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Gender and Preferences for Malaria Prevention in Tigray, Ethiopia

This paper examines how demand for preventive health care differs depending on whose preferences in the household are assessed. The analysis indicates that married women are willing to pay more to prevent malaria in their household malaria than married men. There are, however, no significant differences in the rate at which male and female respondents substitute teenagers and children for adults when choosing an optimal amount of malaria prevention for their household. A new test of the 'common preference' hypothesis is presented.

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Policy Research Report on Gender and Development

Over the last several decades, gender issues have attained increased prominence in the debates over development policy. There is a growing body of evidence and experience linking gender awareness in policy and projects to equitable, efficient, and sustainable outcomes in development. However, these links are still not widely understood nor have these lessons been fully integrated by donors or national policy makers.

In mid 1998, work began on the Policy Research Report (PRR) on Gender and Development. The objectives of the report will be to strengthen the analytical and empirical underpinnings of these links and, in doing so, to clarify the value added of bringing a gender perspective to the analysis and design of development policies and projects.

In pursuit of these objectives, the PRR will draw on interdisciplinary perspectives, from research and project and policy experience. The report will incorporate extensive consultation with Bank staff, researchers and academics outside the Bank, other donor agencies, and groups from civil society. In addition to the consultation process, a series of background papers on selected topics has been commissioned. These papers have been selected to fill some of the gaps in the existing literature as well as to augment knowledge in selected areas.

The Policy Research Report on Gender and Development Working Paper Series is intended to encourage early discussion of the findings of these papers in advance of the expected publication of the PRR in Spring 2000. An objective of the series is to get the findings out quickly, even if the presentation is less than fully polished. The papers are preliminary and carry the names of the authors and should be cited accordingly.

This paper is part of a series of papers on selected topics commissioned for the forthcoming Policy Research Report on Gender and Development. The PRR is being carried out by Elizabeth King and Andrew Mason and co-sponsored by the World Bank's Development Economics Research Group and the Gender and Development Group of the Poverty Reduction and Economic Management Network. Comments are welcome and should be sent directly to the author(s) at julian@lampietti.com. Copies can be found online at http://www.worldbank.org/gender/prr. For paper copies, please send your request to Gender_PRR@worldbank.org.

Gender and Preferences for Malaria Prevention in Tigray, Ethiopia

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Abstract: This paper examines how demand for preventive health care differs depending on whose preferences in the household are assessed. The analysis indicates that married women are willing to pay more to prevent malaria in their household malaria than married men. There are, however, no significant differences in the rate at which male and female respondents substitute teenagers and children for adults when choosing an optimal amount of malaria prevention for their household. A new test of the 'common preference' hypothesis is presented.

***Keywords**: Intrahousehold Allocation; Malaria; Gender Analysis, Non-market valuation, Health Economics*

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Introduction[1]

One of the goals of the literature on intrahousehold allocation is to determine whether husbands and wives would make the same choices when confronted with decisions regarding family welfare. The literature to date suggests that they would not, a finding that has important policy implications. For example, if wives purchase more health care for their families than husbands, policies that place more resources in the hands of women would have significantly different impacts on household welfare than policies to increase the incomes of men. This depends, of course, on women having the opportunity and resources to make these purchase decisions.

This paper examines whether husbands and wives in northern Ethiopia make the same choices with regard to an important form of health care -- malaria prevention.[2] Specifically, we compare husbands' and wives' demand functions for two different goods that prevent malaria. Our interest lies not only in seeing whether the demand functions of husbands and wives differ, but also in how these demand functions are affected by family composition. Holding family size constant, will households with more children buy more bednets or fewer bednets, and will this decision differ between husbands and wives?

While the policy implications of these decisions are important in their own right, this research also contributes to the growing literature on intra-household allocation decisions. As noted by Thomas (1997), tests of the hypothesis that families maximize a common utility function (the common preference hypothesis) rely on the maintained assumption that purchase decisions depend only on the *sum* of non-earned incomes in the family. Rejection of the hypothesis rests on showing that the *distribution* of non-earned incomes within the family affects spending. Measuring non-earned income is, however, fraught with difficulty.

We present a new approach to testing the common preference hypothesis. If one is willing to accept that *stated* choices reflect preferences, then confronting husbands and

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[1] The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors and should not in any way be attributed to the World Health Organization or the World Bank.

[2] This paper builds on a paper by Lampietti (1999).

wives with such choices provides an alternative method of testing whether they have the same preferences. If preferences differ between husbands and wives, then the common preference model cannot hold.

We illustrate this approach using data collected in the Tembien region of Tigray, Ethiopia, in January 1997. Heads of household or their spouses were asked how many hypothetical malaria vaccines or bednets they would purchase for their household at a given price. These data are used to estimate household demand functions for malaria vaccines and bednets for male and female respondents. While the choice of who in the household was interviewed was not random, the demand function for husbands should reflect mean preferences of married men and the demand function for wives should reflect mean preferences of married women.

Whether husbands and wives in Ethiopia have the same demands for malaria prevention depends in part on the form that prevention takes. In the case of a hypothetical malaria vaccine--a private good that, by assumption, would protect each person inoculated with the vaccine for one year -- wives would purchase more vaccines for their families at each price than would husbands. There is however, no difference in the impact of family composition on vaccine demand between husbands and wives. In both cases, families with more children purchase *fewer* vaccines, holding family size constant.

