Psychology, gender, and the intrahousehold allocation of free and purchased mosquito nets*

Vivian Hoffmann♣

January 2008

Abstract: This paper reports results from a field experiment in Uganda. Whether a mosquito net was acquired as an in-kind transfer or purchased with a cash transfer affected who within the household used the net. The proportion of children five years and younger who slept under a mosquito net was 20 percent higher when nets were distributed for free compared to when an equivalent cash transfer could be used to purchase nets. This effect remains significant when controlling for the number of nets acquired. Nets purchased by men tended to be used by the household's primary income earners whereas those purchased by women were used by the household members perceived to suffer from malaria most frequently. The fact that mode of receipt affects intrahousehold allocation can be used to more effectively target interventions at the individual level.

JEL Classification Codes: C93, D13, I12, J13

* I am indebted to Chris Barrett, and David Just, and William Schulze for their guidance throughout this research. Annemie Maertens, Hope Michelson, Daniel Benjamin, Jordan Matsudaira, seminar participants at Cornell and the NEUDC, and three anonymous provided extremely helpful comments on earlier drafts. Special thanks to Gad Ruzaaza of Mbarara University of Science and Technology, to the field and data entry staff for their tireless work, and to the leaders and families of Rubagano and Kimuli for welcoming us into their communities and homes. Cornell University provided generous financial support. All remaining errors are my own.

♣ PhD Candidate, Applied Economics and Management, Cornell University

1. Introduction

Malaria kills over one million people annually, 90 percent of them children under the age of five (World Health Organization, 2004). The use of insecticide treated mosquito nets (ITNs) has been shown to reduce all-cause child mortality by one-fifth and reduce malaria episodes by half (Lengeler 2004) and is considered the most cost-effective available strategy for control of the disease (Breman et al. 2006). In 2000, 44 of the 50 malaria affected countries in Africa committed themselves to increasing the use of ITNs by vulnerable populations, in particular children under five years of age and pregnant women (Roll Back Malaria 2000). In recent years, donor funds for ITN promotion and other malaria control measures have increased dramatically (Global Fund to Fight AIDS Tuberculosis and Malaria 2007).

The appropriate mechanism of ITN delivery—free distribution versus some degree of cost recovery—is hotly debated (Muller and Jahn 2004). While mass distributions of free nets to families with young children have recently been undertaken in a number of African countries, this policy is widely considered fiscally unsustainable.[1] Some also argue that paying for goods motivates people to use them (PSI 2006). Indeed, recent work has shown that higher prices can serve to screen out those who will not use health goods consistently (Ashraf et al. 2007).

Although public health messages emphasize that children should use mosquito nets, some studies have found that when a household does not have enough nets to cover all members, scarce nets are often used by adults rather than children (Korenromp et al. 2003, Mugisha and Arinaitwe 2003). On the other hand, studies tracking the usage of nets given to pregnant women have found

[1] Interviews with Connie Balayo, National Malaria Control Program, Uganda (August 2006); Ali Abdullah Suleiman, Zanzibar Malaria Control Division (April 2007).

that the vast majority of these are used by the women and their newborn infants (Guyatt and Ochola 2003, Dupas 2005). These contrasting results raise the question of whether free net receipt, gender of the net recipient, or the child health message that usually accompanies free nets is responsible for the apparently higher rates of child usage achieved through free distribution programs. In this paper, I analyze the determinants of intrahousehold mosquito net allocation, including the gender of the member who obtained the net and whether the net was purchased or received in kind, holding information and wealth effects constant.

The way in which mosquito nets are distributed varies across and even within countries. However, comparing the intrahousehold allocation of nets across program boundaries is problematic because of spatial variation in both malaria endemicity (which affects adult immunity to malaria) and cultural norms. Using an experimental approach, it is possible to randomize the mode of distribution within one locality and thus to cleanly identify the effect of the distribution policy.

I conducted a field experiment in an area of seasonal malaria transmission in western Uganda. Participants were randomly assigned to receive either cash or ITNs, and then had the opportunity to trade the ITNs for cash or vice versa. In nighttime checks of net usage three weeks later, nets that had been received in kind were more likely to be used by young children. Purchased nets were used more often by the individuals who had purchased them, the primary income earners, and those perceived to suffer from malaria most frequently.

In the following section I review the literature on the household economics of malaria. Findings from the behavioral economics and intrahousehold decision-making literatures which may underlie differences in the usage of free and purchased nets, and in the usage of nets acquired by men and women, are summarized in Section 3. Section 4 discusses the conceptual framework. I describe the setting and baseline data collection in Section 5. Section 6 presents the experimental design and Section 7 describes results. Discussion and concluding remarks follow in the final two sections.

2. Household economics of malaria

Malaria is caused by a parasite that requires both human and mosquito hosts to complete its life cycle. If not treated properly, malaria parasites can remain in the human body long after symptoms subside, causing repeated episodes of illness. With treatment and avoidance of re-exposure, malaria can be cleared from the system completely. In East Africa, the most common species of malaria-transmitting mosquito bites primarily late at night, so that sleeping under a mesh mosquito net is a highly effective means of avoiding infection.

While adults in malarious regions have typically acquired some immunity to the disease through repeated exposure over the course of their lives, they may still suffer symptoms and even death due to malaria. Adults' symptoms are more serious in regions where malaria transmission is seasonal, since immunity diminishes after several months without an infective bite. However the risk of severe malaria resulting in lifelong disability or death is highest for young children and pregnant women across transmission environments (Snow et al. 2003, pp. 11-12). On the other hand, lost labor time often accounts for the largest portion of the private cost of the disease (Cropper et al. 2004). This implies a tradeoff between minimizing the income lost to malaria and minimizing the risk that a household member dies or is permanently disabled, particularly in areas of lower transmission intensity.

Lack of knowledge about the particular vulnerability of young children and pregnant women, as well as non-unitary preferences within the household, imply that an observed allocation of mosquito nets may not maximize household welfare. Determining the welfare-maximizing allocation of nets is beyond the scope of this paper. Rather, I take as given the stated public health priority of covering young children and compare the effects of two net distribution policies on this outcome.

Studies of particular programs in which nets were given for free to expectant mothers suggest that this is an effective way of targeting nets to infants. Guyatt and Ochola (2003) and Dupas (2005) both found that 85 percent of nets given to pregnant women were used by their intended recipients. Guyatt and Ochola, studying two districts in Kenya, noted a lower rate of net use among newborns in the district with lower malaria transmission intensity (80 vs. 91%), where adults tend to suffer more serious symptoms.

In contrast, studies using a broader sample of households, among which many nets are likely to have been purchased through market channels, give inconsistent results on children's net use. Using data from the 2000-2001 Demographic and Health Survey (DHS) in Uganda, where there had been no widespread distribution of free nets, Mugisha and Arinaitwe showed that the coverage of young children in that country was largely incidental to sharing a bed with an adult: children who slept in the same bed as an adult were 22 times more likely to be sleeping under a net than other children (Mugisha and Arinaitwe 2003). A cross-country study using DHS data from 12 African countries revealed that children were no more or less likely than adults to use nets (Korenromp et al. 2003). However more recent work conducted in five African countries after widespread free distribution of nets found that young children were prioritized for net use (Baume et al 2005).

Most of the above studies relied on questions about who slept under a net the previous night. To the degree that respondents believe survey staff have preferences about the allocation of nets, these recall responses may be biased. The only exception is as study by Alaii et al. (2003), who physically checked net usage during the night. This study also represents the only investigation of why young children do not use nets. Even though all study participants were given enough nets for their entire household, under-fives were 14 percent less likely to use a net than others. In this setting of year-round high transmission intensity (and resulting relatively strong immunity outside early childhood), primary reasons reported for lack of net use by under-fives were temperature and the disruption of usual sleeping arrangements. The present research was conducted in an area of low transmission intensity, where adults typically suffer the symptoms of malaria if infected and economic factors may therefore play a stronger role in the intrahousehold allocation decision.

3. Household decision-making and psychological effects

The most basic microeconomic model assumes that the household behaves as a unitary decision-maker and pools income from all sources to maximize a single utility function. According to this model, the intrahousehold allocation of a good will not depend on who within the household acquires it, nor will the way in which a good is obtained determine its use. However, empirical studies of intrahousehold allocation routinely reject the unitary household model. Further, the behavioral economics literature documents systematic ways in which the assumption of income pooling is violated at the level of the individual. Mental accounting, loss aversion, and guilt aversion are three psychological mechanisms that may lead to differences in the usage of mosquito nets that are purchased and those that are received in kind.

