

Intra-household allocation of free and purchased mosquito nets

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For some health goods, intra-household allocation may be more important in determining outcomes than household-level consumption. An example is the use of mosquito nets to prevent malaria. Malaria kills over one million people annually, 90 percent of them children under the age of five. The use of insecticide treated mosquito nets (ITNs) is considered the most cost-effective available strategy for control of the disease. 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.

Adults in malarious regions have typically acquired some immunity to the disease through repeated exposure over the course of their lives. The risk of severe malaria resulting in lifelong disability or death is highest for young children and pregnant women across transmission environments (Robert W. Snow et al., 2003). On the other hand, lost labor time often accounts for the largest portion of the private cost of the disease. This implies a tradeoff between minimizing the income lost to malaria and minimizing the risk that a household member dies or is permanently disabled. Despite public health messages emphasizing the importance of using mosquito nets to protect young children from malaria, nets are often used by adults when a household does not have enough nets to cover all members (Eline L. Korenromp et al., 2003; Frederick Mugisha and Jacqueline Arinaitwe, 2003). Determining the welfare-maximizing allocation of nets is beyond the scope of this paper. Rather, I take as given the

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stated public health priority of covering young children and compare the effects of two net distribution policies on this outcome.

It is often argued that charging a positive price for health goods leads to higher usage rates, whether due to the screening effect of prices, their perceived informational content, or a sunk cost effect. Recent work in Zambia has shown that people who were willing to pay more did in fact use a water purification system more consistently than those with lower willingness to pay (Nava Ashraf, James N. Berry, and Jesse M. Shapiro, 2007), but no such effect was found in a separate study that randomized the prices charged for mosquito nets by health clinics in Kenya (Jessica Cohen and Pascaline Dupas, 2007). The present research addresses the question of whether mode of delivery affects how a health good is used, in particular its allocation among household members.

How nets are distributed may influence intra-household allocation for three reasons. First, distributing nets for free generally leads to a higher number of nets owned per capita than offering nets for sale. Free distribution both overcomes liquidity constraints and creates an endowment effect whereby individuals who would not have purchased nets even absent liquidity constraints retain nets received for free (Vivian Hoffmann, Christopher B. Barrett, and David R. Just, forthcoming). The characteristics of the marginal net user may vary with the number of nets owned by the household.

Second, the population acquiring nets may depend on the distribution mechanism. People buying nets may be those with high valuation of net usage themselves. Those receiving nets for free may value them less for their own use, and instead use them for children in accordance with public health messages.

Finally, one's perception of appropriate usage may differ according to how a net is acquired. Both free distribution and net marketing campaigns typically emphasize the importance of child usage. These messages may be taken more seriously when nets are distributed for free rather than sold. A woman purchasing a net in the market with cash she has earned may see the usage of that net as her decision, whereas the same woman receiving the net for free at an ante-natal checkup would perceive an obligation to use the net to protect her new-born child.

## **I. Experimental design**

The experiment was conducted in rural southwestern Uganda. At the time data were collected there had been no large-scale distribution of free or subsidized ITNs in the country. Conventional nets were occasionally available at a nearby weekly market, and nets bundled with insecticide treatment kits were available in the nearest urban center. The long-lasting insecticide-treated nets (LL-ITNs) offered through the experiment were not commercially available in Uganda. Consumption value per capita among sample households was US \$0.65 per day. 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.

The following description of the experimental design is limited by space constraints. For a more detailed discussion, see Hoffmann (2008). Households which included a pregnant woman or any children aged up to five years were eligible to participate in the study. In total, 143 households were selected, however households that did not include any children five years or younger are excluded from the present analysis, leaving a sample of 131 households.

Approximately half of the households were randomly assigned to a cash transfer treatment, and the remainder to a free nets treatment. Randomization on observables was successful, with none of the household characteristics reported in Table 1 differing at the 10-percent level of significance. The male or female head of each household was randomly selected to participate in a bidding session in which cash could be traded for nets or vice versa. Bidding sessions were held separately for the two treatments, with seven sessions for each. At the beginning of the session, households in the free nets treatment were given a transfer of one, two, or three 190 by 180 centimeter mosquito nets, depending on household size and number of sleeping places. The intention was to provide sufficient nets to cover all members. Those in the cash treatment received a transfer equal to the maximum possible price of the corresponding number of nets. Participants in both treatments were told that what they had been given was compensation for their participation in the study, which they were free to keep or exchange. All participants were read the same statement about malaria, which included information about the particular vulnerability of pregnant women and young children to the disease.