For bednets--a private good that *within households* has some of the properties of a public good -- we cannot reject the null hypothesis that the demand functions are the same. This may be because of the quasi-public nature of the good or because the bednet scenario was administered to about half as many respondents as the vaccine scenario, making it more difficult to reject the null hypothesis of common preferences.

Theoretical Model

This section develops a theoretical model that combines Becker's (1981) benevolent dictator model and Grossman's (1972) health production model. Becker assumes that a single individual, such as a head of household or their spouse, makes the consumption choices for the entire household. Let us call this person the decision-maker and assume he or she is benevolent. Each family member i enters the decision-maker's utility function. Utility is a function of consumption of a numeraire (X_i), leisure time (L_i), the amount of time spent ill with malaria (S_i), and a vector of decision-maker characteristics (***Z***) such as education, age, and gender. Assuming n family members, utility is given by

$$U = u(X_1, \dots, X_n, L_1, \dots, L_n, S_1, \dots, S_n, \boldsymbol{Z}).^3 \tag{1}$$

Grossman's model relates the individual's choice of health inputs to health outcomes. The time spent ill (S_i) with malaria by each individual is a function of preventive care such as vaccines or bednets (A_i) and treatment such as chloroquine (M_i). How effective these inputs are depends on individual health characteristics (H_i) and, in the case of malaria, on the prevalence of the mosquitoes (which transmit malaria) E.

$$S_i = s(A_i, M_i, H_i, E). \tag{2}$$

The decision-maker maximizes utility subject to the household budget constraint,

$$\sum_{i=1}^{n} I_i + \sum_{i=1}^{n} w_i (T - L_i - S_i) = \sum_{i=1}^{n} X_i + p_a \sum_{i=1}^{n} A_i + p_m \sum_{i=1}^{n} M_i \,. \tag{3}$$

where $\sum_{i=1}^{n} I_i$ is the sum of each individual's non-earned income (I) and $\sum_{i=1}^{n} w_i (T - L_i - S_i)$ is earned income, which is equal to the sum of each individual's wages (w) times the total time available for work (T) minus leisure time (L) and time spent sick (S) with malaria. The sum of these equals total household consumption. This budget constraint indicates household expenditures on consumption, prevention, and treatment cannot exceed household income. The decision-maker selects values of vectors ***X***, ***L***, ***A***, and ***M*** to maximize household utility subject to the budget constraint and to the health production functions. This yields a household demand function for preventive care, where A^* is the number of vaccines chosen by the decision-maker:

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[3] This model is observationally equivalent to the common preference model in which members of the household have identical preferences over the vectors ***X***, ***L***, and ***S***.

$$A^* = g(I, \mathbf{w}, p_a, p_m, \mathbf{Z}, \mathbf{H}, E) \tag{4}$$

This function indicates that demand for malaria prevention depends on household non-earned income, a vector of wages for each household member, as well as the prices of preventive and mitigating health care, a vector of decision-maker characteristics, a vector of baseline health for each individual, and the prevalence of mosquitoes.

The demand function can be used to examine how the quantity of preventive care purchased changes with the gender of the respondent and the composition of the household. For example, the literature on intrahousehold allocation suggests that improvements in child health have also been associated with a mother's control over family resources. If true, then we would expect women to purchase more preventive care for their children than men do. Holding household size constant, do households with a large number of children purchase more or less vaccines? How is the answer to this question affected by the gender of the respondent? Answering these questions begins to provide insights into the intrahousehold allocation of preventive health care.

The value of protecting n household members with hypothetical vaccines is the maximum amount of income that can be taken away from the decision-maker while giving him or her A^* vaccines and keeping utility constant. Formally, this is the area under the decision-maker's income-compensated (Hicksian) demand curve for vaccines. This can be approximated using equation (4). The total value the decision-maker places on preventing malaria in themselves and members of their household or Willingness To Pay (WTP) for prevention is the area under the demand curve and to the left of household size. This can be written as:

$$WTP = \int_0^n g(I, \mathbf{w}, p_a, p_b, \mathbf{Z}, \mathbf{H}, E) dA \tag{5}$$

Study Site, Research Design, and Sampling

The data were collected in 1997 in the Tembien sector of Tigray province, northern Ethiopia as part of a project to assess the demand for malaria prevention and to compute the medical costs and productivity losses associated with the disease.[4] The value people place on preventing malaria is a function of their economic circumstances and the severity of the disease. In Tigray, the primary activity is subsistence cultivation. Given the relatively small size of their land holdings, the low productivity of their land, and difficulties in gaining access to inputs and technology, many households are unable to produce enough food (Relief Society of Tigray, 1995).

These problems are compounded by the incidence of malaria, which reaches its peak during the harvest each year (Figure 1). Government control activities include spraying in the early part of the transmission season, encouraging environmental control by communities, and training health workers to recognize and treat malaria with chloroquine.

The research design was tailored to the study area. Two-thirds of the households sampled were presented with the hypothetical vaccine scenario and one third with the bednet scenario. Each household was randomly assigned one of five prices for either the hypothetical vaccine or the bednet.

A three-part survey instrument was administered. The first part asked questions about a household's current health status, knowledge of malaria, and expenditures on malaria prevention and treatment. The second part presented the respondent with one of two contingent valuation scenarios. The third part requested information on the socioeconomic characteristics of the household members.