Mental accounting

One phenomenon that is well established empirically but runs counter to standard theory is that income has limited fungibility (Thaler 1990). People tend to organize financial transactions into separate mental accounts linked to different needs, so that how money is spent depends on how it was acquired. For example, child tax benefits increase expenditures on children's clothing even though there are no rules about how these transfers should be spent (Kooreman 2000). In a rural African setting, Duflo and Udry (2004) showed that income derived from certain crops was associated with expenditures on children's education and food while the income from other crops was associated with private and adult goods, even when the two income streams were under the control of the same individual. In the rural Ugandan villages where the present study was conducted, purchased items may be associated with adult use whereas children are more likely to use goods received for free or handed down from adults. Indeed, the average household in the sample spent less than a dollar on children's clothes and shoes over the past year compared with over $18 on adult clothing and footwear.

Loss and guilt aversion

Another finding from behavioral economics is that utility is reference dependent and that losses relative to a reference point loom larger than gains. Tversky and Kahneman (1991) developed the theory of loss aversion to explain their experimental finding that people charge more to sell a good than they are willing to pay to acquire the same good, a phenomenon known as the endowment effect. Loss aversion has been shown to differ across both gender and goods, being more common among women than men (Brooks and Zank 2006) and stronger for goods with a public good component or moral attribute (Boyce et al 1992, Irwin 1994).

Boyce *et al.* (1992) ran an experiment in which subjects were assigned the opportunity to either buy or sell a houseplant in a kill or a not-kill treatment. Buyers (sellers) were asked to state their maximum willingness to pay (minimum willingness to accept cash) for a plant. In the kill treatments, all plants left over after bidding (buying treatment) or sold back to experimenters (selling treatment) were killed. In the not-kill treatments, no plants were killed. Selling offers in the kill treatment were much higher than in the not kill treatment, but bids to buy plants were only slightly higher in the not kill treatment, suggesting that the responsibility for the life of the plants was more keenly felt when participants owned the plants.

Irwin (1994) elicited subjects' hypothetical willingness to pay and willingness to accept payment for changes in environmental states and private goods, as well their as rankings of the goods in terms of public benefit and moral value, and verbal accounts of the decision-making process. She concluded that moral and public good attributes were more salient in the decision to accept payment, whereas personal gain was the main consideration when deciding whether to pay for something.

One possible explanation for the greater salience of public good attributes in selling modes is guilt aversion, the idea that decision makers experience guilt if they believe they let others down (Charness and Dufwenberg 2006). Charness and Dufwenberg's formulation of this concept requires an external actor with expectations. However the Boyce et al. and Irwin experiments suggest that guilt can also be experienced and influence decisions without the presence of an external judge. If a mother receives a mosquito net for free in conjunction with a message that sleeping under that net can save the life of her child, she may perceive that using the net for her child is the right thing to do. Selling the net, or using it for herself rather than the child would trigger feelings of guilt. Receiving the same information, as well as the resources to purchase a net, may not trigger the same perception of obligation to buy the net and use it for the child.

Gender accounts

Many programs aim to improve child development outcomes by targeting resources to women, based on the assumption that mothers care more about their children than fathers do. Stated preferences have been shown to differ systematically by gender (Kusago and Barham 2001), and the share of income earned by women is indeed positively associated with expenditures on child health across a wide range of settings (Thomas 1990, Bourguignon et al. 1993, Browning et al. 1994, Hoddinott and Haddad 1995, Phipps and Burton 1998). These empirical results reject the unitary model of the household in favor of a bargaining model in which each adult member maximizes his or her individual utility function. In such models, the intrahousehold allocation of goods depends upon the resources controlled by and outside options available to the various household decision-makers (Manser and Brown 1980, McElroy and Horney 1981, Ulph 1988, Lundberg and Pollak 1993, among others).

The empirical studies cited above do not generally control for how income is derived.[2] In general, if income streams associated with child consumption (for example, gifts or government child subsidies) are primarily received by women, such analyses may overstate the impact of gender-specific preferences. Thomas (1990) showed that unearned income under the mother's control has a much greater effect on child survival than does father's income, but noted that the composition of unearned income differs markedly by gender, with women deriving a much greater share from pensions and social security relative to men, who earn a greater portion from financial and physical assets. Hoddinott and Haddad's (1995) analysis relied on attributing

[2] Duflo's (2003) paper showing that the gender of old-age pensioners in South Africa affects child health is a notable exception.

certain crops to male and female control, leaving open the possibility that income from particular crops (perhaps those usually under female control) is associated with public goods expenditures as found by Duflo and Udry (2004).

It is worth noting that the way in which nets are allocated may differ across gender because of differences in the way that men and women value the health of children relative to other household members, or because of gender-specific roles household responsibilities as in Lundberg and Pollak's separate spheres model of marriage (1993). For example, if men control a grater share of the income earned by other household members than women do, one would expect the variation in individual incomes to play a stronger role in men's allocation decisions. If women bear most of the burden of caring for sick household members, they may prefer to give nets to those members they expect to suffer from malaria most frequently.

Using an experimental approach, it is possible to empirically distinguish the effect of gender and the psychological effect of the form in which income is received. Doing so in this paper, I find that giving mosquito nets in kind rather than selling them has a significant effect on child usage, while targeting transfers of nets or cash to the female rather than the male guardian does not.

4. Conceptual framework

Whether a child sleeps under a mosquito net requires first that one or more nets are acquired by the household and second that the child is given one of these to use. Denote the probability of purchasing n nets as buy_n, and the conditional probability of a child sleeping under one of these as $cu(\cdot \mid buy_n)$. Suppose one of the child's guardians, denoted *i*, has an opportunity to purchase between 0 and *N* nets, where *N* is the number of nets required to cover all household members, at a price of *p* per net. The overall probability of a child using a net can be written as:

$$CU_b^i = \sum_0^N buy_n(W_i, X_i, Z_h, p) \cdot cu(n, X_i, Z_h \mid buy_n). \tag{1}$$

In this formulation, the decision to purchase a given number of nets depends upon *i*'s cash on hand W_i, individual and household attributes X_i and Z_h, and the price *p*. The probability of the child using a net given that *n* nets have been purchased depends upon *n* as well as on the characteristics of the guardian who purchased the nets and of the household. The probability of a child gaining access to a net when guardian *i* receives a transfer of $\overline{N}_i$ nets can similarly be written as:

$$CU_f^i = \sum_0^{\overline{N}} retain_n(\overline{N}_i, X_i, Z_h, \overline{p}) \cdot cu(n, X_i, Z_h \mid retain_n), \tag{2}$$

where $retain_n$ is the probability that *n* of the nets that have been received are retained by the household. Retention depends upon how many nets were received, the resale price $\overline{p}$ that can be obtained for the nets, and the guardian's individual and household attributes. The endowment effect implies that buy_n and $retain_n$ may differ for given values of their arguments. Recent work on the use of a home chlorination treatment for drinking water finds weak evidence that the act of paying positively influences usage, but no evidence that that the price paid has any effect (Ashraf et al. 2007). Allowing *cu* to depend on whether nets were retained or purchased explicitly allows for the possibility that paying affects the usage of nets.

In a separate paper, coauthors and I use data from the experiment described here to show that, due to both wealth and endowment effects, nets are much more likely to be retained if received for free than they are to be purchased out of own resources (Hoffmann et al. 2007). The present paper focuses on usage of nets by young children under these two distribution mechanisms and in particular on the difference between $cu(\cdot \mid buy_n)$ and $cu(\cdot \mid retain_n)$. I also investigate whether the probability of a child using a net depends on the gender of the household member who acquired it.

5. Setting and baseline data collection

At the time data were collected in October and November of 2006 there had been no large-scale distribution of free or subsidized ITNs in Uganda. Conventional nets were available in weekly rural markets at a price of approximately $2.72 US, and higher-quality nets bundled with insecticide treatment kits were available in Mbarara, the nearest urban center, for twice this price.[3] The long-lasting insecticidal nets (LLINs) offered through the experiment described here were not commercially available in Uganda. These LLINs are much more durable than other nets, with an estimated 5-year lifespan compared to about one year for the highest quality conventional ITNs. LLINs do not need to be annually retreated with insecticide as do conventional ITNs and are recommended by both the World Health Organization and the Ugandan Ministry of Health.

