor per acre	0	10.18	7.92
	(0)	(15.4)	(10.41)
Hired male labor per acre	0	2.03	2.79
	(0)	(5.42)	(4.79)
Bargaining Index	-0.64	-0.46	0.78
	(0.74)	(0.93)	(1.34)
Observations	153	362	331

Standard deviation in parenthesess

Table 3: Individual Differences Within a Household

	Male	Female	Difference	t Statistics
Individual Characteristics				
Age	47.8	43.8	4.0***	(6.54)
Education (years)	4.6	2.6	2.0***	(6.64)
Literacy (%)	.71	.36	0.35***	(16.19)
Member of a group (%)	.03	.21	-0.18***	(-12.94)
Uncertainty index	.32	.36	-0.04	(-1.80)
Risk	5.3	5.3	-0.08	(-0.90)
Agricultural Involvement				
Involved in agricultural work (%)	.93	.67	0.26***	(15.09)
Involved in transplanting (%)	.76	.69	0.07***	(3.32)
Agricultural technology Index	29.6	24.6	5.1***	(14.01)
Accessed extension last year (%)	.21	.03	0.18***	(12.71)
Access to Credit				
Have a bank account (%)	.66	.41	0.25***	(11.31)
Have a loan (%)	.05	.07	-0.02	(-1.84)
Credit worthiness (Rs.)	33015.5	13145.1	19870.5***	(8.12)
Time Allocation				
Hours spent on household chores	5.2	7.4	-2.2***	(-19.77)
Hours spent on farm work	3.3	1.9	1.4***	(12.26)
Hours spent on leisure	2.4	2.3	0.08	(1.19)

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 4: Women Value MRTs More Than Men Based on their Stated Willingness to Pay

	Male Mean	Female Mean	Difference	Plot Observations
Family only	660.19	750	-89.19**	236
Family & hired	818.90	867.57	-48.67*	680
Male family & hired	915.13	965.25	-51.11**	720
Overall	841.64	891.77	-50.12***	1700

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Oaxaca-Blinder Decomposition of Individual Valuation

	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Equation 1 : Differential (MIWTP - FIWTP)				
Male Mean	836.34***	655.82***	818.98***	907.83***
	(22.50)	(56.55)	(35.94)	(33.90)
Female Mean	890.39***	746.15***	867.26***	964.51***
	(19.36)	(52.29)	(30.24)	(29.30)
Difference	-54.05**	-90.33*	-48.28	-56.69
	(23.95)	(52.04)	(37.28)	(38.97)
Equation 2 : Endowment Difference				
Age	-0.36	-12.48	5.43	-5.15
	(4.75)	(12.72)	(5.67)	(9.09)
Education (years)	10.86**	-6.40	0.40	11.82
	(5.41)	(16.65)	(8.04)	(7.53)
Involved in agricultural work(=1)	-16.02	14.92	-2.03	-15.88
	(11.06)	(16.87)	(14.56)	(21.55)
Accessed extension last year (=1)	29.72***	42.17	41.74***	23.23
	(9.85)	(30.27)	(13.34)	(16.79)
Risk	0.00	7.06	-1.98	-0.66
	(0.07)	(13.31)	(2.88)	(4.29)
Technology index	0.55	31.64	-17.57*	1.97
	(8.72)	(31.76)	(9.63)	(15.52)
Credit worthiness	0.72	-12.42	-8.34	-9.12
	(5.90)	(19.39)	(9.24)	(10.59)
Total	25.46	64.50	17.65	6.21
	(18.79)	(59.52)	(24.64)	(31.21)
Equation 3: Preference Difference				
Age	1.59	420.59**	-27.28	-82.48
	(88.61)	(205.19)	(133.86)	(144.78)
Education (years)	-9.58	3.74	-20.69	2.61
	(19.13)	(27.12)	(23.34)	(37.53)
Involved in agricultural work(=1)	-45.39	-351.25*	84.81	-27.20
	(88.71)	(199.43)	(185.18)	(103.08)
Accessed extension last year (=1)	2.79	3.75	4.13	7.45
	(5.67)	(16.34)	(11.24)	(7.39)
Risk	-140.09*	-262.86	-100.17	-250.81**
	(73.96)	(179.46)	(125.53)	(102.75)
Technology index	63.07	47.39	-62.78	253.77
	(103.29)	(264.11)	(159.19)	(162.69)
Credit worthiness	-7.86	84.82	-3.44	-20.18
	(8.57)	(57.08)	(26.73)	(12.81)
Intercept	55.95	-101.03	59.50	53.95
	(181.90)	(489.57)	(291.03)	(255.74)
Total	-79.51***	-154.84*	-65.92	-62.90
	(30.67)	(84.45)	(43.72)	(49.58)