The hypothetical vaccine scenario started by explaining to the respondent that such a vaccine was not currently and might never become available. Then the enumerator described a vaccine that would prevent the recipient from contracting malaria for one year. The scenario included a detailed description of the commodity, checked respondent understanding of how it worked, and provided reminders of substitute goods and the budget constraint. It was also emphasized that a separate vaccine would need to be purchased for each member of the household in order to protect them from getting malaria for one year.

The respondent was then asked whether he or she would purchase one or more

[4] A detailed description of the project and its results may be found in *The Value of Preventing Malaria in Tigray, Ethiopia* (Cropper et al. 1999).

vaccines at one of five randomly assigned prices. The lowest price was Birr 5 (US$ 1) and the highest price Birr 200 (US$ 32). If the respondent answered 'yes' to the original choice question, he or she was asked how many vaccines would be purchased.

In a separate split sample, respondents received a bednet contingent valuation scenario. This scenario coupled an explanation of how using a bednet reduces the probability of contracting malaria with a demonstration of a double-size polyester bednet impregnated with 1 percent deltamethrin. Again, the scenario checked respondent understanding of how the commodity works, and provided reminders of substitute goods and budget constraints. The respondent was then offered the opportunity to purchase one or more bednets at one of five randomly assigned prices. Prices per bednet ranged from a low of Birr 8 (US$ 1) to a high of Birr 100 (US$ 16).

The sampling strategy employed a three-stage design. Districts were selected in the first stage; villages were selected in the second stage; and households were selected in the third stage. Two points about the choice of respondent should be noted. First, only one individual, either a man or a woman, was interviewed in each household. Second, there was no protocol for selecting whether a man or woman was interviewed. While the choice of households was intended to be random, we cannot guarantee that the gender of the respondent was selected at random.

Eight hundred and eighty-nine field interviews were completed.[5] Forty-one respondents were not familiar with malaria and were dropped from the study. This left 569 respondents who received the hypothetical vaccine scenario and 279 the bednet scenario (Table 1). Approximately 114 interviews were completed for each of the 5 hypothetical vaccine prices and 56 for each of the 5 bednet prices. Fifty-seven percent of our respondents were women and 43 percent were men; thirty-four percent of female respondents were single heads-of-household.[6]

[5] We had to delete one record because the contingent valuation question was not completed properly.

[6] A female head of household is defined as a female respondent who answered no to the survey question "Are you married?" or to the survey question "Is your spouse alive?"

Household Demographic Characteristics

The average household interviewed consisted of five members: two adults, one teenager (12-19 years of age), and two children (0-11 years of age). The mean age of respondents in our sample is 42, with men being slightly above the mean and women being slightly below it. Literacy is low, with only 13 percent of those interviewed claiming they can read a newspaper with ease. There is a considerable disparity in literacy by gender, with 22 percent of the men in our sample responding that they could read a newspaper with ease, while only 7 percent of women responded in this manner.

Labor markets in Tembien are not well developed, making it difficult to measure wages, (**w**), in the theoretical model. It is possible to use an agricultural production function – in which output depends on the time input of each family member – to impute wages for each household member. However, obtaining measures of time input for each family member remains a difficult empirical task that we chose not to undertake. Instead, we estimate household income and use this as a proxy for**w**.

Adding together crop production, annualized livestock holdings, and off-farm income provides a measure of annual household income. Mean household income is Birr 1,387 (US$ 220) and the median is Birr 1,157 (US$ 183). There are a number of households with very low incomes. One explanation for this is that these households do not produce enough food to support themselves but have coping mechanisms, such as participating in local 'food for work' programs, not captured in the survey.

There are significant gender-based differences in reported agricultural income, with men reporting larger figures than women do. This suggests either a systematic difference in households in which men and women were interviewed (non-equivalence of test groups) or gender-based recall error (measurement error). Separating households by respondent gender and marital status reveals that female-headed households are significantly worse off than all others. This may be because of the absence of adult males to undertake plowing at the onset of the rainy season.

There is also a difference in the incomes reported by married men and women (jointly headed households). Examination of non-agricultural measures of wealth in these households, such as off-farm income, housing characteristics, and household assets (lanterns, beds, radios, shoes, and jerricans) reveals that there are no other significant economic differences between these groups (Table 2). This suggests that there are no systematic differences in economic status between married households with male respondents and those with female respondents.

A possible explanation for differences in the reporting of income can be found in the traditional division of household responsibilities. In northern Ethiopia, while both sexes are equally involved in agricultural production, men are responsible for marketing agricultural surplus (livestock and grain) and women for minding the granary. This could explain why men report higher agricultural income than women: men recall production while women recall consumption.

Malaria in Study Area

Malaria is endemic in Tembien, with peak transmission coinciding with the beginning of the harvest. Both *Plasmodium falciparum* and *Plasmodium vivax* are present, with *Plasmodium falciparum* predominating (Ghebreyesus *et al.*, 1996).[7] There appear to be gender-based differences in the respondents' perception of whether malaria is more serious for adults or for children (Table 3). Forty-eight percent of men believe that malaria is more serious for children, while 48 percent believe that it is equally serious for adults and children. Thirty-seven percent of women believe that malaria is more serious for children and 59 percent believe that it is equally serious for both adults and children. That male respondents perceive malaria to be more serious for children than female respondents counters the conventional wisdom that females are more sensitive to the health of children than males.

Malaria is widespread, with 78 percent of respondents reporting that they have had malaria at least once in their lifetime. Incidence is evenly distributed across household members. Fifty-eight percent of respondents had malaria at least once in the last two years. Fifty-three percent report that at least one other adult in their household had the disease in the last two years. Forty-nine percent report that at least one teenager or child in their household had malaria in the last two years.