Mbarara District was chosen for its seasonal transmission pattern of malaria and resultant low adult immunity, allowing identification of the income versus child health tradeoff. To ensure ease of tracking project nets, the sub-county with the lowest baseline net ownership per capita

[3] Return transportation to Mbarara cost US $7.63.

was chosen.[4] The experiment was conducted in Rubagano and Kimuli, villages 10 kilometers apart with populations of approximately 1300 and 900 respectively.

Households with children aged up to five years or a pregnant woman were eligible to participate in the study. A list of all households in each village meeting eligibility criteria was provided by the village chairmen. In order to separately identify the effects of gender-specific preferences and control over income, households were stratified by the marital status of the head. All 41 of the single-headed households identified, 38 of which were headed by women, were selected for inclusion in the sample. An additional 102 of the eligible dual-headed households were randomly selected. Respondents were not necessarily parents of the children under their care: 12 percent of the households interviewed contained at least one child aged five years or younger who was neither the son nor daughter of the head or spouse. All of these children were however relatives of the respondent.

A questionnaire covering demographic information, malaria history and income-generating activities of each member of the family as well as household consumption expenditures was administered during an initial household visit. Which members usually shared a bed or sleeping place was also recorded. Respondents were asked to recall food consumption over the past week, non-durables and services purchased over the past month, and less frequent but regular expenditures such as educational expenses and purchases of clothing and household items over the past year.

[4] The number of nets per capita treated with insecticide in the government's 2005 retreatment campaign (according to district health center records) was used as a proxy for per capita net ownership.

Average consumption value per capita among the sample was US $0.65 per day, excluding expenditures on health care. While values are not strictly comparable because of differences in data collection methods, this is close to the US $0.59 daily per capita private consumption expenditure reported by the World Bank for Uganda in 2005. Almost all households in the sample derived at least some of their living from farming, and home produced goods accounted for 43 percent of total consumption value on average.

Respondents were asked to state the hours worked by each member of the household on own farm, livestock, non-farm enterprises during the past week, how much it would cost to pay someone to do this work, and who in the household primarily controlled the income derived through this activity. The median reported hourly value for each activity was calculated and this activity-specific wage was multiplied by the number of hours worked.[5] Reported earnings from paid jobs during the past week were added to calculate individual incomes.

Respondents reported significant expenditures as a result of malaria: the mean and median costs incurred as a result of the most recent malaria episode, including transport, consultation fees and drugs, were $13.55 and $5.45 respectively. Eighty-seven percent of individuals in the sample were reported to suffer from malaria at least once each year, and 79 percent of respondents claimed to know someone who had died of the disease. Admissions data obtained from the sub-county local health clinic showed that over the past year, 40 percent of visits by children younger than 5 years and 54 percent of visits by older patients were malaria-related. Only six of the 143 households interviewed owned any mosquito nets at the time of the initial household visit. Of the 15 individuals in these households using nets, three were five years or younger, and all three were sharing the net with at least one adult.

[5] Wages for men and women did not differ significantly so a single wage was calculated for each activity.

6. Experimental design

Treatment assignment

Either the husband or wife in each of the dual-headed households was randomly selected to represent the household in one of fourteen bidding sessions held over five days beginning one week after the last household interview. Approximately half of the participants in each category (married men, married women and single heads) were randomly assigned to receive a cash transfer, the other half to receive mosquito nets. Bidding sessions were held separately for the two treatments, with seven sessions for each.

Table 1a shows the number of participants in each treatment by headship and gender. Participants who missed their assigned session were allowed to attend a later session. An effort was made to reassign the participants to a session of the same treatment, however this was not always possible. Staff and participants were unaware until a session began whether it would be an in-kind or cash transfer session. The reassignment of individuals between treatments is therefore unlikely to have introduced bias.

A significant number of households sent a representative other than the one randomly assigned. This person was asked to return home and send the assigned participant. If the representative insisted that the assigned participant was absent and would not be able to attend an alternative session, other community members were asked to verify this. In several instances, others contradicted the claim of the household representative and the intended respondent was eventually found. However for 9 of the 143 participating households, a non-randomly assigned individual participated. I retain these households in the analysis presented. The results are robust to their exclusion as well as to using an intent-to-treat approach in which assigned rather than actual gender is used.

Eleven households containing no children aged five years or younger were dropped from the analysis. Two of these had been included in the initial sample because they contained a woman who was or might soon become pregnant. Although an effort was made to replace households not meeting the eligibility criteria, lack of eligibility was not always discovered before the interview was initiated, resulting in the inclusion of nine ineligible households in the initial sample. As shown in Table 1c, the vast majority of these were single headed households. An additional household whose members could not be located for a follow-up visit to observe net usage is also excluded from the analysis.

Balance across treatments

Randomization implies that the characteristics of participating households are uncorrelated with the treatment in expectation. To test whether randomization was in fact successful, I compare the means of observed household and participant characteristics across treatments and gender categories in Table 2. Indeed, randomization on observables was successful, with none of these variables differing at the 10 percent level of significance.

The gender and headship categories reveal differences between men and married women, and between single and married women. The share of income controlled by men is significantly higher than that controlled by married women ($p<0.01$). Single women likewise control a greater proportion of household income than married women ($p<001$). Single female heads are significantly older and less educated than married women, and the demographic composition of single-headed households differs markedly from that of dual-headed households. Single headed households have fewer members overall, with fewer young children and adults aged 15 to 59, and a greater number of elderly members. Many of the children cared for by single female heads are grandchildren or other relatives.

Notably, respondents perceived children aged 5 years and younger to suffer from malaria less frequently than older individuals ($p<0.01$).

Experimental procedures

Households in the free nets treatment were assigned a transfer of one, two or three 190 by 180 centimeter Olyset brand nets. Those in the cash treatment received a transfer of the maximum possible price of one, two or three nets.[6] The transfer of nets or cash was intended to be sufficient to acquire nets for all household members. In calculating how many nets or how much cash to give to a family, I assumed that individuals already sleeping in the same bed would share a net. I also assumed that separate beds could be moved together in order to share nets if necessary. According to this logic, each household received nets or the cash equivalent equal to the minimum of the following: the number of distinct sleeping sites in the dwelling, the number of household members divided by two and rounded up to the next integer, and three. The maximum of three nets was due to a project budget constraint. Since nets were large enough to cover up to four children, even the largest households in the sample, which contained eleven members, would be able to cover all of their members. Separate sessions were held for households receiving one net, two nets, and three nets, and for those receiving a cash transfer of $7.63 (the maximum possible price of one net), $15.26, and $22.89.

[6] Olyset nets are recommended by the World Health Organization and the Ugandan Ministry of Health. $7.63 US (14,000 Ugandan Shillings) is the approximate wholesale price of these nets in Kenya (they are not commercially available in Uganda); the manufacturing cost is approximately $5 US.

At the beginning of each session, participants were given their transfer of nets or cash, according to the treatment. They were told that this gift of nets or cash was compensation for participation in the study, and that they could exchange or keep and use this compensation as they wished. Participants in all sessions were read the same statement about malaria. This included the following passage about the particular vulnerability of pregnant women and children (see Appendix for the full script):

> Malaria is more likely to be serious for young children and pregnant women. In Uganda malaria is the number one killer of children under 5 years, and is responsible for 6 of every 10 miscarriages. Grown men and women who are not pregnant may also become sick with malaria and may die, but they are less likely to die of malaria than young children and pregnant women. Severe malaria can also cause mental retardation, blindness, and deafness in children.[7]

Staff demonstrated how to hang a mosquito net and tuck it under the corners of the bed or sleeping mat. A villager who had received six of the same brand of LLIN through a UN project several months earlier told the group that these nets killed mosquitoes and had prevented malaria in her family during the time they had used them.

Participants then had the opportunity to exchange nets for cash or cash for nets using the Becker-deGroot-Marschak mechanism (Becker *et al.* 1964). This mechanism is commonly used in experimental economics because it is preference-revealing. The basic mechanism works as follows. Participants enter bids before the price of a good is revealed. The price is then randomly drawn from a distribution of possible prices. Participants in a buying treatment who

[7] Information adapted from the Uganda Ministry of Health (2006).

bid at or above this randomly drawn price purchase the good at the drawn price and keep the remainder of any cash transfer they have received. Those who bid below the price do not purchase the good, keeping instead the entire cash transfer. The mechanism works because it is in the best interest of participants to bid according to their actual valuation of the good on offer. Those who bid less than their true value risk not buying the good when the price is low enough that they would in fact prefer to buy. Conversely, bidding above one's true value risks buying when the price is higher than one would actually be willing to pay.