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

Standard errors clustered at household level in parentheses

Table 6: Mean Difference in Transplanting Attribute Preferences

	Male Mean	Female Mean	Difference (Male - Female)			
			All	Family only	Family & hired	Male family & hired
Family female labor	3.10	3.04	0.06	-0.09	0.51	-0.33
Family male labor	2.70	2.76	-0.06	-0.07	0.41	-0.53*
Hired labor	3.84	3.23	0.61***	0.52	1.00***	0.29
Nursery	.70	2.12	-1.42***	-1.12**	-1.47***	-1.44***
Delay in transplanting	2.11	2.78	-0.67***	-0.12	-0.28	-1.38***
Speed of transplanting	4.17	3.37	0.79***	0.97*	1.12***	0.50*
Observations			1706	306	646	662

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Women and Men Value Different Transplanting Attributes Based on Hedonic Price Decomposition

Dep: FIWTP - MIWTP	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Transplanting cost per acre	-0.03	0.00	-0.00	-0.06
	(0.02)	(.)	(0.03)	(0.04)
Diff 1: Use of female family labor	6.17	20.72	5.24	3.58
	(6.40)	(16.39)	(9.90)	(9.72)
Diff 2: Use of male family labor	3.31	-9.52	2.07	10.65
	(6.63)	(14.54)	(10.77)	(10.22)
Diff 3: Use of hired labor	5.26	0.67	1.36	11.96
	(5.68)	(13.47)	(8.04)	(9.32)
Diff 4: Nursery method	8.53**	23.12***	6.74	7.94
	(3.97)	(8.20)	(6.33)	(6.82)
Diff 5: Delay in transplanting	12.46**	-18.41	26.04***	13.30*
	(4.95)	(14.69)	(7.58)	(7.59)
Diff 6: Speed of transplanting	20.24***	16.76	22.36***	14.99
	(4.91)	(11.71)	(7.58)	(9.20)
Constant	59.21**	38.33	44.90	73.09
	(29.97)	(83.13)	(44.60)	(54.75)
Observations	1656	232	668	697

Standard errors clustered at household level in parentheses

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

Household level random-effects used.

Control variables included but not reported: Difference between female and male in age, education, involvement in agriculture, extension, risk, technology index, and credit worthiness.

Table 8: Examination of Stated and Experimental Willingness to Pay Measures

	All Zero	Auction Zero	Individual Valuation Zero
Soil	-0.45*	-0.13	0.06
	(-1.90)	(-0.82)	(0.37)
Transplanting cost per acre	150.70	1.3	53.7
	(1.56)	(0.02)	(0.84)
Plot size (acres)	0.03	-0.02	-0.15
	(0.20)	(-0.19)	(-1.40)
Transplanting family female labor	-0.84	0.65	-2.24***
	(-0.90)	(1.03)	(-3.61)
Transplanting hired female labor	7.83*	-4.20	0.94
	(1.66)	(-1.31)	(0.30)
Women transplants (=1)	-0.22***	0.02	-0.12**
	(-3.52)	(0.44)	(-2.93)

Standard deviation in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The difference compares the sample that satisfies the criteria (e.g. Set of observations when auction, female, and male Valuation (All Zero) are zero) with the rest of the sample.