A number of factors might contribute to a disparity in reported malaria incidence

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[7] *Plasmodium falciparum* is the more virulent of the two species.

between the sexes in their lifetime (86 percent for men and 72 percent for women). First, men are generally more mobile than women and children, and thus may be more exposed to infection. Second, 98 percent of the community health workers are men carrying out their duties from their homes (Ghebreyesus *et al.* 1996). Focus group discussions have revealed that women are reluctant to see male health workers for cultural reasons, thus they may under-report the occurrence of malaria (Ghebreyesus *et al.* 1996). Finally, males may receive treatment more often and report a higher incidence than females because their health is given priority by the household. This is because males perform critical strenuous agricultural activities, such as plowing, that support the household's agricultural production.

Analysis of Contingent Valuation Responses

The principal choice question asked respondents how many vaccines or bednets they would purchase at one of five randomly assigned prices. Thirty-nine percent of respondents agreed to purchase one or more vaccines. Conditional on buying any, the mean quantity purchased was four and the median three. Sixty-two percent of respondents agreed to purchase one or more bednets, the mean and median quantity purchased were both one.

Cross tabulations reveal that for both vaccines and bednets the quantity purchased decreases with an increase in price (Table 4 and Table 5). The null hypothesis that number purchased *does not* vary systematically with price is rejected for both goods.[8] This suggests that respondents seriously considered the price information in the scenario and that their responses depended upon the price they received.

This is valuable information for the design of malaria prevention programs. Figure 2, which is based on a sub-sample of Table 4, simulates the purchasing behavior of married men and women in a hypothetical 200-household village. At prices above Birr 20 (US$ 3) per vaccine, married females' demand lies to the right of married males' demand.

The figure suggests that at prices over Birr 20 (US$ 3), demand is systematically

[8] For hypothetical vaccines $\chi^2_{(12)} = 136.33$ and for bednets $\chi^2_{(12)} = 52.04$

higher for married females than for married males. Both revenue and population coverage can be increased by targeting married women. For example, at a price of Birr 40 (US$ 6) per vaccine, an additional Birr 3,160 (US$500) in revenue could be collected by targeting. Not only are revenues increased but coverage also goes up, with seven percent more of the population receiving the vaccine at this price. Of course, this kind of targeting depends on two conditions. The first is that women have some level of decision making power in the household and the second is that the cost of targeting women over targeting households does not outweigh the benefits.

Empirical Specification

The theoretical model relates the number of hypothetical vaccines a respondent agrees to purchase to a vector of explanatory variables. These variables include household non-earned income, wages, and the prices of preventive and mitigating health care. The discrete nature of the dependent variable and the large number of zeroes and small values suggests that a count regression model is appropriate. The probability density function, however, is modified so that household size is an upper bound for each observation. In the case of the Poisson model this implies,

$$P[A_i^* = k_i \mid A_i^* \leq n_i] = \frac{e^{\lambda_i}\lambda_i^k / k_i!}{\Pr[A_i^* \leq n_i]} \text{ where } k_i = 1 \text{ to } n_i. \tag{6}$$

We refer to this as the Truncated Poisson model. This model yields convenient expressions for WTP for prevention, which is the area under the household demand curve between zero and n. More formally:

$$\begin{aligned} WTP_i &= -\frac{e^{\mathbf{X}_i\mathbf{B}}}{\beta_p} \text{ if } p_{ni} \leq 0 \text{ and} \\ WTP_i &= \frac{n_i}{-\beta_p} + p_{n_i}n_i \quad \text{otherwise,} \end{aligned} \tag{7}$$

where p_{n_i} is the price at which the decision-maker buys vaccines for all household members.

The Truncated Poisson model can also be used to address the issue of intrahousehold resource allocation. The simplest approach to explaining behavioral differences between men and women is to hold all coefficients in the β vector constant across men and women, except for the intercept. This is equivalent to including a dummy variable for gender in the model. We refer to this as the "reduced" model.

There are more general tests of behavioral differences between males and females with respect to the decision to purchase malaria prevention. One is to specify the statistical model so that $\lambda_i = \exp(\mathbf{X}_{1i}\beta_1 + \mathbf{X}_{2i}\beta_2)$, where $\mathbf{X}_{2i}$ is a vector of explanatory variables interacted with gender (female=1). This is similar to specifying separate structural equations to explain the purchasing behavior of men and women but assumes a common error variance. We call this the "full" model.

If the β coefficients of men and women are the same with regard to purchasing malaria prevention, then their responses may be pooled and treated as identical within the context of the statistical model $\lambda_i = \exp(\mathbf{X}_{1i}\beta_1)$. To test this hypothesis we specify the null hypothesis as H_0: $\beta_2 = 0$ and the alternative as H_1: at least one of the parameters in β_2 is not zero. A rejection of the null hypothesis implies that two populations differ, suggesting that we estimate separate models for men and women.

Equation (4) suggests that the number of vaccines or bednets purchased should depend on the price of the good, household income, and size. It might also depend on family composition – the number of adults, teenagers, and children in the family, and on characteristics of the respondent – gender, age, marital status and education – which may influence preferences for-health related goods. The mean and standard deviation of each of the variables are summarized in Table 6.

Household income enters the demand function in log form. Twenty-eight percent of the observations for off-farm wages were missing. These were replaced with zeroes and a dummy variable for missing wages, which takes on a value of one if the wage observation is not present, was included in the model.