Before bidding for mosquito nets, three non-confidential practice rounds were conducted in which food items and pencils were exchanged for cash. In the free net sessions, participants were given food and pencils which they could keep or sell. In the cash transfer sessions participants were given cash which they could keep or use to purchase these goods. For each practice round, as well as the final ITN round, bidding proceeded as follows. One of the experimenters explained the bidding procedure, and for each item, told participants the possible prices that could be drawn as he placed one ping-pong ball representing each of these possible prices in a bucket. For all sessions, the possible prices were uniformly distributed from $0.54 to $7.63 in increments of $0.54. Participants were given tokens representing currency, which they placed in envelopes to indicate their buying bids or selling offers. Those who had received cash indicated the maximum they were willing to pay and those who had received nets, the minimum they were willing to accept, for three items (in the three net sessions), two items (in the three net and two net sessions), and one item (in all the sessions). By requiring separate bids for the first, second and third nets, the marginal willingness to pay for each net was observed. Staff were available to assist with bids if needed, but participants were asked to keep their net bids as confidential as possible.

After all bids had been recorded (and in the practice rounds displayed), one of the participants drew a ball to select the price. In cash transfer sessions, participants who had bid at least as much as the drawn price for a given number of goods exchanged cash for that number of goods. For example, in a cash transfer session where the price drawn was p, if a participant bid at least $3p$ for three nets, he would buy all three nets at the total price of $3p$. If he bid less than $3p$ for three nets but at least $2p$ for two nets, he would buy two nets for $2p$, and if he bid less than $2p$ for two but more than p for one, he would buy one net at price p. Finally, if he bid less than $3p$, less than $2p$, and less than p for three, two and one net, respectively, he would keep all the cash and receive no nets. Transactions for the in-kind transfer sessions followed the same logic, with participants selling back the nets they had been given at the randomly drawn price.[8] The number of nets offered, number of participants, and price realizations for each session in the in-kind and cash transfer treatments are reported in Tables 3a and 3b.

Before consenting to participate, all participants were told that if they purchased or retained any nets, survey staff or village leaders would visit them at night to see how these were being used. Participants could request that either a fellow community member or member of the survey staff would perform this task. They were not informed of the date on which this the visit would occur. Home visits by community leaders were conducted between 9 pm and midnight on one night per village, three weeks after the bidding sessions. A few days later, again on a single night per village, survey staff visited the homes of those who had requested that an outsider conduct the net use check. During these visits, the net usage of each household member was recorded.

[8] Two participants desired to change their bids after the price for nets was drawn. They were allowed to do so and their bids were altered accordingly.

7. Results

Net purchase and retention

As respondents' willingness to pay for and sell nets received in kind is the subject of a separate paper (Hoffmann et al. 2007), the following discussion concerns primarily the intrahousehold allocation of nets. However, a brief summary of the bids and resulting distribution of nets across treatment groups is in order. Consistent with the endowment effect, those in the free nets treatment entered bids higher by $1.22 on average than those in the cash transfer treatment, resulting in a greater average number of nets per capita owned in the in-kind group (Table 4). Most of this difference is accounted for by those households in the cash group that did not buy any nets; conditional on acquiring at least one net, the number of nets per capita is almost equal across treatments. Some nets of the nets acquired through the experiment were observed but had not been hung at the time of the follow-up visit. Among the free nets group, 10 percent were not using at least one of the nets they received; 13.5 percent of the cash transfer group were not using at least one net.

Individual usage

Looking first at the usage rates across age and gender categories (Table 5), the elderly, women of child-bearing age, and other adults are the most frequent users of nets.[9] Children five years and younger follow, with older children the least likely to be covered. Usage is slightly higher overall among the group that received nets, even conditional on having acquired at least on net. The only group for which this is not the case is adults other than women aged 15 to 45, who have lower mean usage in the free nets group than the cash transfer group, conditional on acquiring at least one net. Because pregnancy is not reliably observed, and because women of childbearing

[9] I do not test for significance of differences among proportions because individual outcomes are correlated within households.

age are also income earners and often share a sleeping place with the household head, I focus on the net usage of children aged five years and younger in the following discussion.

As described in Section 4, net allocation depends on two separate but related decisions. Participants decide both how many nets to purchase and, conditional on this, how to allocate these nets among household members. Both decisions clearly affect children's usage of nets. The most basic and arguably most policy-relevant comparison across treatments does not separate the effect of these two decisions. Table 6a shows the household-level proportion of children aged five years and younger using nets in the free nets and cash transfer groups. Households that did not acquire any nets through the experiment are assumed not to have changed their usage since the baseline survey. The last cell in the first column of Table 6a shows that child coverage in the free nets treatment is 20.5 % higher on average than in the cash transfer treatment. This difference is significant at the one percent level.

Part of the difference in child coverage arises from the fact that due to the endowment effect, a greater number of nets were retained by those that received nets. Restricting the sample to those who acquired at least one net through the experiment, the number of nets per member is almost equal across treatments, with 0.40 nets per member in the cash transfer treatment and 0.42 among those receiving nets in kind. Among this subsample, children's usage still differs across treatments, albeit by a lower margin at with less significance (Table 6b). This result suggests that conditional on the number of nets owned, the intrahousehold allocation decision depends upon the way in which nets were acquired. Splitting the sample by gender, the difference in children's usage across treatments is significant only among women: 75.6% of children five years and younger use a net if a female guardian purchases at least one, whereas 81.7% percent of such children use a net if a female guardian is given nets and retains at least one, with the

15.1% percentage point difference significant at the ten percent level. The point estimate of the difference is almost identical for single and married women. Whether a male guardian purchases nets or receives them for free has a small and statistically insignificant impact on who uses them. The share of children using nets when the nets were received or purchased by men (pooling treatments) is not significantly different from the proportion using nets if they were acquired by a married woman.

Multivariate analysis of children's usage

Next I turn to a multivariate analysis of the same outcome. The primary regressors of interest are a binary variable indicating that the participant received nets in kind, another indicating that the gender of the participant was female, and the interaction of these terms. The first three columns of Table 7 present results from a linear probability model of net usage. As shown in the simple comparisons of means above, higher child coverage is achieved when nets are given in kind. Households that received nets covered an estimated 11.8 percent more of their young children than households that received cash, controlling for the number of nets acquired. Also as above, there is no effect of a woman receiving the nets or cash rather than a man (column 2). The interaction of treatment and gender in is insignificant, suggesting that the impact on allocation of receiving free nets is not particular to women (column 3).

Simply controlling for the number of nets acquired is problematic since this is a choice variable. I therefore use the number nets given or offered for sale to the household as an instrument. Recall that the number of nets or amount of cash that given to a participant depended upon the household size and number of distinct sleeping places according to the formula *min*{round(household size/2), number of distinct sleeping places, 3}. Due to the upper limit on the transfer and the discontinuous nature of this function, significant variation in the size of the transfer remains after controlling for household size, number of distinct sleeping places, and members per sleeping place, all of which are likely to be directly correlated with children's net usage. Because the number of nets available may affect purchases differently from retention, I include the interaction of treatment and nets available as a second instrument.

Controlling in addition for the variables of interest, the excluded instruments are highly significant predictors of nets acquired, with a joint F-statistic ranging from 14.69 to 18.87 in the OLS specifications shown in columns (4) through (6) of Table 7. I use a limited information maximum likelihood (LIML) estimator due the superior small sample properties of this estimator compared with two-stage least squares (Anderson et al. 1982).[10] The results in column (7) indicate that controlling for the number of nets acquired in this way, receiving nets in kind leads to a higher rate of use among children. Again, there is no difference in children's usage when the nets are received by women versus men nor does the effect of free receipt differ significantly by gender.

The question arises of which if any household members lose access to nets as a result of increased child coverage. Performing the same regressions with the proportion of different groups using nets as the dependent variable reveals no evidence that nets received in kind are less likely to be used by children aged 6 through 14 or adults (not shown). Rather, the number of people sharing each net appears to increase when nets are received for free. Table 8 shows results from the same specifications as presented in Table 7, with proportion of all household members using nets as the dependent variable. The free nets dummy is positive and weakly significant in the instrumented specification. Notably, nets received or purchased by married women are more intensively used, with 11 percent more household members covered compared

[10] Tobit and two stage least squares models give qualitatively similar results.

to when a married man purchases or receives the nets. This effect is significant at the 5 percent level. The free nets × female interaction term has no effect on total household usage.