**Table 1.** Means of household characteristics by treatment

	Received nets	Received cash
	(1)	(2)
Expenditures per capita (USD/week)	4.85 (0.36)	4.88 (0.36)
Years education of male or single female head	3.73 (0.44)	4.23 (0.48)
Years education of spouse	2.81 (0.48)	2.87 (0.46)
Proportion of household children 5 years or younger who “suffer from malaria every year”	0.81 (0.04)	0.86 (0.04)
Proportion of household members aged 15-59	0.89	0.94

who “suffer from malaria every year”	(0.03)	(0.02)
Number of members aged 0-5 years	2.20 (0.13)	1.95 (0.10)
Household size	6.11 (0.26)	6.00 (0.26)

Standard errors are in parentheses. Equality of means between treatment groups is tested using a t-test or a test of proportions for binary variables \* significant at 10-percent level; \*\* significant at 5-percent level; \*\*\* significant at 1-percent level

Participants then had the opportunity to exchange nets for cash or cash for nets using the Becker-deGroot-Marschak mechanism (Gordon Becker, Morris DeGroot, and Jacob Marschak, 1964). The basic procedure worked as follows. Those in the cash treatment stated the maximum they would be willing to pay for ITNs, and those in the free nets treatment stated the minimum price they would be willing to accept for the ITNs they were holding. The ITN price was then randomly drawn from a known distribution. Participants in the cash treatment who bid at or above the randomly drawn price purchased nets at the drawn price and kept the remainder of their cash transfer. Those who bid below the price did not purchase the nets, keeping instead the entire cash transfer. The procedure for the free nets group was analogous. It was in the best interest of participants to bid according to their actual valuation of ITNs. Those who bid less than their true value risked failing to buy nets when the price was low enough that they would in fact prefer to do so. Conversely, bidding above one’s true value risked buying when the price was higher than one would actually be willing to pay.

Before consenting to participate, participants were told that if they purchased or retained any nets, survey staff or community volunteers would visit them at night to see whether nets were being used. They were not informed of the date on which this the visit would occur. Home visits by community members 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 visit. During these visits, the net usage of each household member was recorded.

## II. Experimental Results

### A. Net purchase and retention

Consistent with the endowment effect, those in the free nets treatment entered bids higher by \$1.20 on average than those in the cash transfer treatment, resulting in a higher number of nets per capita owned in the free nets group (Table 2). 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—and not statistically significantly different—across treatments, at 0.42 and 0.40 among households receiving nets and cash respectively.

**Table 2:** Average bid and nets obtained, by treatment

	Received nets	Received cash
Average buying bid or selling offer (up to 3 nets)	\$7.22	\$6.02***
Proportion keeping or buying at least one net	0.99	0.85***
Nets obtained per capita	0.42	0.34**
Nets obtained per capita, conditional on acquiring at least one net	0.42	0.40

\* Difference in means is significant at 10 percent; \*\* significant at 5-percent level; \*\*\* significant at 1-percent level

### B. Individual usage

Across age and gender categories, the elderly, women of child-bearing age, and other adults were the most frequent users of nets (column 1, Table 3). Children five years and younger were next, with those aged six to 14 the least likely to be using a net. Overall coverage was higher, though not statistically significantly, within the group receiving nets for free. Since both groups received a transfer of equivalent value, this difference in coverage can be attributed to the endowment effect.

Among the group purchasing nets with cash, children under five years of age were the least likely to be using a net (column 2). Previously published results using these data (Hoffmann, Barrett and Just, 2008) indicate that participants with more young children were willing to pay less for nets, but were no more likely to sell them. This suggests that part of the difference in child coverage is due to the selection of different populations into net ownership under purchase versus free receipt.

Children five years of age and younger were particularly advantaged when nets were received for free. The difference between children’s usage in the free vs. purchased nets group is significant at the one percent level when all households are included, and remains significant at the ten percent level when considering only those households who obtained at least one net.<sup>1</sup> Pregnant women were also more likely to use nets when nets are received for free, however this effect is significant only at the ten percent level and only when all households are included. The only group with lower usage rates when nets were given free were men in the net-owning sub-sample aged 15 to 59.

**Table 3.** Proportion using net, by treatment, age and gender category

	Whole sample <sup>a</sup>			Obtained at least one net		
	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled sample	Received cash	Received nets	Pooled sample	Received cash	Received nets
Age 0-5	0.69	0.56	0.79***	0.76	0.69	0.80*
Age 6-14	0.64	0.59	0.68	0.67	0.66	0.68
Female 15-45	0.85	0.79	0.91*	0.92	0.91	0.92
Other adults	0.84	0.80	0.87	0.89	0.90	0.88
Age 60+	0.89	0.82	1.00	0.94	0.90	1.00
Total	0.73	0.65	0.79	0.78	0.76	0.80

<sup>1</sup> In order to account for correlation of the errors within the households, I test differences in means using a probit model in which the dependent variable is equal to one if the person is using a net and zero otherwise, with a treatment dummy as the only independent variable and standard errors clustered at the household level.



<sup>a</sup> Assumes no change from baseline net usage in households that did not acquire any nets through the experiment.

\* Difference in means is significant at 10 percent; \*\* significant at 5-percent level; \*\*\* significant at 1-percent level. Differences in means are tested using a probit model of net usage within each subgroup with a treatment dummy as the only independent variable and standard errors clustered at the household level

To explore other determinants of net usage, I a binary variable indicating net usage on individual characteristics and interactions of these with a treatment indicator (Table 4). 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.