The decision-maker's demand also depends on each family member's susceptibility to malaria and the prevalence of the disease. Susceptibility is a household-specific measure of direct cost of illness in the past year. It is computed as the product of the sample mean direct cost of illness for adults, teenagers, and children times the number of episodes in each age category in the household in the previous year.[9] This weighted average approach was used to avoid issues of endogeneity. A proxy for the prevalence of malaria, altitude, is also included in the model. This is a good exogenous predictor of incidence because the vector is more common at lower altitudes.

Household size can be included in the model as either a discrete or a continuous variable. Both specifications were tested and the magnitude of the coefficients, the number of significant variables, and the WTP results were virtually identical. For brevity, the results including household size as a continuous variable are presented here.

Household composition is measured by two variables, the number of teenagers and the number of children. Since the number of adults is the omitted category, these variables reflect the trade-off between teenagers or children and adults.

Respondent-level parameters include marital status, gender, age, and ability to read a newspaper. Marital status is captured by a dummy equal to one if the respondent is married and his or her spouse is alive. Gender is a dichotomous variable in the reduced model, equal to one if the respondent is female. Literacy is measured by whether or not the respondent can read a newspaper with ease.

The model was estimated with both village and enumerator fixed effects. Village effects were not significant and therefore are not included in the final specification. Enumerator effects are significant and their inclusion in the model allows us to control for the influence of enumerators on respondent choices.

Multivariate Results

Vaccines

The multivariate results for the vaccine scenario are presented in Table 7. Column 1 of the table presents a model in which only the intercept term is allowed to differ by gender (the "reduced" model). Columns 2 and 3 of the table present vaccine demand functions estimated separately for men and for women. The reduced model for vaccines is generally consistent with economic theory. The quantity of vaccines the respondent

[9] The missing observations (less than 1 percent) for this variablewere imputed using ordinary least squares regression.

agrees to purchase varies inversely with price. Respondents at higher altitudes (less exposed to the malaria vector) purchase less vaccines than respondents at lower altitudes. The quantity purchased increases with income and with the higher the cost of treatment. Age of respondent is significant and negative, indicating that older respondents purchase less vaccines.[10] While not presented in Table 7, the results from the model with the full set of interaction terms (the "full" model) indicate that there are significant differences in the effects of price, income, missing wages, household cost of illness, literacy, and age on male and female purchasing behavior. We therefore reject the null hypothesis that men and women have identical demand functions for vaccines and estimate separate demand functions.

Holding income fixed, the price elasticity of females' demand is significantly lower than it is for males, indicating that females are less sensitive to changes in price than males. Male demand is unit elastic at Birr 50 (US$ 8) and female demand unit elastic at Birr 70 (US$ 11). At a price of Birr 100 (US$ 16) the price elasticity of demand for male respondents is -2.0 and for females –1.5, implying that a 10 percent increase in price will result in a 20 percent reduction in male demand but only a 15 percent reduction in female demand. These results are consistent withFigure 2.

The income elasticity of demand is significantly higher for females than males. A 10 percent increase in household income produces only a 2.6 percent increase in male demand, whereas it produces a 6.1 percent increase in female demand.[11] Gertler and van der Gagg (1990) note that in industrialized countries the income elasticity of demand for medical care is typically between 0.2 and 0.3. In Mali, Birdsall *et al.* (1983) found that the income elasticity of WTP for improvements in health services and water supply was around 0.35.[12] In Taiwan, Alberini *et al.* (1997) place the income elasticity of WTP to avoid an episode of respiratory illness at 0.45. That the income elasticity of demand is consistent with other studies increases our confidence in the validity of the results.

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[10] These results did not change when age and age squared were included in specification.

[11] In the reduced model the income elasticity of demand is 0.4, suggesting that a 10 percent increase in income results in a 4.0 percent increase in demand.

[12] The income elasticity of demand is not the same as the income elasticity of WTP when quantity is fixed, as it was in these studies.

We can gain insights into intrahousehold allocation by examining the coefficients on teenagers and children in the reduced model. They are both negative and significant, suggesting that the quantity respondents agree to purchase decreases as adults are replaced by teenagers and children in the household. This result makes sense from a productivity perspective, because children contribute less to the household financially than do adults. Furthermore, the coefficient on the number of children is three times larger than it is on teenagers. This is consistent with teenagers being better substitutes for adult labor than younger children.

In the full model, there are no significant differences in the effect of the number of teenagers or children on the number of vaccines purchased by male and female decision-makers. In Table 7, the coefficient on children is of approximately the same magnitude for men and women. This suggests males and females have the same preferences for trading the health of adults against the health of children; it also begins to provide an answer to one of the questions posed at the outset of this paper. In the context of this study, both men and women appear to place the same priority on the health of adults over the health of other demographic categories in the household.

The negative coefficient for female respondents in the reduced model suggests that they would purchase fewer hypothetical vaccines than males; however, as noted earlier, this is a crude measure of gender-based differences in demand. The coefficient is negative because it is capturing the interaction between female-headed households and income. Female headed households are systematically worse off than all other types of households in the sample.

The large positive effect of female cost of illness is consistent with females spending more time caring for the ill in their household. The large positive effect of female literacy is consistent with the literature that indicates that there are large social benefits linked to female education in developing countries (World Bank, 1995). The larger negative effect of female age is also driven by the high percentage of older female-headed households in the sample.