Determinants of individual net usage

I explore the determinants of net usage with a probit regression of individual net usage on individual characteristics and household controls. The dependent variable is equal to one if the person was using a net at the time of the night-time visit and zero otherwise. Individuals in households that did not purchase any nets are assumed not to have changed their ITN usage since the time of the baseline survey. Explanatory variables of interest are the share of total household income earned by the individual, age, and binary variables indicating that the individual personally received the transfer of nets or cash, whether the individual "usually gets malaria every year" according to the respondent in the baseline interview, and whether the individual is aged five years or younger and a child of the participant who received the transfer. As for the household model, I use the number of nets offered as an instrument for the number of nets acquired, controlling for the household size, number of distinct sleeping places, and people per sleeping place. Standard errors are clustered by household.

The results, given in Table 9, suggest that when purchased with a cash transfer, nets are more likely to be used by the individual who personally purchased them, by those contributing most to household income, by those perceived to suffer from malaria most often, and by older individuals. Recall from the discussion of baseline characteristics that adults are perceived as suffering from malaria more frequently than young children. In contrast, nets received for free are more likely to be used by children. The coefficient on the child dummy differs between treatments at the 5 percent significance level.

Differences across gender

Next I split the sample by gender to explore how net allocation differs by gender and by mode of acquisition within gender categories. Because of the multiple dimensions along which single and married women differ, differences in outcomes between these groups cannot be attributed to headship alone. Moreover, after dropping households with no children aged five or younger only 30 single female-headed households remain. For both reasons, I pool the single and married households with female participants for this analysis.

In the first set of models, presented in Table 10, I control for the number of nets acquired per member without instrumenting, and include only those households that acquired at least one net through the experiment. These results serve to illustrate how nets were used by each subsample, though differences in the determinants of allocation across treatments may be driven in part by the correlation between the net purchase and allocation decisions. Earnings affected allocation only for male participants in the cash transfer treatment. Among those households in which the male head purchased at least one net, a member earning one hundred percent of household income was 73 percent more likely to be using a net than a member not earning any income (Table 10, column 8). When a man purchased one or more nets, he always used one of these for himself.

Women in the cash transfer treatment were also likely to use nets themselves, though the effect is not as stark as for men. In addition, women favored giving nets to those household members perceived as suffering from malaria each year. As in the previous set of models, young children and older members are more likely to use nets received in kind. The treatment effect on child usage is significant at the 5 percent level for both men and women. Age is a significant predictor of net use across most gender and treatment categories.

In order to separate the allocation decision from the net purchase decision within the male and female subsamples, I again turn to an instrumental variables approach (Table 11). Splitting the sample by both treatment and gender, the instrument becomes weak for the cash transfer sub-groups, causing standard errors to become large, especially for the male sub-sample. However the same basic results hold as shown above. Women who purchase nets are more likely to use these for themselves and for household members they perceive to suffer from malaria most frequently. Men who purchase nets favor older household members. The child dummy is positive and significant for the free net subgroup within both genders, and also for the female cash transfer group.

8. Discussion

The above results show that the determinants of net allocation when nets are purchased (income, perceived frequency of illness, and own receipt) are not significant predictors of nets which are received in kind. Rather, young children, whose vulnerability to malaria is highlighted in a message accompanying net distribution, are more likely to use nets received for free. The allocation of nets without the message about child vulnerability is not observed, but it is worth noting that unless nets are received in kind, young children are less likely to use nets than other household members, suggesting that information alone has a limited effect on behavior.

The behavioral economics literature suggests several possible explanations for why nets received for free are more likely to be used for children. The effect could be due to mental accounting, with free goods more closely associated with children and purchased goods associated with adults. Alternatively, receiving enough nets for all family members may have led participants to perceive the status quo as all members using a net. If those who received cash had a different perception of the status quo, and if child health is subject to greater loss aversion than adult health, this could explain the observed difference in usage across treatments. Finally, if participants' perceptions of the researchers' beliefs—or their own beliefs—about who should use the nets varied across treatments, guilt aversion could underlie the differences in net usage. Even with identical verbal messages, the normative message implicit in giving a net versus giving cash could lead to such a difference in beliefs across treatments.

The question arises over whether the fact that people knew they would be monitored is the degree to which the knowledge of future monitoring affected usage differentially across treatments. Indeed, community-based monitoring is considered a highly effective strategy for increasing compliance with pharmaceutical regimens to treat tuberculosis (WHO, 1997). The same may be true for usage of mosquito nets, and may be justified given the positive externalities in reducing malaria transmission associated with high community-wide levels of insecticide treated net usage (Hawley et al 2003).

8. Conclusions

Distributing nets for free leads to a greater number of children covered, even when households are able to afford to purchase nets for the entire family. This result is partially due to the endowment effect: the number of free nets retained is higher than the number of nets purchased with a cash transfer of equal value. However the difference in allocation patterns persists even when conditioning on the number of nets owned. Contrary to the received wisdom that women care more for their children than men, women are generally no more likely than men to use nets for children. Women do however tend to cover a larger proportion of household members with the nets they acquire.

While it is not possible to distinguish among the various possible psychological mechanisms driving these results, the evidence presented here does suggest that free and purchased mosquito nets are allocated differently. When a mosquito net has been purchased, the decision of who will use that net appears to turn on an economic cost-benefit calculation, with income-earners and the individual purchasing the net prioritized for net use, as well as those perceived as suffering from malaria most often. On the other hand, receiving a net in kind induces parents to allocate nets to children in accordance with a message emphasizing their particular vulnerability.

The health benefits of many goods, including mosquito nets, depend upon their allocation within the household. It is broadly recognized that parents may have heterogeneous preferences and keep separate accounts. The stylized fact that women value child health more than men is often used in the design of programs to promote child health. Less well understood is the link between how a good is obtained and how it is used, though this area is drawing increasing attention. The finding that intrahousehold allocation of a good is affected by the way in which it was obtained has implications for the design of programs targeting particular groups at the sub-household level. Such targeting may be appropriate if the preferences of household decision-makers are at odds with social preferences, or if decision-makers misperceive the relative vulnerability of household members.

Tables

Table 1a: Sample by headship, assigned treatment, and gender of assigned participant

		Received nets	Received cash	Total
Dual headed	Male	25	25	50
	Female	25	27	52
Single headed	Male	1	2	3
	Female	20	18	38
Total		71	72	143

Table 1b: Dual-headed households sending non-assigned participant, by assigned treatment and gender of assigned participant

		Received nets	Received cash	Total
Dual headed	Male	3	2	5
	Female	2	2	4
Total		5	4	9

Table 1c: Households with no children under 5 years, by headship, assigned treatment, and gender of assigned participant

		Received nets	Received cash	Total
Dual headed	Male	0	1	1
	Female	1	1	2
Single headed	Male	0	0	0
	Female	2	6	8
Total		3	8	11

Table 1d: Households absent during monitoring of net usage.

		Received nets	Received cash	Total
Dual headed	Male	1	0	1
	Female	0	0	0
Single headed	Male	0	0	0
	Female	0	0	0
Total		1	0	1

Table 1e: Final sample by actual treatment, headship and gender.