Since most households consist of a nuclear family in which a single guardian or couple cares for one or more children, it is difficult to disentangle the effects of income, headship, and net receipt on usage. I therefore control for these characteristics jointly with an indicator variable that is equal to one if the individual shares a sleeping place with the experimental participant. In all but four cases, the one who had received or purchased nets was later found to be using a net (in two of these households the nets were not being used by anyone). This is consistent with the findings of Cohen and Dupas (2007), who monitored the usage of nets by women and newborns, most of whom share a sleeping place. In this more diverse sample, however, only 43 percent of net recipients shared a sleeping place with a child aged five or younger.

Whether the individual “usually gets malaria every year” according to the respondent in a pre-experiment baseline interview is a strong predictor of usage when nets are purchased. The interaction of this variable with the free net treatment indicator is of the same magnitude with the opposite sign, suggesting that those who received nets for free did not allocate them on the basis of perceived

frequency of malaria. Rather, whether an individual was aged five years or younger determined usage when nets were received for free. A caveat to these results is that knowledge of future monitoring may have affected usage differentially across treatments.

**Table 4.** Determinants of individual net use

<i>Individual attributes</i>	
shares bed with participant	0.178*** (0.043)
child of participant $\leq 5$ years old	-0.096** (0.043)
usually gets malaria each year	-0.223** (0.105)
<i>Interactions</i>	
free * shares bed with participant	0.094 (0.082)
free * child of participant $\leq 5$ years old	0.118** (0.055)
free * usually gets malaria each year	-0.223** (0.105)
<i>Household controls</i>	
participant received nets free	0.275** (0.111)
Number of observations	771
probability > Chi-squared	0.000
Number of households	131

Marginal effects reported. Standard errors, clustered by household, in parentheses; \* significant at 10-percent level; \*\* significant at 5-percent level; \*\*\* significant at 1-percent level.

Notably, adults are perceived as suffering from malaria more frequently than young children. Taking averages at the household level, 91 percent of adults were believed to suffered from malaria each year. The proportion of children aged five years and younger thought to have malaria at least once a year was only 83 percent. Experimental participants were asked to assess the likelihood that each household member's next bout of malaria would be life-threatening. Again, children five years and younger were assigned significantly lower probabilities on average (35 percent) than older individuals (39 percent). This is despite the fact that subjects had just been told about the higher likelihood of

death from malaria among children, and suggests the difficulty of influencing health beliefs and behaviors through information alone.

### **III. Concluding Remarks**

When caregivers in rural Uganda were given cash and the opportunity to purchase mosquito nets, net usage by young children five years and younger was lower than for any other age group. Free mosquito nets were more likely to be used by children in accordance with information on children's particular vulnerability to malaria than purchased nets. This result appears to be due to the higher number of nets retained under free distribution compared to acquired through purchases, to the acquisition of nets by households with more young children under free distribution, and possibly to a difference in how free versus purchased nets are perceived by household decision-makers.

The finding that the intrahousehold allocation of a good can be affected by the way in which it is 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. Despite being given information on the particular dangers of malaria to young children, the majority of participants in the experiment described here believed young children were *less* vulnerable to malaria than adults.

Whether purchased or received for free, nets were almost universally used by the individual who acquired them. In the majority of cases, this person did not share a sleeping place with any young children. This result lends support to calls for nets to be targeted more broadly than to young children

and pregnant women, since children who sleep separately from adults are likely to remain unprotected unless the household owns multiple nets.

## References

Ashraf, Nava, James N. Berry, and Jesse M. Shapiro. 2007. "Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia." NBER Working Paper W13247

Becker, Gordon, Morris DeGroot, and Jacob Marschak. 1964. "Measuring Utility by a Single-Response Sequential Method." *Behavioral Science* 9: 226-36.

Cohen, Jessica and Pascaline Dupas. 2007. "Free Distribution or Cost-Sharing? Evidence from a Randomized Malaria Prevention Experiment." Brookings Global Economy and Development Working Paper 11.

Hoffmann, Vivian. 2008. "Psychology, Gender, and the Intrahousehold Allocation of Free and Purchased Mosquito Nets." University of Maryland Department of Agricultural and Resource Economics Working Paper 08-15.

Hoffmann, Vivian, Christopher B. Barrett, and David R. Just. Forthcoming. "Do free goods stick to poor households? Experimental evidence on insecticide treated bednets." *World Development*.

Eline L. Korenromp, John Miller, Richard E. Cibulskis, M. Kabir Cham, David Alnwick, and Christopher Dye. 2003 "Monitoring mosquito net coverage for malaria control in Africa: possession vs. use by children under 5 years." *Tropical Medicine and International Health*. 8(8): 693-703.

Mugisha, Frederick. and Jacqueline Arinaitwe. 2003. "Sleeping arrangements and mosquito net use among under-fives: results from the Uganda Demographic and Health Survey." *Malaria Journal* 2:40

Snow, Robert W., Charles R.J.C. Newton, Marlies H. Craig, Richard W. Steketee. 2003. "The public health burden of Plasmodium falciparum malaria in Africa: Deriving the numbers." National Institutes of Health Fogarty International Center Disease Control Priorities Project Working Paper 11.