Table 8 explores the implications of the male and female demand functions in Table 7 for willingness to pay (WTP) to prevent malaria among all household members. The table presents estimates of the integral under the vaccine demand function by respondent gender and marital status. The mean WTP of married females is about 18 percent more than it is for married males. Married males' median WTP for vaccines is Birr 151 (US$ 24) and for married females it is Birr 181 (US$ 29). The number of observations in single parent households is very low, decreasing confidence in these results.

That married females' are, at both the mean and median, willing to pay more for hypothetical vaccines than married males is consistent with the evidence in the literature on intrahousehold allocation. This literature suggests that giving women greater control over household resources will result in a more direct impact on household welfare, and in particular child welfare, than giving it to men. In Burkina Faso, reallocating factors of production from men's plots to women's plots increases overall crop yields by about ten percent (Udry et al., 1995). In Bangladesh, women borrowing 100 additional Taka increase household consumption by 18Taka, men by 11 Taka (Pitt and Khandker, 1999). In Brazil, Thomas (1997) finds that additional income leads women to increase spending on food by about three percent and men by about one-half of a percent.

It also raises an important policy issue. Even if wives are willing to pay more to protect their household from malaria than husbands are, they may not have the freedom to act on this. Under such conditions, it is ambiguous how the policy analyst should treat women's preferences. It should also be emphasized that the role women play in household decision making in Ethiopia differs depending on their ethnic and cultural affiliation. Therefore, project's design can be improved by understanding intrahousehold resource allocation in the target population.

Bednets

The multivariate results for the bednet scenario are presented in Table 9, which is similar in structure to Table 7. While the signs of the coefficients in the reduced model for bednets are generally consistent with economic theory, only the coefficient of price is statistically significant at conventional levels. This is partly due to the smaller sample size for the bednet scenario (279 households v. 569 households for the vaccine scenario).

The smaller sample size may also explain why, when the model with the full set of gender interaction terms is estimated, we are unable to reject the null hypothesis that coefficient vector of the interaction terms is the zero vector. This result, nevertheless, suggests observations for men and women may be pooled and treated as identical. When this test is repeated on the sub-sample of jointly-headed households, the findings are the same.

Conclusions

Comparing males' and females' responses to questions about how much preventive health care they will purchase for their household begins to shed light on the questions asked in the introduction. In the formal test of the common preference model, we reject the null hypothesis that male and female behavioral characteristics can be pooled in the context of demand for vaccines. In the case of men and women living with their spouses, rejection of the null hypothesis suggests the common preference model will hold only if the husband or wife is a dictator. As noted at the outset, this test rests on the assumption that there are gender specific utility functions (e.g. all husbands have comparable utility functions and all wives have comparable utility functions).

A more surprising result, however, is that are no significant differences in the rate at which male and female respondents substitute children for adults when choosing the number of vaccines to buy for their household. This suggests that both men and women consider the health of adults a priority because they are the primary income earners. Or, stated slightly differently, while married women are willing to pay more for vaccines than married men are, the choice of who in the household gets the vaccines is the same.

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Table 1. Treatment and Sample Size

Hypothetical vaccine scenario		bednet scenario	
Price (Birr)	*n* (percent)	Price (Birr)	*n* (percent)
5	117 *(21%)*	8	58 *(21%)*
20	120 *(21%)*	20	59 *(21%)*
40	117 *(21%)*	40	54 *(19%)*
100	118 *(21%)*	60	52 *(19%)*
200	97 *(17%)*	100	56 *(20%)*
Total	569 *(100%)*	Total	279 *(100%)*

Table 2. Jointly Headed Household Income and Assets

	n	Mean Men	N	Mean Women
Annual agric. income (Birr)	342	1423	322	1207*
Annual wage income (Birr)	255	318	218	332
Number of rooms	342	1.25	321	1.21
Number of buildings	342	2.46	318	2.36
Lamp	342	1.12	322	1.10
Bed	342	0.13	322	0.14
Radio	342	0.34	322	0.18
Bicycle	342	0.02	321	0.01
Shoes	147	1.01	179	0.94
Jerrican	147	0.50	178	0.50

* indicates difference between men and women is significant at the 5 percent level

Table 3. Perception of Seriousness of Malaria (percent)

	Total	Male	Female
Adults	34	4%	4%
Children	351	48%	37%*
Equally serious for adults and children	459	48%	59%*
Not serious for adults and children	2	0%	0%

* Difference is significant at 5 percent level

Table 4. Number of Hypothetical Vaccines Purchased by Price (n=569)

Price (Birr)	0 vaccines	1-3 vaccines	4-6 vaccines	>=7 vaccines
5	24%	35%	33%	8%
20	48%	25%	22%	6%
40	68%	21%	10%	2%
100	81%	10%	6%	3%
200	90%	6%	4%	0%

Table 5. Number of Bednets Purchased by Price (n=279)

Price (Birr)	0 nets	1 net	2 nets	3 or more nets
8	19%	21%	43%	17%
20	22%	33%	32%	13%
40	41%	37%	20%	2%
60	52%	23%	19%	6%
100	63%	25%	11%	2%