		Received nets	Received cash	Total
Dual headed	Male	24	24	49
	Female	27	23	50
Single headed	Male	1	2	3
	Female	18	12	30
Total		70	61	131

Table 2: Means of household and respondent characteristics, by treatment, gender and headship

	Treatment		Respondent gender and headship		
	Received nets	Received cash	Male	Female married	Female single
	(1)	(2)	(3)	(4)	(5)
Free nets treatment	1.00	0.00	0.48	0.55	0.60
	(0.00)	(0.00)	(0.07)	(0.07)	(0.09)
Female participant	0.64	0.57	0.00***	1.00	1.00*
	(0.06)	(0.06)	(0.00)	(0.00)	(0.00)
Single headed household	0.27	0.23	0.06*	0.00*	1.00
	(0.05)	(0.05)	(0.03)	(0.00)	(0.00)
Expenditures per capita (USD/week)	4.85	4.88	4.82	4.81	5.04
	(0.36)	(0.36)	(0.38)	(0.48)	(0.40)
Share of household income under respondent's control	0.40	0.36	0.39***	0.26	0.58***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.05)
Age of household head	38.64	41.41	37.94	35.51	51.17***
	(1.64)	(2.04)	(2.00)	(1.48)	(3.12)
Years education of male or single female head	3.73	4.23	5.04	4.73	0.87***
	(0.44)	(0.48)	(0.48)	(0.56)	(0.27)
Years education of spouse	2.81	2.87	2.97	2.71	.
	(0.48)	(0.46)	(0.43)	(0.50)	(.)
Proportion of household children 5 years or younger who "suffer from malaria every year"	0.81	0.86	0.87	0.78	0.87
	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)
Proportion of household members aged 15-59 who "suffer from malaria every year"	0.89	0.94	0.92	0.88	0.94
	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)
HH average expenditure on last malaria episode of child 5 or younger (USD)	9.75	6.62	8.22	9.17	7.00
	(1.54)	(1.44)	(1.27)	(2.06)	(2.32)
HH average expenditure on last malaria episode of member ≥ 6 years (USD)	17.07	15.71	18.12	14.33	17.23
	(2.26)	(2.07)	(2.43)	(1.93)	(4.34)
# of members aged 0-5 yrs	2.20	1.95	2.26	2.18	1.60***
	(0.13)	(0.10)	(0.16)	(0.12)	(0.15)
# of members aged 0-5 yrs who are not children of the participant	0.19	0.18	0.10	0.02	0.60***
	(0.07)	(0.06)	(0.06)	(0.02)	(0.15)
# of members aged 6-14 yrs	1.70	1.74	1.70	1.76	1.67
	(0.17)	(0.18)	(0.19)	(0.22)	(0.23)
# of members aged 15-59 yrs	2.11	2.13	2.44	2.27	1.33***
	(0.12)	(0.16)	(0.17)	(0.11)	(0.20)
# of members aged 60+ yrs	0.10	0.21	0.12	0.08	0.33***
	(0.04)	(0.06)	(0.05)	(0.05)	(0.09)
Household size	6.11	6.00	6.50	6.29	4.93***
	(0.26)	(0.26)	(0.29)	(0.31)	(0.32)

Standard errors are in parentheses. Tests of equality are between treatments (significance shown in column 1), between married men and women (significance shown in column 3, and between dual-headed and single-headed households (significance shown in column 5) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3a: Number of participants, nets, and randomly drawn price, free net sessions.

Chronological session number	2	4	5	8	9	11	13	Mean
Number of nets or equivalent cash transfer	1	3	2	3	2	3	3	2.42
Number of participants in final sample	3	9	13	9	11	13	12	10
Randomly drawn price	2.72	5.46	1.09	6.54	4.35	4.90	5.44	4.35

Table 3b: Number of participants, nets, and randomly drawn price, cash transfer sessions.

Chronological session number	1	3	6	7	10	12	14	Mean
Number of nets or equivalent cash transfer	1	2	3	3	3	3	3	2.57
Number of participants in final sample	3	10	7	8	12	10	11	8.71
Randomly drawn price	3.81	5.99	5.99	5.45	3.81	6.54	7.08	5.58

Table 4: Bids, net purchases or retention, and usage by treatment

	Received nets	Received cash
Average buying bid or selling offer (up to 3 nets)	$7.16	$5.94***
Proportion keeping or buying at least one net	0.986	0.853***
Nets obtained per capita	0.415	0.334***
Nets per capita, conditional on acquiring at least one net	0.421	0.398
Number of unused nets	0.188	0.135
Proportion with at least one net unused	0.101	0.135

* Difference in means is significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Proportion using net, by age and gender category.

	Whole sample*			Obtained at least one net		
	Pooled sample	Received cash	Received nets	Pooled sample	Received cash	Received nets
Age 0-5	0.690	0.562	0.793	0.757	0.687	0.804
Age 6-14	0.637	0.590	0.678	0.670	0.660	0.678
Female 15-45	0.854	0.791	0.909	0.918	0.914	0.921
Other adults	0.835	0.797	0.870	0.888	0.895	0.882
Age 60+	0.889	0.818	1.000	0.941	0.900	1.000
Total	0.728	0.654	0.792	0.780	0.755	0.799

*Assumes no change from baseline net usage in households that did not acquire any nets through the experiment.

Table 6a: Proportion of household children aged five years and younger using a net, by treatment, participant gender, and household headship. Assumes no change from baseline net usage in households that did not acquire any nets through the experiment.

	All households	Female participants	Dual-headed households with female participants	Single female-headed households	Male participants		
	(1)	(2)	(3)	(4)	(5)	(3) – (4)	(3) – (5)
Pooled	0.703	0.728	0.767	0.661	0.665	0.106	0.115
						(0.094)	(0.079)
ITN transfer	0.799	0.817	0.849	0.769	0.764	0.080	0.115
						(0.101)	(0.093)
Cash transfer	0.594	0.610	0.667	0.500	0.574	0.167	0.093
						(0.169)	(0.128)
Difference	0.205***	0.208**	0.182*	0.269	0.190		
(se)	(0.070)	(0.090)	(0.105)	(0.165)	(0.115)		

* Difference in means significant at 10%; ** significant at 5%; *** significant at 1%

Table 6b: Proportion of household children aged five years and younger using a net, by treatment, respondent gender, and household headship, conditional on acquiring at least one net through the experiment.

	All households	Female participants	Dual-headed households with female participants	Single female-headed households	Male participants		
	(1)	(2)	(3)	(4)	(5)	(3) – (4)	(3) – (5)
Pooled	0.762	0.756	0.782	0.708	0.773	0.074	0.009
						(0.093)	(0.074)
ITN transfer	0.811	0.817	0.849	0.769	0.797	0.080	0.052
						(0.101)	(0.087)
Cash transfer	0.697	0.667	0.697	0.600	0.746	0.097	-0.049
						(0.175)	(0.123)
Difference	0.114*	0.151*	0.152	0.169	0.051		
(se)	(0.068)	(0.089)	(0.104)	(0.171)	(0.103)		

* Difference in means significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Proportion of children 5 years or younger using nets. Assumes no change from baseline usage in households that did not acquire any nets through the experiment.

Model	Linear probability model			Linear probability model, instrumenting for the number of nets acquired (LIML)					
Dependent variable	Proportion of 0-5 year olds using nets			Number of nets acquired (first stage)			Proportion of 0-5 year olds using nets		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Received nets in kind	0.118*		0.064	0.220		0.573	0.191**		0.184
	(0.070)		(0.107)	(0.519)		(0.624)	(0.086)		(0.112)
Married woman		0.100	0.046		0.141	0.308		0.101	0.116
		(0.070)	(0.099)		(0.151)	(0.245)		(0.070)	(0.108)
Single woman		-0.056	-0.117		-0.037	0.131		-0.056	-0.076
		(0.100)	(0.128)		(0.193)	(0.275)		(0.101)	(0.105)
Received nets * female			0.088			-0.311			-0.046
			(0.134)			(0.283)			(0.139)
Number of children 5 and younger	-0.018	-0.011	-0.026	-0.207***	-0.214***	-0.205***	-0.051	-0.016	-0.047
	(0.036)	(0.038)	(0.038)	(0.075)	(0.074)	(0.073)	(0.046)	(0.039)	(0.044)
Household size	0.011	0.021	0.007	-0.079	-0.073	-0.065	0.034	0.026	0.032
	(0.058)	(0.060)	(0.060)	(0.105)	(0.097)	(0.103)	(0.067)	(0.063)	(0.067)
Number of sleeping places	-0.049	-0.076	-0.047	0.271*	0.249*	0.236*	-0.019	-0.073	-0.041
	(0.094)	(0.098)	(0.097)	(0.147)	(0.132)	(0.142)	(0.108)	(0.098)	(0.100)
People per sleeping place	-0.092	-0.190	-0.122	0.302	0.222	0.199	-0.094	-0.195	-0.157
	(0.198)	(0.211)	(0.208)	(0.349)	(0.317)	(0.338)	(0.220)	(0.216)	(0.222)
Number of nets acquired	0.209***	0.228***	0.211***				0.039	0.201*	0.093
	(0.039)	(0.036)	(0.039)				(0.117)	(0.102)	(0.139)
Number of nets available				0.737***	0.732***	0.810***			
				(0.200)	(0.160)	(0.217)			
Number of nets available * received nets in kind				0.089	0.168***	0.022			
				(0.203)	(0.053)	(0.209)			
Constant	0.498	0.687*	0.584	-0.570	-0.393	-0.670	0.653	0.723*	0.710
	(0.365)	(0.396)	(0.389)	(0.852)	(0.607)	(0.864)	(0.412)	(0.431)	(0.445)
Observations	131	131	131	131	131	131	131	131	131
R-squared	0.2409	0.2438	0.2643	0.4135	0.4193	0.4267	0.1409	0.2411	0.2166
F-stat on excluded instruments				17.81	18.87	14.69			

Huber-White heteroskedasticity-consistent standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Proportion of household members using nets. Assumes no change from baseline usage in households that did not acquire any nets through the experiment.