Table 9: Women Have a Lower Influence vis-à-vis Men in Household Demand: Basic Bargaining Model

Dep: Auction WTP	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Male Individual WTP	0.60***	0.69***	0.88***	0.36***
	(0.10)	(0.07)	(0.10)	(0.12)
Female Individual WTP	0.35***	0.23*	0.13	0.61***
	(0.06)	(0.12)	(0.07)	(0.13)
FWTP × Barg. index	-0.01	0.04	-0.03	-0.03
	(0.02)	(0.08)	(0.04)	(0.03)
FWTP × Barg. index × Inv. in trans	-0.00			
	(0.04)			
Disc with others (ln)	295.25***	365.27*	415.74***	171.29
	(76.14)	(176.97)	(136.18)	(122.98)
(Rank=2) × Disc. with oth	-119.55	-105.33	-218.33	-67.36
	(96.72)	(174.56)	(137.08)	(119.07)
(Rank=3) × Disc. with oth	-270.49**	-203.00	-429.96***	-145.06
	(110.17)	(155.32)	(137.67)	(132.22)
(Rank=4) × Disc. with oth	-339.34***	-189.25	-676.03***	-110.22
	(108.44)	(162.59)	(173.07)	(120.31)
Observations	429	46	166	201

Standard errors in paranetheses clustered at village-level

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

Table 10: Bargaining Model of Household Demand

Dep: Auction WTP	(1)	(2)	(3)	(4)
	All	Family labor only	Fam. & hired	Male fam. & hired
Male Individual WTP	0.29***	0.34***	0.15	0.29*
	(0.09)	(0.10)	(0.10)	(0.16)
Female Individual WTP	0.08	0.06	-0.13	0.34**
	(0.06)	(0.13)	(0.10)	(0.16)
FWTP × Barg. index	0.00	-0.19	-0.05	-0.08
	(0.05)	(0.18)	(0.07)	(0.08)
Bargaining Index	-32.32	310.37*	-14.15	56.22
	(47.93)	(179.53)	(78.42)	(90.10)
Inv. in trans (=1)	74.58			
	(83.73)			
FWTP × Barg. index × Inv. in trans	0.03			
	(0.05)			
Disc with others (ln)	109.23	222.05**	65.49	52.25
	(68.83)	(96.31)	(99.43)	(107.16)
(Rank=2) × Disc. with oth	-31.63	-83.28**	-19.42	1.47
	(50.66)	(38.51)	(65.74)	(101.30)
(Rank=3) × Disc. with oth	-90.95	-104.45**	-47.15	-72.13
	(74.35)	(45.86)	(91.40)	(147.27)
(Rank=4) × Disc. with oth	-122.17	-162.36	-88.94	-64.52
	(82.51)	(125.89)	(155.67)	(133.88)
Knows service provider	46.58	-43.85	65.99	-2.70
	(53.81)	(194.08)	(94.84)	(82.71)
Understood auction	62.83	81.40	158.58*	-24.43
	(161.28)	(97.90)	(86.31)	(217.39)
Plot area (acres)	27.47**	1.95	49.88	26.58
	(13.99)	(33.81)	(39.03)	(17.67)
Household is upper caste	53.41	11.62	292.23**	-27.23
	(69.59)	(147.54)	(147.27)	(94.70)
Wealth Index	-15.05	-233.04*	15.12	-10.14
	(18.48)	(123.19)	(70.89)	(24.78)
Constant	506.91**	698.70	723.19***	487.02
	(258.41)	(447.58)	(275.23)	(394.08)
Observations	428	46	166	200

Standard errors in paranetheses clustered at village-level

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

Household-level random effects used

Appendix A. Timeline of Field Activities

2015								
March	April	May	June	July	August	September	November	December
Rabi wheat season				*Kharif* rice season				
Baseline survey								
Co-head survey								
	Intrahousehold hypothetical valuation exercise							
		Experimental auctions						
				MRT service provision				

Appendix B. Attribute Elicitation Chart Used to Compare Traditional and Mechanical Rice Transplanting

तुलना चार्ट

पहलु	हाथ से रोपाई	मशीन से रोपाई
1. परिवार की महिलाओं की उपयोग 		
2. परिवार के पुरषों का उपयोग 		
3. मजदूरों का उपयोग 		
4. नर्सरी करने की विधि 		
5. रोपाई करने में देरी 		
6. रोपाई करने की गति 		

Appendix C. Willingness to Pay for the Technology on Different Plots

Own valuation of MRT (Rs/acre)															
	Plot ('name')	*Size (ac)*	600	700	800	900	950	1000	1050	1100	1200	1300	1400	1500	1600
A.			√	√	√	√	√	√							
B.			√	√	√										
C.			√	√											