Table 6. Means and Standard Deviations of Variables in Models

	Vaccine Model			Bednet Model		
Variable	N	Mean	Std.Dev.	N	Mean	Std.Dev.
Number of vaccines purchased	569	1.45	2.19	279	1.07	1.14
Price (Birr)	569	68.30	68.22	279	44.89	32.78
Log income (Thousand Birr)	569	2.40	0.84	279	1.97	1.23
Missing wage (1 if no wage)	569	0.28	0.45	279	0.39	0.49
Number of teenagers	569	0.81	0.91	279	0.56	0.78
Number of children	569	1.95	1.35	279	1.74	1.33
Household direct COI (Birr)	569	18.25	16.48	279	22.26	16.45
Married (1 if married)	569	0.82	0.39	279	0.70	0.46
Gender (1 if female)	569	0.53	0.50	279	0.66	0.47
Read (1 if read easily)	569	0.38	0.49	279	0.53	0.50
Age (years)	569	42.56	14.25	279	41.04	15.04
Alt (hundred meters)	569	16.80	1.54	279	16.51	1.89
Household size	569	5.09	2.00	279	4.53	2.03
Enumerator_2	569	0.03	0.18	279	0.06	0.24
Enumerator_3	569	0.04	0.20	279	0.08	0.26
Enumerator_4	569	0.09	0.29	279	0.00	0.00
Enumerator_5	569	0.08	0.27	279	0.00	0.00
Enumerator_6	569	0.09	0.28	279	0.00	0.00
Enumerator_7	569	0.08	0.27	279	0.00	0.00
Enumerator_8	569	0.03	0.18	279	0.08	0.28
Enumerator_9	569	0.04	0.20	279	0.09	0.29
Enumerator_10	569	0.04	0.19	279	0.09	0.28
Enumerator_11	569	0.09	0.28	279	0.00	0.06
Enumerator_12	569	0.04	0.20	279	0.08	0.27
Enumerator_13	569	0.04	0.19	279	0.08	0.27
Enumerator_14	569	0.04	0.19	279	0.09	0.29
Enumerator_16	569	0.04	0.20	279	0.08	0.28
Enumerator_17	569	0.10	0.30	279	0.00	0.06
Enumerator_18	569	0.05	0.22	279	0.09	0.29
Enumerator_19	569	0.04	0.20	279	0.09	0.28

Table 7. Parameter Estimates for Hypothetical Vaccine Models (n = 569)

Variable	Reduced Model	Males	Females
Price	-0.016[a]	-0.020[a]	-0.015[a]
(Birr)	0.001	0.001	0.001
Log household income	0.391[a]	0.256[a]	0.608[a]
(log thousands of Birr)	0.047	0.085	0.085
Missing wage	0.062	-0.478[b]	0.564[a]
(1 if no wage)	0.100	0.251	0.127
Number of teenagers	-0.087[b]	-0.216[a]	-0.024
(number of individuals)	0.055	0.098	0.099
Number of children	-0.305[a]	-0.221[a]	-0.239[a]
(number of individuals)	0.043	0.075	0.080
Household cost of illness	0.015[a]	-0.004	0.031[a]
(Birr)	0.002	0.003	0.004
Married	0.455[a]	0.701[b]	0.281
(1 if married)	0.131	0.434	0.183
Gender	-0.308[a]		
(1 if female)	0.070		
Read	0.299[a]	0.116	0.536[a]
(1 if read easily)	0.069	0.118	0.121
Age	-0.023[a]	-0.008[b]	-0.031[a]
(years)	0.003	0.004	0.006
Altitude	-0.095[a]	-0.098[a]	-0.026
(hundreds of meters)	0.018	0.031	0.035
Household size	-0.025	-0.098	-0.118
(number of individuals)	0.040	0.067	0.081
Intercept	2.792[a]	2.594[a]	-0.104
	0.410	0.840	0.806

Notes: Standard errors are below parameter estimates.

[a] Significant at the 5% level

[b] Significant at the 10% level

Table 7 Continued.

Variable	Reduced Model	Males	Females
Enumerator_2	-0.252	-0.119	0.349
	0.433	0.713	0.891
Enumerator_3	1.765[a]	1.416[a]	0.825[a]
	0.198	0.401	0.452
Enumerator_4	-0.949[a]	-0.339	-0.955[a]
	0.193	0.325	0.470
Enumerator_5	-0.636[a]	-1.460	1.260[a]
	0.217	0.405	0.463
Enumerator_6	1.427[a]	0.855a	1.148[a]
	0.185	0.356	0.393
Enumerator_7	-0.852	-1.114	
	0.215	0.350	
Enumerator_8	0.051	-1.426	2.313[a]
	0.246	0.710	0.744
Enumerator_9	0.026	-0.726	1.413[a]
	0.292	0.618	0.683
Enumerator_10	1.032[a]	0.193[a]	1.714[a]
	0.220	0.410	0.472
Enumerator_11	-0.426[a]	-1.043	1.079[a]
	0.207	0.386	0.431
Enumerator_12	-0.362	-0.714	1.066[a]
	0.240	0.438	0.521
Enumerator_13	1.201[a]	0.478[a]	1.557[a]
	0.213	0.366	0.453
Enumerator_14	0.865a	1.953a	-1.140[a]
	0.195	0.421	0.468
Enumerator_16	-1.693[a]	-2.151	0.418[a]
	0.345	0.507	0.722
Enumerator_17	0.131	-0.224b	0.410[a]
	0.192	0.368	0.415
Enumerator_18	0.143	-0.946	1.904[a]
	0.214	0.385	0.471
Enumerator_19	1.075[a]	0.267	1.393[a]
	0.196	0.709	0.732

Notes: Standard errors are below parameter estimates.