Model	Linear probability model			Linear probability model, instrumenting for the number of nets acquired		
	(1)	(2)	(3)	(4)	(5)	(6)
Received nets in kind	0.036		-0.004	0.114*		0.104
	(0.042)		(0.073)	(0.062)		(0.072)
Married woman		0.105**	0.071		0.108**	0.116
		(0.047)	(0.056)		(0.049)	(0.072)
Single woman		-0.032	-0.069		-0.030	-0.041
		(0.059)	(0.067)		(0.064)	(0.071)
Received nets * female			0.062			-0.025
			(0.087)			(0.088)
Number of children 5 and younger	0.012	0.012	0.007	-0.024	-0.001	-0.020
	(0.023)	(0.023)	(0.024)	(0.029)	(0.024)	(0.028)
Household size	0.023	0.029	0.022	0.047	0.042	0.047
	(0.048)	(0.050)	(0.051)	(0.056)	(0.053)	(0.056)
Number of sleeping places	-0.140*	-0.154*	-0.141*	-0.108	-0.145*	-0.126
	(0.078)	(0.080)	(0.082)	(0.091)	(0.084)	(0.091)
People per sleeping place	-0.215	-0.274	-0.245	-0.216	-0.289	-0.269
	(0.166)	(0.174)	(0.178)	(0.195)	(0.184)	(0.196)
Number of nets acquired	0.252***	0.256***	0.253***	0.070	0.180***	0.110
	(0.027)	(0.026)	(0.025)	(0.088)	(0.062)	(0.085)
Constant	0.889***	0.982***	0.947***	0.114*		0.104
	(0.283)	(0.298)	(0.303)	(0.062)		(0.072)
Observations	131	131	131		0.108**	0.116
R-squared	0.4554	0.4845	0.4892		(0.049)	(0.072)

Huber-White heteroskedasticity-consistent standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Probit model of individual net use (=1 if individual was sleeping under net at time of follow-up visit; 0 otherwise), instrumenting for the number of nets acquired, by treatment; standard errors clustered by household; estimated coefficients shown. Assumes no change from baseline net usage in households that did not acquire any nets through the experiment.

Treatment	Pooled		Received Cash		Received Nets	
	Number of nets acquired	Individual uses net	Number of nets acquired	Individual uses net	Number of nets acquired	Individual uses net
	(1)	(2)	(3)	(4)	(5)	(6)
Individual-level variables						
Share of household income	-0.141	0.666*	-0.274*	1.074**	0.020	0.156
	(0.099)	(0.398)	(0.151)	(0.439)	(0.123)	(0.632)
Individual is net recipient	-0.054*	0.274	-0.102	0.581**	-0.016	0.074
	(0.031)	(0.169)	(0.069)	(0.244)	(0.019)	(0.157)
"Gets malaria each year"	-0.225**	0.239	-0.235	0.670***	-0.192**	-0.123
	(0.088)	(0.157)	(0.173)	(0.242)	(0.081)	(0.215)
Age	0.003	0.024***	0.003	0.020**	0.001	0.035***
	(0.002)	(0.008)	(0.003)	(0.009)	(0.002)	(0.011)
Child of respondent ≤ 5 years	-0.106*	0.463***	-0.224**	0.399	0.003	0.617***
	(0.064)	(0.154)	(0.088)	(0.254)	(0.089)	(0.198)
Household-level controls						
Household size	-0.098	0.199	-0.412*	0.372*	0.118	0.142
	(0.126)	(0.141)	(0.229)	(0.203)	(0.139)	(0.214)
Number of sleeping places	0.199	-0.487**	0.641**	-0.739**	-0.110	-0.324
	(0.176)	(0.219)	(0.298)	(0.368)	(0.210)	(0.304)
Members per sleeping place	0.084	-0.893*	0.912	-1.280**	-0.523	-0.598
	(0.435)	(0.465)	(0.653)	(0.632)	(0.606)	(0.764)
Number of nets acquired		0.521*		0.905**		-0.165
		(0.267)		(0.399)		(0.370)
Number of nets available	0.775***		0.994***		0.792***	
	(0.150)		(0.305)		(0.129)	
Number of nets available * received nets in kind	0.154***					
	(0.054)					
Constant	-0.083	0.855	-1.734	0.114	1.067	2.034
	(0.804)	(0.921)	(1.388)	(1.184)	(1.004)	(1.449)
F-stat of nets offered	19.61		10.48		36.78	
Number of observations	755		350		405	
Number of households	128		60		68	
Prob > Chi2	0.0000		0.0000		0.0028	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Probit model of net individual net use (=1 if individual was sleeping under net at time of follow-up visit; 0 otherwise), by treatment and gender with standard errors clustered by household; marginal effects shown. Sample includes only households that acquired at least one net through the experiment.

	All households			Households with female participant			Households with male participant		
Treatment	Pooled	Received Cash	Received Nets	Pooled	Received Cash	Received Nets	Pooled	Received Cash	Received Nets
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Individual-level variables									
Share of household income	0.162	0.223	0.089	0.104	0.143	0.006	0.266	0.732**	0.233
	(0.134)	(0.197)	(0.168)	(0.154)	(0.221)	(0.193)	(0.225)	(0.363)	(0.321)
Individual is net recipient[1]	0.088**	0.159**	0.036	0.099*	0.165**	0.053	0.035		-0.007
	(0.045)	(0.063)	(0.043)	(0.052)	(0.082)	(0.048)	(0.070)		(0.087)
"Gets malaria each year"	0.094*	0.272***	-0.016	0.077	0.373***	-0.078	0.151*	0.116	0.147
	(0.053)	(0.080)	(0.057)	(0.062)	(0.104)	(0.055)	(0.088)	(0.143)	(0.103)
Age	0.007**	0.006	0.009***	0.005*	0.005	0.008**	0.011**	0.009	0.013
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.005)	(0.006)	(0.008)
Child of respondent ≤ 5 years	0.117***	0.081*	0.151***	0.109**	0.069	0.133**	0.154***	0.129	0.209***
	(0.034)	(0.048)	(0.046)	(0.045)	(0.070)	(0.055)	(0.053)	(0.090)	(0.077)
Household-level controls									
Number of nets acquired per member	0.598***	0.640***	0.488**	0.626***	0.455	0.600**	0.568*	1.015**	0.174
	(0.171)	(0.244)	(0.243)	(0.204)	(0.328)	(0.241)	(0.306)	(0.470)	(0.580)
Observations	702	301	401	440	177	263	262	105	138
Households	118	51	67	77	32	45	41	19	22
Pseudo R-squared	0.132	0.192	0.116	0.131	0.203	0.145	0.154	0.150	0.129

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1.

[1] Perfectly predicts net usage for households in which a male participant received cash and purchased at least one net.

Table 11: Probit model of individual net use (=1 if individual was sleeping under net at time of follow-up visit; 0 otherwise), instrumenting for the number of nets acquired, by treatment, with standard errors clustered by household; estimated coefficients shown. Assumes no change from baseline net usage in households that did not acquire any nets through the experiment.

	Female participant				Male participant			
	Received Cash		Received Nets		Received Cash		Received Nets	
	Number of nets acquired	Individual uses net	Number of nets acquired	Individual uses net	Number of nets acquired	Individual uses net	Number of nets acquired	Individual uses net
Individual-level variables								
Share of household income	-0.168	1.079	0.003	0.133	-0.551*	0.965	0.005	0.206
	(0.158)	(0.671)	(0.179)	(0.758)	(0.334)	(0.687)	(0.148)	(1.079)
Individual is net recipient	-0.029	0.884**	-0.006	0.199	-0.354**	0.158	-0.017	-0.064
	(0.060)	(0.348)	(0.028)	(0.233)	(0.149)	(0.300)	(0.036)	(0.178)
"Gets malaria each year"	0.052	0.998***	-0.254**	-0.372	-0.576**	0.287	-0.164	0.464
	(0.195)	(0.304)	(0.123)	(0.300)	(0.242)	(0.453)	(0.137)	(0.306)
Age	0.001	0.022	0.001	0.033***	0.013*	0.026**	-0.000	0.044**
	(0.003)	(0.016)	(0.002)	(0.010)	(0.007)	(0.012)	(0.004)	(0.022)
Child of respondent ≤ 5 years	-0.185	0.628*	-0.029	0.637**	-0.208	0.277	0.008	0.618***
	(0.117)	(0.333)	(0.104)	(0.263)	(0.136)	(0.353)	(0.071)	(0.225)
Household-level controls								
Household size	-0.157	0.532**	0.104	-0.113	-0.904	-0.055	0.140	0.298
	(0.160)	(0.260)	(0.298)	(0.373)	(0.700)	(0.470)	(0.105)	(0.219)
Number of sleeping places	0.307	-0.890**	-0.111	0.029	1.306	-0.182	-0.116	-0.637
	(0.227)	(0.411)	(0.412)	(0.497)	(0.926)	(0.765)	(0.182)	(0.408)
Members per sleeping place	0.452	-1.662**	-0.581	0.214	2.200	0.122	-0.421	-1.120
	(0.451)	(0.714)	(1.141)	(1.329)	(2.132)	(1.459)	(0.514)	(0.967)
Number of nets acquired		0.976**		-0.028		0.844		-0.035
		(0.407)		(0.443)		(0.687)		(0.732)
Number of nets available	0.893***		0.735***		1.262**		0.930***	
	(0.316)		(0.188)		(0.625)		(0.260)	
Constant	-1.123	-0.017	1.433	0.899	-3.958	-1.418	0.432	2.137
	(1.164)	(1.441)	(1.902)	(2.450)	(3.826)	(2.063)	(0.928)	(2.264)
F-stat of nets offered	7.87		14.68		3.85		12.06	
Prob > Chi2		0.0000		0.0116		0.0021		0.0088
Observations	191		263		159		142	
Households	35		45		25		23	

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Appendix: Experiment Scripts

A1. Compensation Statement

Cash Transfer Treatment: The money you have been given is compensation for your participation in this study. You may use this for whatever you wish. Later today you will have an opportunity to exchange this cash for mosquito nets, but you are in no way obligated to do so.

Free Nets Treatment: The nets you have been given is compensation for your participation in this study. You may use these for whatever you wish. Later today you will have an opportunity to exchange these nets for cash, but you are in no way obligated to do so.

A2. Malaria Statement

Malaria is a serious, sometimes fatal disease that is spread through the bites of certain mosquitoes. The symptoms of malaria are fever, headache, weakness, vomiting, and loss of appetite. Children may also suffer convulsions, and adults may feel pains in their joints, dizziness and backache.

Malaria is more likely to be serious for young children and pregnant women. In Uganda malaria is the number one killer of children under 5 years, and is responsible for 6 of every 10 miscarriages. Grown men and women who are not pregnant may also become sick with malaria and may die, but they are less likely to die of malaria than young children and pregnant women. Severe malaria can also cause mental retardation, blindness, and deafness in children.

The mosquitoes that carry malaria usually bite late at night, so an effective way of avoiding malaria is to sleep under a mosquito net. Mosquito nets are especially effective for preventing malaria in young children, since children tend to stay in bed during the night when mosquitoes are biting.

Mosquito nets are more effective when they are treated with a chemical that kills mosquitoes but is safe for humans. Mosquitoes die when they land on such treated nets, so if there is a hole in the net, or an opening between the bed and the net in the net they are unlikely to find it. Also, there are fewer mosquitoes in the house to bite people not sleeping under nets or who leave temporarily their nets during the night. Most of the mosquito nets you can buy in the market are not treated with chemicals. You can buy chemicals to treat these nets which are effective for 6 months. Then the nets must be treated again.

Cash Transfer Treatment:

[hold up net and pass it around the room for inspection]

This mosquito net has been treated with special chemicals that are effective for 5 years. You will not need to treat this net again, even after washing it. Also, it is made from stronger threads than the mosquito nets found in the market, and will last much longer without tearing.

Free Nets Treatment:

[Everyone is has been given their own net(s), and are asked to inspect them]

The nets we have given you have been treated with special chemicals that are effective for 5 years. You will not need to treat your nets again, even after washing them. Also, these nets are made from stronger threads than the mosquito nets found in the market, and will last much longer without tearing. Each net is big enough to cover two single beds side by side.

All Treatments:

[demonstrate how the net should be hung over a bed]

A3. Bidding Scripts

Buying Treatment: We are interested in finding out how much you would pay for (this net / two of these nets / three of these nets), and who in your family will use (it / them) if you don't have enough nets for everyone.

We will ask you to tell us the maximum price you are willing to pay for (one net / one and two nets / one, two, and three nets). I will then choose a price randomly. If the price you tell me is higher than the price I choose, you will give me the amount of money I have chosen and I will give you the net. If the price I choose is lower than the maximum you are willing to pay, you will keep all the money I have given you and I will keep the net.

Under this procedure, it is in your best interest to tell me exactly the maximum you are willing to pay; no more and no less. If you tell me a price that is higher than the maximum you actually want to pay, you will be forced to pay this price if I choose it. If the price you tell me is lower than the maximum you would pay, then if I draw a low price you will not be allowed to buy the nets even if you want to.

Free Nets Treatment: We are interested in finding out how much you value the nets we have given you, and who in your family will use it them if you don't have enough for everyone. We will ask you to tell us the minimum price at which you are willing to sell (one net / one and both nets / one, two, and all three nets). I will then choose a price randomly. If the price you tell me is lower than the price I choose, you will give me the net and I will give you amount of money I have chosen. If the price I choose is lower than the maximum you are willing to pay, you will keep all the money I have given you and I will keep the net.

Under this procedure, it is in your best interest to tell me exactly the minimum you are willing to accept; no more and no less. If you tell me a price that is lower than the minimum you would want to sell for, you will be forced to sell at this price if I choose it. If the price you tell me is higher than the minimum you would pay, then if I draw a high price you may not be allowed to sell the nets even if you want to.

First, we will practice this procedure with other items.

Cash Transfer Treatment:

<u>One:</u> I will ask you to tell me the maximum price you are willing to pay for one X. I will then choose a price randomly. If the amount you are willing to pay for an X is higher than the price of one X, you will give me the price and I will give you an X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep the money I have given you and I will keep the X.

<u>Two</u>: I will ask you to tell me the maximum price you are willing to pay for one and two X. I will then choose a price randomly. If the amount you are willing to pay for two X is higher than the price of two X, you will give me the price of two X and I will give you two X. If the amount you are willing to pay for two X is lower than the price of two X, but higher than the price of one X, you will give me the price of one X and I will give you one X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep all your money and I will keep the X.

<u>Three:</u> I will ask you to tell me the maximum price you are willing to pay for one, two, and three X. I will then choose a price randomly. If the amount you are willing to pay for three X is higher than the price of three X, you will give me the price of three X and I will give you three X. If the amount you

are willing to pay for three X is lower than the price of three X, but higher than the price for two X, you will give me the price of two X and I will give you two X. If the amount you are willing to pay for two X is lower than the price of two X, but higher than the price of one X, you will give me the price of one X and I will give you one X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep all your money and I will keep the X.

Free Nets Treatment

<u>One:</u> I will ask you to tell me the minimum price at which you are willing to sell the X I have given you. I will then choose a price randomly. If the value at which you are willing to sell the X is lower than the price of one X, I will give you the price and you will give me your X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep the money I have given you and I will keep the X.

<u>Two:</u> I will ask you to tell me the minimum price at which you would be willing to pay for one and two X. I will then choose a price randomly. If the amount you are willing to pay for two X is higher than the price of two X, you will give me the price of two X and I will give you two X. If the amount you are willing to pay for two X is lower than the price of two X, but higher than the price of one X, you will give me the price of one X and I will give you one X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep all your money and I will keep the X.

<u>Three:</u> I will ask you to tell me the maximum price you are willing to pay for one, two, and three X. I will then choose a price randomly. If the amount you are willing to pay for three X is higher than the price of three X, you will give me the price of three X and I will give you three X. If the amount you are willing to pay for three X is lower than the price of three X, but higher than the price for two X,

you will give me the price of two X and I will give you two X. If the amount you are willing to pay for two X is lower than the price of two X, but higher than the price of one X, you will give me the price of one X and I will give you one X. If the amount you are willing to pay for one X is lower than the price of one X, you will keep all your money and I will keep the X.