[a] Significant at the 5% level

[b] Significant at the 10% level

Table 8. Willingness to Pay by Respondent Gender and Marital Status (Birr)

	Hypothetical Vaccines			
	Males		Females	
	Mean	Median	Mean	Median
Married	219	151	267*	181
N	*255*		*211*	
Single	210	123	161	95
N	*11*		*92*	

* Indicates difference between mean male and female WTP is significant at 5% level

Table 9. Parameter Estimates for Insecticide Treated Net Models (n = 279)

Variable	Reduced Model	Males	Females
Price	-0.015[a]	-0.017[a]	-0.015[a]
(Birr)	0.003	0.006	0.003
Log household income	0.092	0.198	0.055
(log thousands of Birr)	0.082	0.398	0.098
Missing wage	0.047	-0.084	0.219
(1 if no wage)	0.258	0.728	0.312
Number teenagers	0.143	0.418	0.056
(number)	0.144	0.417	0.188
Number children	0.048	0.332	-0.054
(number)	0.125	0.382	0.157
Household cost of illness	-0.003	0.010	-0.009
(Birr)	0.006	0.016	0.007
Married	-0.020	0.670	-0.090
(1 if married)	0.237	0.903	0.282
Gender	0.067		
(1 if female)	0.189		
Read	0.002	0.125	-0.120
(1 if read easily)	0.200	0.506	0.285
Age	-0.010	-0.018	-0.007
(years)	0.007	0.019	0.009
Altitude	0.054	-0.003	0.084
(hundreds of meters)	0.046	0.126	0.057
Household size	0.039	-0.257	0.130
(number of individuals)	0.116	0.327	0.140
Intercept	-0.368	0.996	-1.190
	0.882	2.557	1.140

Notes: Standard errors are below parameter estimates.

[a] Significant at the 5% level

[b] Significant at the 10% level

Table 9 Continued.

Variable	Truncated Poisson	Males	Females
Enumerator_2	-0.120	-1.437	0.161
	0.405	2.064	0.448
Enumerator_3	0.729	-0.114	1.215[a]
	0.307	1.203	0.377
Enumerator_8	0.106	-0.445	0.342
	0.365	1.358	0.441
Enumerator_9	0.491	-0.357	0.931[b]
	0.377	0.926	0.524
Enumerator_10	-0.056	-1.115	0.432
	0.414	1.098	0.513
Enumerator_12	-0.783	-0.686	-1.086[b]
	0.383	0.814	0.606
Enumerator_13	0.027	-0.662	0.384
	0.438	1.106	0.578
Enumerator_14	0.511	-0.409	0.831[a]
	0.325	0.740	0.398
Enumerator_16	-0.850	-0.712	-0.664
	0.446	1.068	0.583
Enumerator_18	-0.086	-0.632	0.255
	0.397	0.901	0.511
Enumerator_19	0.058	-0.440	0.260
	0.456	1.172	0.569

Notes: Standard errors are below parameter estimates.

[a] Significant at the 5% level

[b] Significant at the 10% level

Figure 1. Malaria Incidence and Cropping Calendar in Tigray, Ethiopia

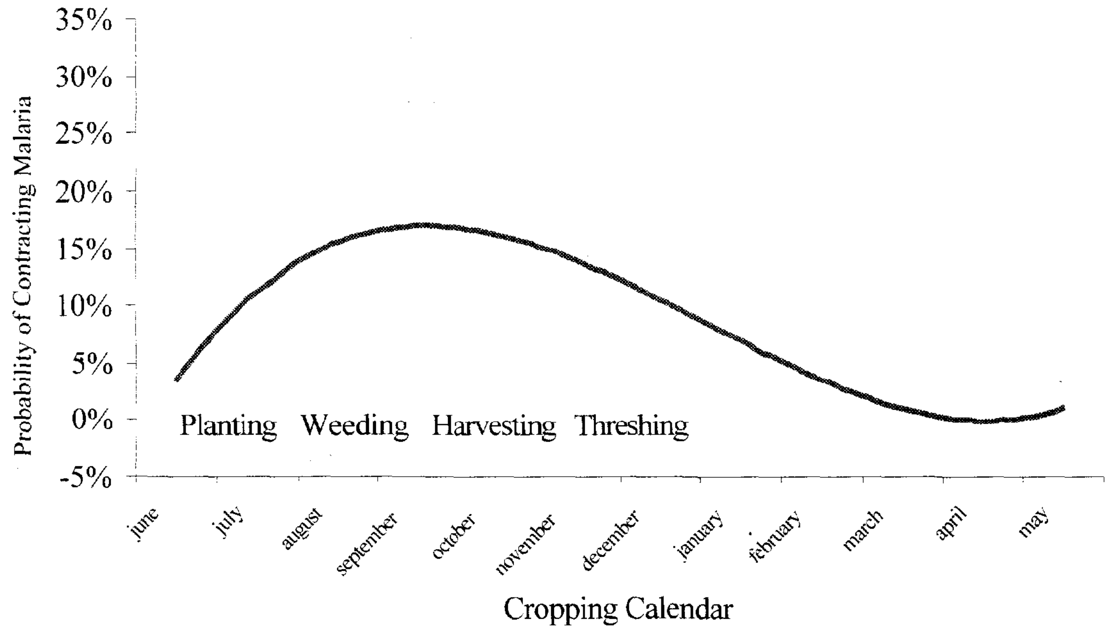

Figure 2. Simulated Demand for Malaria Vaccine in 200 Household Village